STRATEGIC AGILITY, MANAGEMENT PRACTICES, AND TRAINING PROGRAMS IN AUTOMOTIVERESEARCH AND EXPERIMENTAL DEVELOPMENT FOR JIANGHUI LABORATORY PERFORMANCE

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ABSTRACT

Automotive research and development (R&D) laboratories, particularly within policy-intensive environments such as China, often face a significant efficiency paradox. Despite substantial financial investment and strong patent outputs, the translation of these investments into successful commercial returns remains weak, a phenomenon described as “high investment, low conversion.” This study investigates how strategic decision-making, management practices, and training programs interact to shape laboratory performance. A qualitative case study was conducted at the Jianghuai Automotive R&D Laboratory, drawing on data from 15 semi-structured interviews with directors, project managers, engineers, and training specialists. Thematic analysis reveals that while agile strategic cycles, integrative management structures, and dual-track training enhance performance, they also generate critical organizational tensions. These include a compliance–agility paradox, where policy mandates conflict with market-responsive innovation, and sustainability challenges in human capital development. By examining these interdependencies, this research offers an integrated framework for balancing dynamic capabilities, human capital, and collaborative structures to optimize innovation outcomes in complex, state-influenced R&D settings.

Keywords: Automotive R&D, Laboratory Performance, Strategic Decision-Making, Management Practices, Training Programs

ABSTRAK

Makmal penyelidikan dan pembangunan automotif (R&D), terutamanya dalam persekitaran yang intensif dasar seperti China, sering menghadapi paradoks kecekapan yang ketara. Walaupun pelaburan kewangan yang besar dan output paten yang kuat, terjemahan pelaburan ini ke dalam pulangan komersial yang berjaya kekal lemah, fenomena yang dijelaskan sebagai "pelaburan tinggi, penukaran rendah". Kajian ini menyiasat bagaimana pengambilan keputusan strategik, amalan pengurusan, dan program latihan berinteraksi untuk membentuk prestasi makmal. Kajian kes kualitatif telah dijalankan di Makmal R&D Automotif Jianghuai, berdasarkan data dari 15 wawancara separuh terstruktur dengan pengarah, pengurus projek, jurutera, dan pakar latihan. Analisis tematik mendedahkan bahawa walaupun kitaran strategik lincah, struktur pengurusan integratif, dan latihan dual-track meningkatkan prestasi, mereka juga menghasilkan ketegangan organisasi kritikal. Ini termasuk paradoks ketahanan pematuhan, di mana mandat dasar bertentangan dengan inovasi responsif pasaran, dan cabaran kemampanan dalam pembangunan modal manusia. Dengan memeriksa saling bergantung ini, penyelidikan ini menawarkan rangka kerja bersepadu untuk mengimbangkan keupayaan dinamik, modal manusia, dan struktur kerjasama untuk mengoptimumkan hasil inovasi dalam tetapan R & D yang kompleks dan dipengaruhi negara.

Kata kunci: R&D Automotif, Prestasi Makmal, Pengambilan Keputusan Strategik, Amalan Pengurusan, Program Latiha

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LIST OF ABBREVIATIONS

ACES Autonomous driving, Connected mobility, Electrification, and Shared services

AI Artificial Intelligence

BYD Build Your Dreams (automobile manufacturer)

CFIH Cross-Functional Innovation Hub

CNIPA China National Intellectual Property Administration

DCT Dynamic ability Theory

Digital RBV Digital Resource-Based View

ESG Environmental, social, and governance

EU European Union

GDPR General Data Protection Regulation

GMP Good Manufacturing Practice (implied in context of standards)

HITECH Health Information Technology for Economic and Clinical Health

IT Information Technology

IP Intellectual property

KPI Key Performance Indicator

OEM Original Equipment Manufacturer

PM Project Management

R&D Research and Experimental Development

TSIP Technical-Strategic Integration Program

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter provides the foundation for the research by defining the context and justifying the research. It starts with an explanation of the macro-environmental changes that the Fourth Industrial Revolution (Industry 4.0) caused. The cyber-physical integration of production systems is one of the distinctive features of Industry 4.0 supported by the technologies of artificial intelligence (AI), the Internet of Things (IoT), big data analytics, and advanced robotics (Kagermann, 2020; Xu et al., 2021). It is a critical transformation in the automotive sector of isolated mechanical engineering to interconnected, software-defined mobility, which can worsen the necessity of innovation in the whole operations of R&D (Zheng et al., 2022).

This chapter proceeds to narrow down to the statement of the problem, the high investment, low conversion paradox, which has affected the automotive R&D laboratories in spite of its massive investment at the global level. To answer this issue, this chapter provides research objectives and formal research questions in the study that focus on the impact of strategic decision-making, management practices, and training programs on the performance of a laboratory. Finally, the chapter forms the scope of the study and the significance of the research with reference to the theoretical and practical implications. The factors furnish the platform on which opportunities for achieving maximum performance of automotive R&D can be explored.

1.2 Background of the Study

The 4th Industrial Revolution has the forces converging to bring rapid change in the global economy and technology, and lead to a paradigm shift. The existing era of extensive digitalization, the urgent demands of sustainability, and the altered geopolitical conditions demand unprecedented degrees of strategic agility of organizations on a global scale (Schwab, 2020). To be competitive, the companies have to radically transform the management practices and human capital development strategies, and no longer be guided by the old models of innovation, which are linear.

One of the most significant contributors to technological advancements, supply chain growth, and the development of society in the world is the automotive industry. It is already undergoing a massive change, which is summarized in the emergence of autonomous, connected, electric, and shared cars ACES (autonomous, connected, electric, and shared) (McKinsey & Company, 2023). This shift has moved the automotive innovation research and development R&D laboratory a great deal. These facilities no longer have the back of the house label as they are a key to innovation, capable of not just creating the basic technology like artificial intelligence and electrochemistry but converting it into a commercial product within no more than 12 months.

However, an issue has been worldwide and debatable in the sector. Even with USD 50 billion annual automotive research and development expenditure, which is enormous (International Energy Agency, 2025), one believes that it remains unnoticed that there are numerous laboratories that cannot materialize this considerable technological potential into a plausible commerce and social arena. Empirical studies reveal that there is a clear-cut line between agile advocates who have pointed out the success of dynamic strategic structures and several institutions that are confined to inflexible patterns during their operations. Indicatively, a study by García et al. (2021) revealed that about 68% of traditional R&D organisations, owing to their inability to be flexible, had a commercialization rate of patents 20% below the norm. This points to a typical high investment and low conversion problem, as well as the paramount importance of strategic decision-making, management practices, and training programs.

The dynamics of this international issue are currently focused on the Chinese market, the world's largest automotive market. With an annual R&D spending rate of 18.5 percent and an ambitious state-led industrial policy, New Energy Vehicle Industry Development Plan (2021-2035), China has an automotive R&D environment that is a policy-based ecosystem. The labs in this area tend to exhibit one of the variations of the global paradox, sometimes called the patent paradox, in which the cost of meeting government-regulated IP (intellectual property) targets may lead to a decline in commercialization rates below global standards (Chen & Li, 2024). This involves making considerable investments in patent acquisition, yet categorizing patents has failed to record the anticipated commercialization rate, and, indeed, it ends up being a liability in other cases.

Jianghuai Laboratory is a good example of such a challenge in the global context, one that can be discussed in the Chinese context. The state-funded R&D center is located in the city of Hefei, an identified science-driven innovation center under the Made in China 2025 program, and its specialisation is in electric vehicle batteries and autonomous driving technologies. As of 2024, it had more than 16222 authorised patents, and 98 additional authorised patents were registered that year (including 65 invention patents) (CNIPA, 2024). However, the parent company, Anhui Jianghuai Automobile Group Corp., Ltd. (2024), registered revenues of USD 6.039 billion in the same year, a 6.25% annual decline.

In the context of the whole world, the direction followed by Jianghuai, as well as its shift to the agile decision-making system, introduction of the dual-track training system, and the attempt to resolve cross-functional obstacles, offers a microcosm of the typical global industry problems.

1.3 Problem Statement

The efficiency of automotive R&D laboratories is a fundamental assumption for how effectively they convert high investments into market innovations and competitive advantages (Müller et al., 2023). Ideal state, the strategic resources must be dynamically deployed to the projects which have the most significant commercial potential, the management practices ought to smoothly combine cross-functional expertise in order to hasten the development cycles, and the respective training ought to constantly prepare the personnel with the required technical expertise, as well as the strategic expertise, to implement (Teece, 2020; Schmidt & Wagner, 2022). This synergy must ensure a high ratio of R&D spending into lucrative intellectual property and viable products.

Nevertheless, practically, especially in policy-intensive innovation systems such as those in China, there is a strong efficiency paradox in laboratories. One example of this difficulty is the Jianghuai Laboratory. Although its parent company, Anhui Jianghuai Automobile Group Corp., Ltd., registered a 6.25% annual drop in its revenue to USD 6.039 billion in 2024 (Anhui Jianghuai Automobile Group Corp., Ltd., 2024), the firm has a substantial intellectual property base, which has 16,222 authorized patents and 98 new patents in 2024 alone (CNIPA, 2024). Such a distance reflects another deep-seated patent paradox as well: the necessity to generate the necessary amount of output quotas in the innovation standards is bound to decrease the degree of commercialization and the market occupation of the created technology (Chen & Li, 2024). On the inside, this strategic dissonance is augmented by management and operational failure. The fragmented workflows and lack of alignment among specialized groups, including software AI and battery engineering, strain project schedules and do not support the integrated system development necessary for modern electric and autonomous vehicles (Chen, 2023). Thus, the laboratory struggles with the tension between complying with top-down policies and, at the same time, maintaining bottom-up agility and a commercial orientation needed in the market.

Although there is existing literature on agile strategy (Muller et al., 2023) and specialized training models (Ibrahim & Johnson, 2023), there remains a significant knowledge gap. Integrated, empirical research on the interaction of strategic decision-making processes, management practices, and training programs in configurative interaction to solve this particular, high-investment, low-conversion dilemma in state-influenced automotive R&D settings, such as that Jianghuai operates in, does not exist. The majority of studies consider such variables separately or in the context of Western and market-oriented conditions, which does not reflect the interdependence and trade-offs that occur under powerful policy guidelines (Liu & Chen, 2023; Zhou & Li, 2022). Thus, the proposed study will fill this gap by analyzing the intertwining role of these three issues in determining the performance of Jianghuai Automotive R&D Laboratory.

1.4 Research Questions

This study investigates the effect that strategic decision making and management practices have on laboratory performance. This study addresses three research questions.

RQ (1): How does strategic decision-making influence project performance outcomes in an automotive R&D laboratory?

RQ (2): How does management practices effect project performance outcomes in an automotive R&D laboratory?

RQ (3): How does training programs impact project performance outcomes in an automotive R&D laboratory?

1.5 Research Objectives

This study is anchored in key gaps that were recognized in the current research and practice, and aims for three connected things:

1. To analyze the influence of strategic decision-making on project performance outcomes in an automotive R&D laboratory.

2. To evaluate the effect of management practices on project performance outcomes in an automotive R&D laboratory.

3. To examine the impact of training programs on project performance outcomes in an automotive R&D laboratory.

1.6 Scope of the Study

This research has narrowed to the automotive R&D industry, examining the dynamics of laboratory performance in this high-tech sector. Geographically and background-wise, the work can only be restricted to Hefei City, Anhui Province, China.

In the research, one case, namely, Jianghuai Laboratory, is considered based on the investigation. The presence of such a clean boundary enables a rich qualitative investigation of inside practices without watering down cross-organizational comparisons. In this case, particular attention of the study is paid to the operational practices and strategic approaches adopted in the laboratory.

The qualitative methods define the scope methodologically, as semi-structured interviews are the primary tool of data collection. Because of time, this research did not employ any quantitative surveys or longitudinal data tracking. The unit of analysis is the lab performance that is dependent on the three core variables under research.

1.7 The research outline

The dissertation has five significant chapters, and this makes it a rational and comprehensive study of research.

Chapter One: Introduction establishes the base of the research by presenting the background, problem statement, research questions, and research objectives. It establishes the scope of the study, important terms, and provides an overview.

Chapter Two: literature review focuses on the current academic knowledge regarding the main variables and their relationships with each other. It develops a conceptual framework, develops the theoretical basis of DC theory and Digital Resource-Based View, and points to the specific research gap that the current study satisfies.

Chapter Three: The research methodology, which describes the qualitative case study methodology presented by the research. It expounds on research design, how the data collection tool, which is the semi-structured interview guide, was developed, and how the empirical evidence will be collected using the Jianghuai Laboratory case.

Chapter Four: Data Analysis and Results. The research results are introduced in this chapter. It examines the data obtained to estimate the impact of strategic decisions, training programs, and management competencies in improving the performance of the lab and finally summarizes the most important findings.

Chapter Five: Discussion and conclusion. The results are discussed and related to the research questions and literature in the discussion and conclusion. It provides the conclusion of the study, its limitations, recommendations on future research, and recommendations on the practical ways of enhancing the output of the Automotive R&D laboratory.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the findings of the study regarding the strategy of decision-making, training plans, management practices, and the performance of the lab in the automotive sector. It reviews later publications as recent as 2019 to 2024 and provides gaps in knowledge about the interaction of these aspects to speed up innovation in Chinese laboratories. The review gives a theoretical basis to both digital Resource-Based View (Ngo, L. V., & O'Cass, A., 2019) and the theory of dynamic capability (Teece, D. J., 2020) that deal with flexibility and resource optimization in the rapid research and experimental development.

2.2 Concept of Laboratory Performance

The performance concept in an automotive R&D lab is an integrative, complex phenomenon, and it is at the very focal point of the organizational strategy in the upper ranks and operational implementation in the lower ranks. It cannot be measured by one metric, but it is a synthesized measure of outcomes in the strategic, operational, and project-specific domains (Muller et al., 2023). The strategic performance of the laboratory is the ability of the laboratory to transform high levels of R&D activity into commercially feasible new technology that can create a sustainable competitive advantage, and this is literally the most significant performance measure. This is consistent with the dilemma that is at the center of the investigation, the high investment, low conversion paradox, in which the monetary resources have to be converted into the business yields efficiently (García et al., 2021; Chen & Li, 2024).

At the same time, the operational aspect of performance is measured by facility efficiency, test accuracy, meeting deadlines, and strict adherence to safety and quality standards (e.g., ISO 26262 on functional safety). At the project-implementation level, the demonstrated high performance is reflected in the delivery of tested technological solutions that can effectively balance commercial goals with external policy requirements and regulatory conditions (Schmidt & Wagner, 2022).

Another elaboration in mainstream scholarly perspectives is made regarding this multidimensionality. One of the most dominant views, grounded in the Dynamic Capabilities View, holds that laboratory performance is an organization’s capacity to sense, capture, and reconfigure resources in response to technological and market changes (Teece, 2020). Performance, in relation to a Resource-Based View (RBV) and its digital counterpart (Digital RBV), is regarded as an outcome of successfully bundling and capitalizing on unique, hard-to-imitate resources, such as advanced human capital acquired through special training programs and integrated digital resources (Ngo & O C, 2023; Warner & Wäger, 2019). Moreover, the Balanced Scorecard model is frequently customized to R&D environments, where the focus is made on a combination of financial, customer, internal process, and growth indicators (Marr, 2020).

The current direction of research indicates a shift in how laboratory performance is defined and measured, especially in policy-driven, rapidly digitizing industries such as China’s automotive sector.

It involves an increasing tendency to focus on Beyond Patent Counts beyond the quantitative quotas of patents as the only metric, to measures reflecting the rate of commercialization and economic influence of intellectual property, in response to the identified patent paradox (Chen & Li, 2024; Li & Zhang, 2022).

Agile and Innovation Metrics, which include indicators of strategic agility, such as time-to-market of prototypes, the success rate of iteration development sprints, and the frequency of dynamic resource adjustment to disruptions (Müller et al., 2023; Liu & Wang, 2024).

Integration and Collaboration Measures, which evaluate the performance in terms of the cross-functional synergy, such as the ratio of co-authored interdisciplinary patents, the number of project delays due to siloed workflows, and the performance of the structure, such as innovation hubs (Schmidt & Wagner, 2022; Zhang et al., 2021).

Performance that relates to environmental, social, and governance (ESG) objectives and proactive compliance with the current international regulations (e.g., EU AI Act, data security laws) is becoming increasingly important to Sustainability and Compliance Readiness as a form of risk reduction and a competitive advantage (Furr, 2023; Li et al., 2024).

In summary, to execute a project, high performance would be based on the provision of proven technological solutions that effectively balance between commercial objectives and external policy requirements.

2.3 Strategic Decision-making

Strategic decision-making enables an automotive R&D laboratory to quickly sense and respond to external changes, including market and technological disruptions, regulatory shifts, and so on, and then realign its resources and priorities (Teece, 2020). Mechanisms supported in this study include iterative planning cycles, dynamic resource allocation, and AI-powered market-sensing tools to attain this variable. Indicatively, a nimble lab could shift a significant portion of its budget to Li-ion-to-Na-ion battery research in the event of a supply chain failure, to mitigate risks and pursue new opportunities (Liu & Wang, 2024).

This flexibility plays a critical role in balancing long-term policy-based requirements with the short-term market demands. The following paper discusses the theoretical worth of these motivation factors.

Table 1

Strategic decision-making Factor

Strategic decision-making Factor	Mechanism for Improving Laboratory Performance	Supporting References
1. Iterative & Agile Planning Cycles	The substitution of the long-term and inflexible plans with the short and flexible cycles enables fast re-tuning of the R&D projects. This minimizes the period of development and speeds up the time-to-market of the innovations in the safety-critical industries.	Al-Sarihi et al. (2025); Teece (2020)
2. Dynamic Resource Reallocation	Facilitates the speed of redeployment of capital and human forces in areas of need in case of an external shock. As an illustration, a strategy to move to sodium-ion technologies to avoid constraints in lithium supply and lower the costs can be used.	Lazard (2025); Peters et al. (2025)
3. AI-Driven Market & Policy Sensing	Utilizes the application of artificial intelligence and big data analytics to keep track of market trends and regulatory changes on a daily basis. This improves the precision of strategic senses, so that R&D is in tandem with consumer intelligence needs.	Precedence Research (2025); Spherical Insights (2024)
4. Balancing Policy Mandates with Market Demands	Formulates a mechanism to meet both state-stated goals at the same time (e.g., patent quotas) and commercially viable projects. It solves the patent paradox where the high output tends to override the low commercialization rates.	Zhang et al. (2021); Chen et al. (2023)
5. Decentralized decision-making Authority	Enables faster decision-making by middle managers and project teams in context-specific decisions to reduce red tape and respond faster to technical problems when working in large-scale agile environments.	Teece (2020); TandF (2024)
6. Scenario Planning	Systematically examines the possible alternative	Lazard (2025);

Strategic decision-making Factor	Mechanism for Improving Laboratory Performance	Supporting References
& Contingency Analysis	futures to establish preemptive responses, hence making the organization more robust to the sudden shock.	MDPI (2025)

2.4 Management Practices

Management practices are structured ways, processes, and behavioral principles that are used in an organization in order to manage work, distribute resources, and coordinate strategic objectives (Douch et al., 2025). In R&D laboratories in the automotive industry, practices are significant in functional silo dissection, knowledge integration, and alignment of operational processes with dynamic innovation goals.

The other most notable form of effective management practice in automotive R&D performance application is the greater cross-functional integration and accelerated execution of the project. In the example, as Schmidt and Wagner (2022) observe, within technologically intensive settings, collaborative structures are strategically determined to reduce the project delay caused by inter-departmental misalignment. This is observed in aspects like the creation of integrated innovation groups, which are organized in order to allow communication across fields like artificial intelligence, battery engineering, and regulatory compliance. By 2024, the percentage of cross-departmental patent filings of Jianghuai Laboratory had risen to 34 percent of total filings due to the introduction of the CFIH (Cross-Functional Innovation Hub) (Chen, 2024). This study validates the importance of these driving factors using established theoretical frameworks.

Table 2

Management Practices Factor

Management Practices Factor	Mechanism for Improving Laboratory Performance	Supporting References
1. Cross-Functional Collaboration Structures	Implements formal mechanisms, such as innovation hubs and integrated project teams to break down departmental silos. This enhances knowledge flow, reduces alignment-related delays, and fosters interdisciplinary innovation.	Chen (2024); Schmidt and Wagner (2022)
2. Hybrid Governance Models	Balances agile team autonomy with structured oversight and compliance checks. This model "empowers rapid iteration while maintaining adherence to policy and ethical standards" (Li et al., 2024), thus optimizing both speed and risk control.	Li et al. (2024); Warner and Wäger (2019)
3. Dynamic Resource & Talent Reallocation	Enables managers to rapidly redirect personnel and funding from lower-priority projects to emerging challenges or opportunities. This maintains project momentum and ensures resource efficiency in volatile environments.	Schmidt and Wagner (2022); Teece (2020)
4. Knowledge Sharing Incentives	Establishes reward systems and communities of practice that discourage information hoarding. Creates a culture where "cross-functional knowledge sharing becomes routine, accelerating problem-solving and ideation"	Li et al. (2024)
5. Fostering Psychological Safety	Cultivates an environment where team members feel secure to propose novel ideas and report failures without fear of blame.	Edmondson (2021)
6. Data-Driven Performance Monitoring	Implements real-time KPI dashboards and analytics to track project health and team output, enabling proactive management interventions and continuous improvement.	Marr (2020)

2.5 Training Programs

Training programs are intentional, scheduled programs that are designed to develop the knowledge, skills, and strategic capabilities of an organizational workforce in a planned manner (Ibrahim & Johnson, 2023). Such programs play a vital role in the automotive R&D laboratories to generate a source of talent that is able to strike a balance between the twin-pronged needs of the sophisticated technological development and the complex market-policy conditions. Under the Digital Resource-Based View, strategic bundling of human and digital resources through targeted learning interventions is a crucial, inimitable source of innovation (Ngo & O'Cass, 2023).

In the context of laboratory performance, beneficial training programs are characterized by rapid project implementation, improved innovation quality, and strong preparedness for compliance. This is done by directly empowering engineers and researchers with the technical skills to advance core technologies and the strategic skills to align development with regulatory and commercial needs. For example, the use of regulatory literacy modules in technical training programs in Chinese automotive R&D environments reduced prototype rework rates by up to 40 percent, thereby dramatically reducing time-to-validation (Li et al., 2024). This shows that training is a preventive measure for risk-averse projects and enhances workflow efficiency. On the other hand, improperly calibrated programs are costly. Long and intensive curricula have been associated with high burnout rates, which have since been mitigated by adaptive technologies, e.g., micro-learning (Schmidt & Wagner, 2022). Micro-learning is a technology-based instructional method that provides short, focused units with a single learning goal or outcome, usually in a relatively brief period of 3 to 7 minutes (Hug, 2021; Khin & Ho, 2022).

Table 3

Training Programs Factor

Training programs Factor	Mechanism for Improving Laboratory Performance	Supporting References

Training programs Factor	Mechanism for Improving Laboratory Performance	Supporting References
1. Dual-Track Curriculum Design	Engineering training must simultaneously address hands-on technical proficiency and strategic market-regulatory literacy to embed compliance and commercial viability into the R&D process from the initial design phase.	Ibrahim and Johnson (2023)
2.Interdisciplinary Collaboration Training	Creates a forced dialogue between disparate expert domains, which is a necessary condition for the exchange of tacit knowledge and the accelerated development of architectures for complex system integration.	Zhang et al. (2021)
3. Adaptive & Sustainable Delivery Methods	Promotes sustained engagement and knowledge retention by aligning learning delivery with the cognitive load capacity and workflow patterns of technical employees, thereby preserving productivity.	Khin and Ho (2022)
4. Ethical and Regulatory Compliance Focus	Functions as a strategic risk mitigation tool, directly reducing the probability of non-compliance penalties and protecting the economic value and social license of innovation projects.	Ngo and O'Cass (2023)
5. Personalized Learning Pathways	Enhances human capital development efficiency by dynamically mapping learning interventions to individual competency gaps and project role requirements, creating a unique resource configuration	Ngo & O'Cass (2023)
6. Strategic Mentorship & Job Rotation	Critical mechanisms for the diffusion of contextual, tacit knowledge and for fostering a systemic understanding of the end-to-end innovation value chain	Zhang et al. (2021)

2.6 Previous study on variables

There is a general analysis of automotive research and experimental development laboratories, especially in policy-based ecosystems such as China, where critical limitations and unresolved tensions persist in current research.

The strategic decision-making literature is instrumental in highlighting why dynamic capabilities are needed to overcome the challenges of technological disruption (Teece, 2020; Müller, Pfarrer, and Wohlgezogen, 2023) in market-oriented settings. Nevertheless, there is a significant theoretical and empirical gap regarding the functioning of these agile frameworks in the face of substantial state impact. Elsewhere (such as in China), laboratories face a different compliance-agility paradox (Liu & Chen, 2023), in which quantitative output requirements (e.g., patents) must come at the expense of market-oriented commercialisation requirements. Leading Western paradigms, which are oriented toward market sensing, do not explain how to overcome the tension between serving policy quotas and engaging in actual market innovation (Zhou & Li, 2022).

Regarding management practices, the literature effectively supports the use of cross-functional teams to dismantle departmental barriers (Poberschnigg et al., 2020). However, we do not investigate in depth viable models of hybrid governance suited to safety-critical automotive R&D. In the literature, a dichotomous decision is commonly made between fixed, plan-based, and dynamic, autonomous. This creates a practical knowledge gap about how laboratories can institutionalize processes that enable fast iteration needed to develop software and AI while ensuring uncompromised compliance with high-functional safety standards such as ISO 26262 (Berger & Böhm, 2024). The management methods of harmonizing these conflicting requirements in integrated project processes are under-researched.

In terms of training programs, the recent discussion correctly refers to acute competency gaps, in particular, when it comes to the transition to electric and digital mobility (Ibrahim & Johnson, 2023; Saleh & Ainiah, 2024). Nevertheless, strategic alignment is often an essential aspect that is not taken into account in empirical research. Studies are also heavily oriented towards technical mastery, i.e., learning new simulation tools, with little emphasis made on the acquisition of the so-called dual-track competencies that would lead to commercial success. In turn, there is scanty evidence on how the lack of strategic and regulatory literacy among engineering personnel can impair high-level R&D strategy implementation, which leads to the establishment of a key strategy-execution gap (Khin & Ho, 2022).

The most significant restriction in the existing scholarly landscape is that it does not take these variables into isolation. The continuing high investment, low conversion paradox that afflicts the industry is probably not due to any particular reason being ineffective, but to the systemic disintegration of human capital development, management, and strategy. Although all domains are also investigated thoroughly, there is a considerable research gap in terms of configurational interaction of domains and their mutual interaction, either synergistic or antagonistic, within a particular context. Thus, the research attempts to fill this integrative void by exploring the interdependent networks between strategic decision-making, management practices, and training programs in determining the performance of automotive R&D laboratories as a part of the ecosystems of influence of the state.

2.7 Underpinning Theory

This study is based on two theoretical frameworks is Dynamic Capabilities View (DCV) and Digital Resource-Based View (Digital RBV). These theories collectively provide a solid foundation for analyzing how automotive research and development laboratories can configure their strategies, management, and human resources to achieve outstanding performance in the face of rapid technological and regulatory changes.

2.7.1 Dynamic Capabilities View (DCV)

The dynamic capabilities view (Teece, 2020) explains the impact of independent variables on laboratory performance. Strategic decision-making is the perception and catching. it includes the agile interpretation of market trends and policy changes followed by active reallocating of R&D resources (Teece, 2020). Management practices is transformation practices. It takes leadership and structures practices to break the silos of an organization, to rework the flows, to make a way for the collaboration between different functions that are necessary to implement the new strategy (Schmidt & Wagner, 2022). Therefore, DCT sees the lab as a dynamic system rather than a static entity, whose performance is dependent upon the strategic updating that it is able to do.

2.7.2 Digital Resource-Based View (Digital RBV)

Training plans variable is the core of digital RBV. training plans are the main way to develop human capital, and human capital is one of the most important traditional resources. In digital RBV, this human resource does best when connected to digital resources. For example, training engineers not only needs to learn the technical skills of ISO 26262, but also need to use digital tools for EU AI Act regulation, which will form a hybrid and valuable and difficult to imitate ability (Ibrahim&Johnson, 2023; Li et al., 2024). So, the training plans is a catalyst to effectively combine people and digital resources, and this combined effect improves the performance of the laboratory directly.

2.8 Chapter Summary

In this chapter, existing literature has been comprehensively reviewed, laying a solid theoretical foundation for the research. It laid out the main variables: strategic decision-making, management practices, and training plans, and put them in the conceptual framework as connected causes of lab performance. Dynamic ability Theory and Digital Resource Based View's underpinning theory was developed to explain how these variables enable a laboratory to sense, seize and reconfigure resources in a dynamic environment. Review sharply recognized a knowledge gap on how such factors interact within policy-intensive auto R&D ecosystems, an issue highlighted as "high investment, low conversion". To empirically examine this interplay, next chapter outlines the research methodology, which describes the qualitative case study design and development of a semi-structured interview guide directly operationalizing the theory to Jianghuai Lab.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the research methodology used to investigate the performance drivers at the Jianghuai Automotive R&D Laboratory. It discusses the qualitative approach followed throughout the research philosophy and design. The chapter goes on to describe the specific method of data collection, such as semi-structured interviews and purposive sampling. The chapter ends with a summary that verifies the validity and relevance of the chosen methodology to address the research questions.

3.2 Research Framework

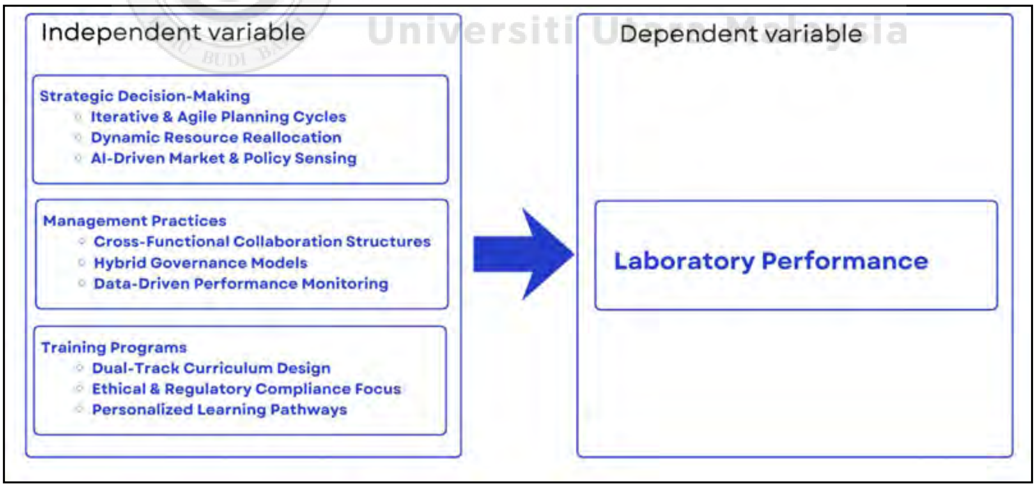

Figure 1 The Research Framework

Figure 1 explains how strategic decision-making, training plan, and management practices work together to drive laboratory performance. The core of this framework is to use laboratory performance as the dependent variable, measured by patent commercialization rate, project schedule, and stakeholder satisfaction.

The Strategic decision-making process, characterized by recurrent planning and rapid resource mobilization, enhances laboratory performance by developing strategic agility. The process allows the laboratory to detect market and technological changes quickly and re-allocate resources, which would enhance efficiency in transforming the R&D investment into commercial outputs (Teece, 2020; Müller et al., 2023).

Best practices in management within the laboratory, like the introduction of cross-functional collaboration arrangements, are effective in promoting laboratory performance by means of an integrative implementation process. This has the direct effect of eliminating departmental silos, enhancing the knowledge flow, and shortening project timelines, and it is directly related to such metrics as patent co-authorship, project delay reduction (Schmidt & Wagner, 2022; Chen, 2024).

Specific training initiatives contribute to the improvement of laboratory performance using a human capital development method. This mechanism develops the dual-track competencies, which provide the personnel with the technical and strategic-regulatory literacy. It is a direct way of augmenting the quality of innovation, enhanced compliance, and enhanced problem-solving abilities (Ngo & O'Cass, 2023; Li et al., 2024).

The social reality is not objective and unique but is created by the meanings, experiences, and subjective interpretations of people in their particular settings (Eriksson & Kovalainen, 2020; Thanh & Thanh, 2021). The research questions to be answered include how the complex phenomena of strategic decision-making, the management practices, and the training programs are perceived, experienced, and make sense within the minds of managers, engineers, and specialists in Jianghuai Laboratory. Their focus is on examining their subjective meanings and common meanings that define processes within organizations as opposed to quantifying objective, law-like associations among the variables (Saunders et al., 2019).

The theoretical framework created in Figure 1 is the directing framework of this research, which will act as the primary variable in the setting of the automotive research and development lab.

3.3 Research Design

The research uses a qualitative method, utilizing a one-case study approach to examine the interdependences between strategic decision making, management practices, training programs, and laboratory performance at the Jianghuai Automotive R&D Laboratory. The qualitative research design is especially appropriate to provide an answer to the question of how and why; to thoroughly investigate the processes and reasons behind the complex phenomena of the organization (Bhattacherjee, 2022; Creswell & Poth, 2023). The single case study approach offers the contextual richness required to study the high investment, low conversion paradox in its real-world context in a holistic manner.

The qualitative research methodology was chosen as a central investigation strategy since the research questions are based on the need to gain an in-depth, more sophisticated insight into the processes, perceptions, and contextual forces. The research will seek to comprehend the interaction of the three elements of strategic decision making, management practices, and training programs on the laboratory performance and the reasons why the “high investment, low conversion paradox continues to exist even after reforms. Only qualitative research can reveal these complex, socially constructed realities by examining the meanings, experiences, and interpretations of people who are part of the Jianghuai Laboratory (Eriksson & Kovalainen, 2020). This method will enable the satisfaction of the compliance-agility paradox and the collaboration-specialization dilemma based on a personal experience of participants, which cannot be fully represented and described using only quantitative data (Bansal et al., 2022). Qualitative research, through its research paradigm, can thus be applied to give a detailed exploration of the mechanisms and tensions that may be missed in quantitative measures.

The qualitative research strategy adopted in the study focused on a single case study, in which the focus was on the Jianghuai Automotive R&D Laboratory. Single-case study design is an established and strong approach to the methodology that can be used to investigate complex and modern phenomena in their natural settings, especially when the demarcations between the phenomenon and the environment are not easily visible (Harrison et al., 2020). The single-case study research design is quite suitable in this inquiry because it makes it possible to consider the paradox of high investment, low conversion in its organizational and national context of innovation systems (Yin, 2024).

The Jianghuai Laboratory was considered to be a critical case because it is representative and unique in the context of policy-oriented Chinese automotive R&D environment. It is representative because it reflects the general concept of the patent paradox, where high patent rates are accompanied by difficulties in the commercialization of work, thus becoming a perfect place to study the central issue of the research (Chen & Li, 2024). At the same time, its distinctiveness as a state-funded lab that experienced a range of dramatic agile and integrative reforms is an accolade in itself, offering a golden chance to research the dynamism of the implementation of the variables in question and the trade-offs thereof. The present case study offers contextual richness and the ability to track how these three factors of strategic, managerial, and human capital are interrelated and how these elements have changed over time, which is necessary in theory-building in complex, situated contexts (Grodal et al., 2021). Thus, the single case study of Jianghuai Laboratory is not aimed at statistical generalization to other cases, but at analytical generalization where the results can inform about the similar cases in other policy-intensive R&D settings (Thomas, 2021).

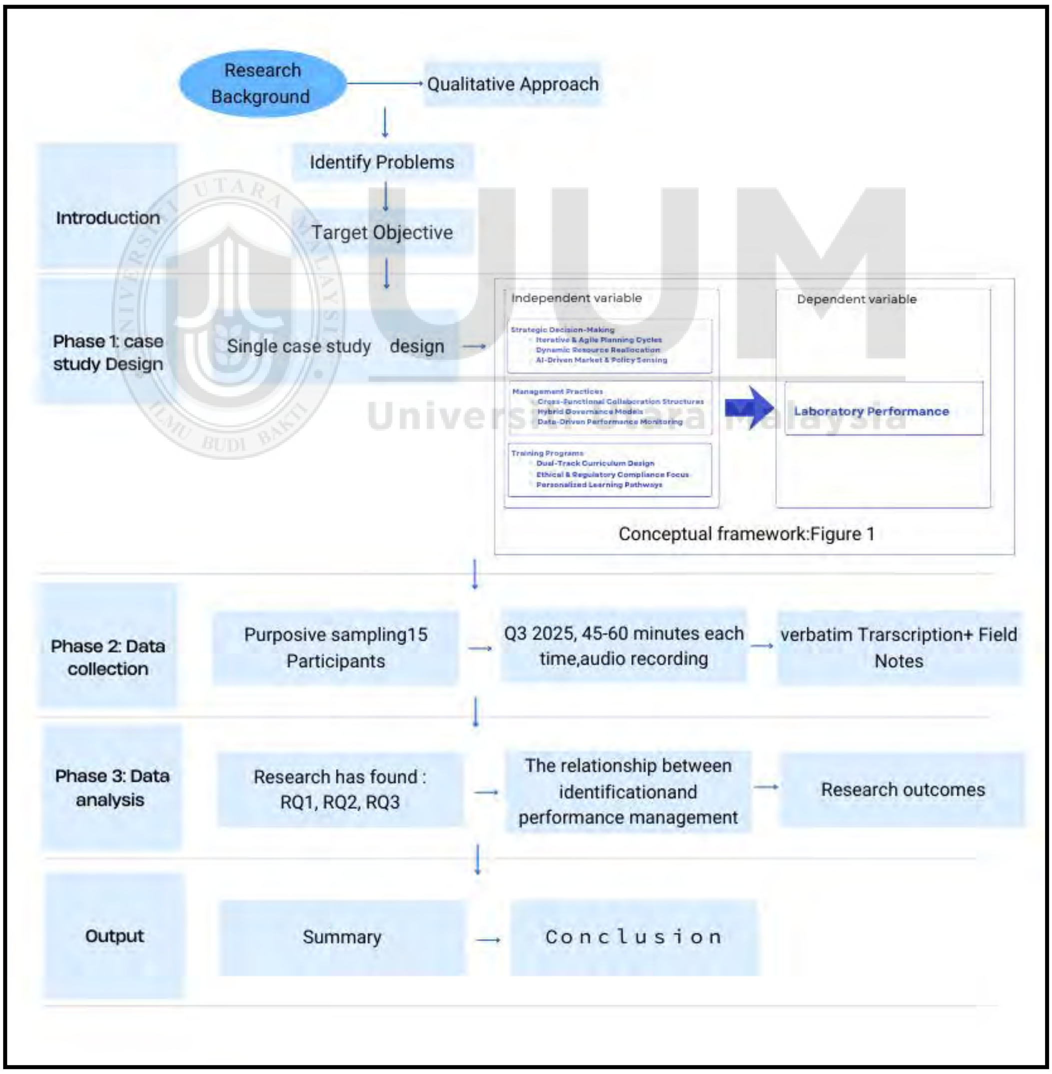

Figure 2 Research Design Path

3.4 Research Method

This study used a qualitative research approach, anchored in a single-case study design, to investigate the complex relationships affecting laboratory performance at the Jianghuai Automotive R&D Laboratory. The case study approach is considered a strong methodological option to explore complex and modern phenomena in the context of the real world when the delineation of the phenomenon and its surroundings is not clear (Harrison et al., 2020; Yin, 2024). The Jianghuai Laboratory single-case study was chosen because it is representative in terms of reflecting the phenomenon of the so-called high investment, low conversion, within the framework of the Chinese policy-driven automotive R&D environment and, thus, offers the required contextual depth of a thorough analysis (Chen & Li, 2024; Grodal et al., 2021).

Firstly, the analysis of semi-structured interviews conducted with 15 purposely selected respondents of the Jianghuai Laboratory, senior laboratory directors, project managers, senior research engineers, and human resource/training specialists was used as the primary source of information. Those descriptive accounts were examined with the help of in-depth thematic critiques to detect, study, and record tendencies in the data to gain an opportunity to study the lived experiences and perceptions of participants (Kallio et al., 2020). The connections between the strategic, managerial, and human capital variables and the laboratory performance were analyzed in the context of the theoretical perspectives of the Dynamic Capabilities View (Teece, 2020) and the Digital Resource-Based View (Ngo & O'Cass, 2023).

Semi-structured interviews were a significant way of collecting empirical data. A semi-structured interview is a qualitative method of data collection that involves employing a pre-planned interview guide that delineates the important topics or questions, but leaves much room to dig deeper into the answers, explore new themes, and adjust the flow of discussion according to the knowledge of the participant (Kallio et al., 2020; Saunders et al., 2023). This approach was chosen because it best incorporates the concentration and comparability of a structured format and the level of depth and flexibility of an unstructured conversation. The systematic coverage of the core research variables, strategic decision-making, management practices, and training programs was guaranteed by the predetermined questions, which were based on the conceptual framework of the study as well as the literature review (see Table 5). At the same time, the semi-structured format, being flexible and discursive, provided participants with the opportunity to share their experiences, which resulted in the development of rich and contextualized information and the emergence of unexpected themes that were essential to comprehending the subtle compliance-agility paradox and the collaboration-specialization dilemma in the laboratory (Eriksson & Kovalainen, 2020).

The study also included a sound analysis of secondary sources to place the primary interview data into perspective and triangulate them. This involved the reference to academic literature, industry reports (e.g., McKinsey and Company, 2023), internal organizational reports, and official patent data of the China National Intellectual Property Administration (CNIPA, 2024). The logical combination of documentary data is the foundation of rigorous case study research, which is used to support the results of interviews, offer objective performance data, and reduce the drawbacks linked to the use of one source of data, which increases the validity and exhaustiveness of analysis (Denzin, 2021; Johnston, 2024).

3.5 Sampling

The present study has utilized a purposive sampling strategy to select and sample information-rich participants who would give in-depth information about the research problem. The target population was all the members of the Jianghuai Automotive R&D Laboratory that had direct operational experience or strategic control of the phenomena under study: strategic decision-making, management practices, and training programs. In order to circumvent this constrained population in the single-case study, purposive sampling was chosen as the technique of sampling.

Purposive sampling, a non-probability method, involves the intentional selection of individuals or cases based on their potential to provide rich, relevant, and in-depth information about the central issues being studied (Patton, 2020; Suri, 2021). The given strategy is consistent with qualitative, exploratory objectives of this study, where depth of knowledge and the quality of information are the primary concerns. In contrast, statistical representativeness is not a priority (Campbell et al., 2020). The selection criteria were clearly structured to get people who had direct and considerable influence over or a supervising role in the core areas of operations being studied. This served to guarantee that all participants had a high level of credibility, experience, and contextual understanding of the area of study of driving forces of performance in the laboratory and thus make as much of the data as possible relevant and deep (Robinson, 2023).

A total of fifteen participants were obtained through this process. The qualitative inquiry does not predetermine the magnitude of the sample based on the statistical power tests, and instead, it is guided by the assumption of theoretical saturation or saturation of data (Hennink & Kaiser, 2022). Data saturation refers to the stage of data collection when new substantive information, themes, or variations to the research questions of interest are no longer obtained, which means that a complete picture of the phenomenon under study is obtained (Saunders et al., 2023; Mason, 2025). For this study, data collection was planned to continue, through additional interviews if necessary, until saturation was reached. The analysis of interviews was conducted concurrently with data collection. After conducting and thematically analyzing 15 interviews, it was determined that theoretical saturation had been attained, as subsequent interviews provided redundant information and no new codes or themes emerged related to the three core variables and their interdependencies (Fusch & Ness, 2021). Therefore, the sample size of 15 was deemed sufficient to answer the research questions with depth and rigor.

The resultant sample comprised individuals from four key organizational roles, ensuring a holistic view of the laboratory's operations, as detailed in Table 4.

Table 4

List of Interviewees

Serial No.	number of people	Experience (years)	Positions
1	3	15	Senior Laboratory Directors
2	4	8	Project Managers
3	5	7	Senior Research Engineers
4	3	7	Human Resource and Training Specialists

Such a stratified purposive sample helped to ensure that the entire spectrum of views about the central variables was taken into account, starting with the highest strategic level, moving to the lowest level of operational implementation, which greatly contributed to the enrichment of the study results, their credibility, and reliability (Tracy, 2020).

3.6 Research Instruments

The primary data collection tool was a semi-structured interview protocol, which was developed carefully to ascertain a systematic investigation of the main variables of the study. This protocol consisted of an elaborate protocol that stated the most important topics, prompts, and follow-up questions, which were necessary to keep the focus and, at the same time, provide flexibility and depth to the response (Kallio et al., 2020; Saunders et al., 2023).

The interview protocol was divided into four separate sections in order to make it a complete and logical flow. Part One focused on introductions and rapport-building, creating a comfortable, open environment for participants at the beginning of each interview. This stage involved introducing the study, obtaining informed consent, ensuring participants' confidentiality, and engaging in an initial informal conversation to encourage open and honest communication. Part Two comprised background and contextual questions, enabling the researcher to collect preliminary information regarding participants' roles, professional experiences, and familiarity with the laboratory's operations. Short, focused questions were used to gain insight into participants' backgrounds and relevant experiences related to the study. Part Three comprised the core of the interview and featured thematic questions aligned with the study's key variables. Specifically, the main questions were organized around the three independent variables, which are strategic decision-making, management practices, and training programs, and were designed to elicit detailed and reflective accounts of participants' experiences, processes, and perceived outcomes. Finally, Part Four functioned as the closing and summary section, offering participants an opportunity to share additional insights, confirm the researcher's interpretation of key points, and formally conclude the interview. This final stage included a brief recap of the main issues discussed, an invitation for any final comments, and a formal expression of appreciation for participants' time and contributions.

The development of the core thematic questions was clearly and strictly based on the theoretical framework and literature review described in Chapter 2. All questions were designed to operationalize a certain construct of the literature, hence, directly answering the purpose of the research and basing the empirical research on existing academic discourse. The initial frameworks that guided question formulation were the principles of the Dynamic Capabilities View (DCV) and the Digital Resource-Based View (Digital RBV) (Teece, 2020; Ngo & O'Cass, 2023).

The table below delineates the mapping between the interview questions, their corresponding research objectives, and their underpinnings in the literature and theory, illustrating the deliberate and theory-guided construction of the research instrument.

Table 5

Semi-Structured Interview Guide

Research Variable & Objective	Interview Question	Theoretical & Literature Foundation	Purpose
Strategic Decision-Making (RO1: To analyze its	1. How do internal processes for sensing external technological	Dynamic Capabilities View: "Sensing" the environment (Teece, 2020). Literature on	To investigate the mechanism of external scanning

Research Variable & Objective	Interview Question	Theoretical & Literature Foundation	Purpose
influence)	shifts translate into concrete adjustments of your R&D portfolio?	agile R&D portfolio management (Müller et al., 2023).	and its direct link to strategic project selection.
	2. Can you describe a specific instance where resources were dynamically reallocated in response to a disruption?	Dynamic Capabilities View:“Seizing” opportunities through resource reconfiguration (Teece, 2020). Case studies on dynamic reallocation (Liu & Wang, 2024).	To explore the practice and efficacy of flexible resource deployment in crisis response.
	3. What mechanisms balance state-mandated patent quotas with commercially viable projects?	Literature on the “patent paradox” and policy-compliance tension in Chinese innovation (Chen & Li, 2024).	To examine the strategic navigation of dual policy and market imperatives.
	4. To what extent are project teams empowered to make decentralized decisions?	DCV and literature on decentralized authority for strategic agility (Teece, 2020; Chen, 2024).	To assess the level of autonomy granted to teams to accelerate execution.
	5. How does the laboratory employ scenario planning for resilience?	Literature on strategic foresight and resilience planning (Vecchiato, 2022).	To understand proactive strategy formulation for future uncertainties.
Management Practices (RO2: To evaluate its enhancement)	6. What structures facilitate collaboration between discrete functions (e.g., AI and battery teams)?	Literature on cross-functional integration and innovation hubs (Schmidt & Wagner, 2022; Chen, 2024).	To identify formal mechanisms for breaking down silos.
	7. How does the governance model balance team autonomy with oversight and compliance?	Literature on hybrid governance models in high-stakes R&D (Li et al., 2024; Warner & Wäger, 2019).	To explore the tension between agility for innovation and control for safety/quality.
	8. Can you provide an example of rapid talent reassignment from a low to high-priority project?	Dynamic Capabilities View: “Reconfiguring” assets (Teece, 2020). Studies on dynamic talent management (Schmidt & Wagner, 2022).	To investigate the management of human resources as a dynamic capability.
	9. What incentives exist to promote knowledge sharing across teams?	Literature on knowledge management and collaborative culture (Li et al., 2024).	To assess cultural and systemic enablers of knowledge flow.
10. How would you characterize the level of psychological	Foundational work on psychological safety and team learning (Edmondson, 2021).	To evaluate the social environment for risk-taking and innovation.	

Research Variable & Objective	Interview Question	Theoretical & Literature Foundation	Purpose
safety?			
Training Programs (RO3: To examine its improvement)	11. How are training programs designed to measurably enhance laboratory efficiency or innovation quality?	Digital RBV: Training as a key investment in human capital (Ngo & O'Cass, 2023). Literature on competency development (Ibrahim & Johnson, 2023).	To link training design directly to performance outcome goals.
	12. Describe training activities designed to force collaboration between different disciplines.	Literature on interdisciplinary training for innovation (Zhang et al., 2021).	To examine pedagogical tools for breaking down disciplinary barriers.
	13. What methods are used to ensure training remains adaptable and sustainable?	Literature on micro-learning and sustainable pedagogy to prevent burnout (Khin & Ho, 2022; Schmidt & Wagner, 2022).	To explore the delivery mode's impact on engagement and sustainability.
	14. How does training on ethical/regulatory standards directly influence project design?	Digital RBV: Integrating strategic (compliance) knowledge with technical skills (Ngo & O'Cass, 2023). Literature on compliance-by-design (Furr, 2023).	To assess training's role in proactive risk mitigation and strategic product development.
15. To what extent are learning pathways personalized?	Digital RBV: Personalized development as a unique resource configuration (Ngo & O'Cass, 2023).	To investigate the tailoring of human capital development to individual and project needs.	

The above is the outline of the semi-structured interview questions for this study. This outline helps to construct the relevance of the problem and build its effectiveness, ensuring that they effectively apply the theoretical concepts of the study to empirical research.

3.7 Data Collection

The data collection phase was executed over a focused three-month period in the third quarter of 2025. This stage was carefully designed and implemented in accordance with the accepted guidelines of a qualitative study, including contact with the participants, the process of interviews, and high-quality ethical standards (Flick, 2024).

The preliminary communication with the potential participants was done in a formal way. An official invitation email was sent to identified persons following the approval of one of the gatekeepers of the Jianghuai Laboratory, who was the Human Resources department of this organization, with the purpose of the study, scope, and the voluntary nature of participation. Since the Chinese professional environment implies additional communication through WeChat, other uses of this specific tool included scheduling and logistics, which is a common effective procedure in organizing research interactions in this environment (Liu & Chen, 2023). The entire interview process was carried out in real life, face to face, on the Jianghuai Laboratory premises or in special private meeting rooms to make the case study research conducive and allow the observation of contextual nuances that are crucial to any case study research (Yin, 2024). It was a face-to-face format because it was chosen to establish rapport, gather non-verbal information, and enrich the depth of the interactive process, one of the foundations of semi-structured interviewing (Brinkmann & Kvale, 2020).

A rigorous ethical procedure was used to control the study in accordance with the international guidelines of social science research (Israel & Drenth, 2021). Formal permission was obtained by the institutional ethics review board before the collection of the data.

Informed Consent, before every interview, an informed consent form was shown and explained to every participant. The objectives of the study, the interview process, the rights of the participant (the right to withdraw at any point in time), and the precautions to be taken regarding confidentiality and data handling were presented in this form. All participants were given written consent.

Anonymity and Confidentiality to preserve the identities of the participants, anonymity was absolute. Pseudonyms or generic role descriptions (e.g., Senior Engineer P8) are also used in transcriptions, analysis, and any further publications to refer to all individuals and the organization. The participants were informed that none of the personally identifiable information would be disclosed.

Privacy and Data Use, it is clearly stated that the audio recordings and transcribed data will be used in this study project only to conduct academic analysis. All information has been kept in safe devices secured by passwords, only available to the research team, and will be destroyed after a specified retention period. Such guarantees were essential to the creation of an atmosphere of confidence and the promotion of honest answers (Saunders et al., 2023).

The semi-structured interviews were to take a duration of between 45 and 60 minutes each. This time is identified as the most productive to investigate rather complicated issues at adequate depth and keep the participants focused on the session and paying attention to time (Kallio et al., 2020). All interviews were recorded in their entirety on a digital recorder with the express consent granted during the consent procedure in order to have an accurate and complete verbatim record. Audio recording is deemed necessary to maintain the integrity of the stories of the participants and to make them analyze the themes in detail (Creswell & Poth, 2023).

In order to supplement the audio data and to obtain deep contextual information, detailed field notes were made throughout the interviews and upon conclusion of the interviews. The notes included the observational notes, non-verbal behavior, the thoughts that the interviewer had at first glance, and thoughts about the developing themes, which provided a significant interpretive background to verbal data (Saldana, 2021). After the interviews, the researcher had the audio recordings transcribed verbatim, which is a tedious task but the basis of the textual information used in the analysis.

A point of theoretical saturation was reached, and this marked the end of the data collection process. The term is the primary concept of qualitative inquiry that implies the point when the primary research questions do not provide any new substantive information or thematic differences, and it seems that the ultimate concept of the phenomenon is reached (Saunders et al., 2023; Mason, 2025).

After conducting and preliminarily analyzing 15 interviews, it was determined that saturation had been attained, as subsequent data did not reveal new properties of the central categories pertaining to strategic decision-making, management practices, and training programs.

3.8 Chapter Summary

This chapter has discussed the qualitative research method adopted in exploring the drivers of performance at the Jianghuai Automotive R&D Laboratory. Case study design, through semi-structured interviews of 15 purposeful selection participants, is the most suitable to explore the complex interrelationships among strategic decisions-making, management abilitiy, and training plans. Using thematic analysis procedures to ensure the rigor, credibility, and credibility of this study. The next chapter will present the data analysis and results as derived through this methodological approach, which addresses the research questions guiding this inquiry directly.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

4.1 Introduction

This section is about the empirical examination and the findings of the study, moving from the framework of methodology in the last chapter to an examination of the data that was collected. The primary purpose of this study is to analyze the impact of important independent variables on the performance of Jianghuai Automobile R&D laboratory. Therefore, based on the rich data collected during fifteen in-depth interviews with individuals, this section is given as a theme, as to how such aspects are experienced and lived within this context of operations shaped by policy.

4.2 Data Analysis and discussion of findings

4.2.1 Strategic decision-making's Impact on Laboratory Performance

Most participants agreed that this agility enables the laboratory to dynamically sense external changes and reconfigure resources, thereby improving the efficiency of converting R&D investment into commercial outputs. The shift from rigid, long-term planning to iterative, agile cycles was consistently highlighted as a critical positive change.

Regarding the adoption of agile planning cycles, "...the first time we used **a quarterly sprint** to completely redesign a battery module **in six weeks**, a task that previously took **a full fiscal year**… the results spoke for themselves..."

(Participant 5)

This implies that development cycle time is significantly decreased when long and fixed roadmaps are substituted with short and flexible planning cycles. Quick recalibration of R&D initiatives enables the laboratory to capture new opportunities as well as speed up time-to-market on innovations. This result is consistent with the dynamic capabilities literature, according to which the cycles of iterations are one of the primary ways of sensing and seizing strategies in turbulent environments (Muller et al., 2023; Teece, 2020).

Moreover, participants stressed the significance of dynamic redistribution of resources towards the resiliency of organizations.

*"...**Within 48 hours**, we had **a provisional budget** and **a dedicated tiger team** exploring sodium-ion alternatives. We did not wait for the next quarterly review; **we took action**, and it saved a project deadline..."*

(Participant 6)

This implies that it is important to empower the organization to respond quickly to the crisis by redeploying capital and people to mitigate the risk before it occurs (disruption of the supply chain) and avoid stagnation of the project. This is an example of the ability of resource reconfiguration, which fits the strategic management literature of identifying flexible resource allocation as a key to continuing to gain momentum in dynamic innovation environments (Loon et al., 2020; Teece, 2020).

Decentralization of decision-making was also identified as one of the performance enhancers.

*"...Now we have **the autonomy to pivot**. We worked with an outside AI startup for the model, **a choice we made within our budget**. We validated a new material **in 3 weeks, not 3 quarters**..."*

(Participant 3)

This implies that the authority to make tactical decisions devoid of higher-level approval places teams in a substantially faster, more reactive, and empowered culture of operation. In large-scale agile R&D environments with high levels of bureaucracy, decentralized decision-making is necessary to reduce bureaucratic delays and increase responsiveness (Chen,2024).

Nevertheless, a certain strategic tension was also detected in the analysis.

*"...We have **a dual-track**. One team is just about getting out the patents **to hit their numbers**... At the same time, our agile teams work on **20% of these marketable patents**. It is not efficient, but we have no choice..."*

(Participant 11)

This implies that strategic decision-making has to find a way through a compliance-agility paradox, in which the need to achieve quantitative policy outcomes can introduce inefficiencies and potentially focus on commercially viable ventures. This point is a first-premier symptom of the balanced scorecard between policy requirements on the one hand and those of the market on the other, which is a long-standing conflict in state-mediated innovation systems (Chen & Li, 2024; Liu & Chen, 2023).

Lastly, the participants warned of the trade-offs of over-market-oriented agility in the long term.

"...the constant pressure to generate market-responsive prototypes is starving our foundational research. We have pulled the plug on three blue-sky projects… We are winning the sprint but losing the marathon…"

(Participant 1)

This shows that agile decisions are good at increasing the short-term conversion rate but can also be costly in the long-term context at the expense of exploratory and high-risk research needed to create breakthrough innovations. The result fits the literature warning that the extreme emphasis on dynamic seizing tends to drain the resource base and absorptive capacity to be used in the future in seizing, sensing, and radical innovation (Ahammad et al., 2020; Teece, 2020).

Overall, strategic decision-making has a positive impact on the laboratory performance as it improves its responsiveness, its resilience, and speed of execution due to agile planning, dynamic resource distribution, and decentralization of authority.

4.2.2 Training Programs Impact on Laboratory Performance

The interpretation of the data obtained during the interview shows that specific training activities are a key process of improving the performance of the laboratories, which is primarily achieved through the establishment of the dual-track competencies required to overcome not only the complexity of the technological environment but also the environments of strategic and regulatory risks. The direct translation of this development is the increase of efficiency in projects, quality of innovation, and proactive risk reduction. Introduction of the Technical-Strategic Integration Program (TSIP) in the Jianghuai Laboratory was always mentioned as the turning point intervention.

The dual-track curriculum design has served to ensure the balance between the technical implementation and strategic business feasibility. This proposed approach will result in the employment of the engineering staff not only with profound technical understanding but also the skills of deciphering the demands of the market and regulatory frameworks in order to offer compliance and business perspective to the R&D process that are present in the initial phases of the process.

".... Before the TSIP, we would design a battery module to the highest energy density specs, only to have it rejected late in the process for not meeting new EU carbon footprint regulations. Now, that ***regulatory checklist*** *is part of our* ***initial design sprint****. We've* ***cut rework cycles by almost half****...."*

(Participant 8)

This means the strategic-regulatory literacy and technical proficiency forms of training constitute a proactive derisking device. Instead of receiving compliance as a downstream validation hurdle, it transforms this parameter into an upstream design parameter, thereby significantly lowering costly iterations and speeding up time-to-validation. The discovery is consistent with the Digital Resource-Based View, which explains that the combination of human capital and strategic knowledge results in a valuable, non-imitable resource (Ngo & O'Cass, 2023). Moreover, it supports the studies that point out the necessity of compliance-by-design to be efficient in product development in regulated industries (Furr, 2023).

The training on interdisciplinary collaboration was found to be one of the primary factors in silo breaking and integrative innovation. Such training can be done by stimulating and compelling dialogue between divergent expertise areas to facilitate the transmission of tacit knowledge required to create intricate, interconnected systems such as electric and autonomous vehicle platforms.

*"......The mandatory '**AI for Battery Engineers' and 'Electrochemistry for Software Teams' workshops** were initially met with resistance. However, within months, we saw **a 30% increase in cross-departmental patent filings**. Engineers started speaking **a shared language**, which unblocked system-level optimization problems...."*

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This means that organized interdisciplinary training is a precondition of the development of the common cognitive foundation on which the complex system integration is to be based. It directly improves the integrative innovation power of the laboratory in terms of such metrics as co-authored patents. This fact substantiates the current literature, which concludes that intentional pedagogical instruments of interdisciplinary exchange play a significant role in achieving innovation in the field of automotive R&D (Zhang et al., 2021).

The change in the intensive training blocks to the adaptive and sustainable delivery techniques was paramount in ensuring the workforce remains engaged and burnout is avoided. The first high-intensity version of the TSIP was efficient; however, it caused an unsustainable cognitive load, which is why it is essential to consider the learning models that are based on the workflow patterns.

".... Our first TSIP cohort reported ***a 65% burnout risk****. We pivoted to* ***a micro-learning model,*** *short weekly modules on platforms like WeChat Work.* ***Completion rates stayed above 90%****, and qualitative feedback showed much better integration of learning into daily tasks* ***without disrupting project momentum****...."*

(Participant 11)

This means that human capital development depends on the mode of delivery as far as its sustainability is concerned. Adaptive technologies such as micro-learning maintain productivity and knowledge acquisition by being in line with the cognitive load of the technical personnel, and hence, training becomes a performance improvement and not a drag. This finding is aligned with the findings pointing to burnout caused by intensive and long-term curricula and the importance of sustainable pedagogy in building long-term competencies (Khin & Ho, 2022; Schmidt & Wagner, 2022).

Ethical and regulatory compliance in training programs had a high emphasis that was used as a strategic risk mitigation strategy. This concentration directly affected the design of the project and ensured the social license of the laboratory to work.

"*.... Our training on* ***the EU AI Act*** *is not a legal formality; it is* ***a design framework****. When our autonomous driving team prototypes a new perception algorithm, they now automatically run it through* ***the compliance checklist from their training****. This has prevented at least* ***two major redesigns post-prototype****...."*

(Participant 9)

This means that the integration of ethical and regulatory principles into training programs can make compliance a cost center that responds to issues instead of a value center that serves to protect values as part of the innovation process. It directly minimizes the chance of penalty for non-compliance and protects the economic worth of R&D projects. This role of training is the main one in the Digital RBV, where such a strategic human capital development is perceived as an investment that reduces the risk and increases the value of the resources (Ngo & O'Cass, 2023).

In Summary, training programs have a positive impact on the performance of laboratories as they systematically create dual-track competencies, non-relaxingly compel to collaborate across disciplines, adopt sustainable delivery approaches to maintain the workforce's well-being, and make compliance a proactive design perspective. The effectiveness of these programs speaks of their being a crucial, configurational resource, which, when combined with strategic and managerial practices, directly offers a resolution to the high investment, low conversion paradox, through enhancing the quality, speed, and market-readiness of R&D deliverables.

4.2.3 Management Practices Impact on Laboratory Performance

The interview results analysis suggests that management practices can be considered a significant operational driver that directly transforms the strategic intent into laboratory performance. Effective practices can be used to improve performance by structurally supporting cross-functional integration, dynamically optimizing resources, and creating a culture that is favorable to iterative innovation. Nonetheless, these developments may be typically associated with internal conflicts between autonomy and control, collaboration and specialization.

Formal cross-functional collaboration structures, including the Cross-Functional Innovation Hub (CFIH), are one of the top management practices that will significantly improve the performance of the laboratory by silo busting and speeding up the integrative problem-solving process.

*".... The **CFIH mandate** forced our AI software and battery thermal management teams **to co-locate** for a critical project. The weekly **integrated design reviews** cut our **system integration timeline by 40%** compared to the old sequential handoff model...."*

(Participant 8)

This implies that the presence of the intentionally designed structural interventions that physically and procedurally incorporate the difference in expert fields is necessary to eliminate the inherent tension of sequential development processes.

Giving rise to continuous, synchronous communication, such practices diminish misalignment, accelerate the transfer of knowledge, and directly shorten project cycle times, which is supported by the research that identifies designed collaborative structures as the determinants of project delays reduction in complex R&D (Schmidt & Wagner, 2022; Chen, 2024).

The use of hybrid forms of governance that ensure that team independence and formal control are balanced is an important management activity in ensuring that both the speed of innovation and integrity of compliance in safety-critical R&D settings are maintained.

"...Our agile teams have ***the freedom to pivot their sprint goals****, but any change affecting system safety or regulatory compliance triggers* ***an automatic review gate*** *with the quality assurance unit. This* ***hybrid model*** *lets us move fast on features but never bypass the non-negotiables...."*

(Participant 5)

This indicates that to have effective management in the field of automotive R&D, the governance strategy must be subtle in distinguishing between areas that need flexibility and areas that need rigor. It will be solved through this practice as, on the one hand, it guarantees the dynamism of project execution without jeopardizing the necessary levels and compliance with regulations, which aligns with the research on hybrid governance in high-stakes innovation settings (Li et al., 2024; Warner & Wäger, 2019).

Empowered by management, dynamic resource and talent redistribution is an essential practice to sustain the project momentum and strategic responsiveness in a dynamic R&D portfolio.

".... When a competitor announced a breakthrough in solid-state electrolytes, management ***re-prioritized within 72 hours****. They* ***reassigned three senior engineers*** *from a mature Li-ion project to our exploratory solid-state team, giving us* ***the critical mass to accelerate our prototyping****...."*

(Participant 1)

This implies that one of the dynamic capabilities is managerial power and processes of swiftly reallocating human and capital resources. This approach enables the laboratory to be quick to capitalize on new areas of technology or address a threat, so that the most valuable resources of the enterprise, its most skilled employees, are permanently synchronized with the strategic issues of the priority, which ensures the maximum payback of an investment in research and development (Teece, 2020; Schmidt & Wagner, 2022).

Management practices that promote psychological safety are a more fundamental and underestimated factor in laboratory performance since the practice allows the necessary risk-taking and open dialogue to facilitate breakthrough innovation.

".... Since leadership started openly discussing ***project failures*** *in monthly forums and rewarding* ***'lessons learned' submissions****, we have seen a measurable increase in* ***proactive issue reporting*** *and more* ***radical idea proposals*** *during brainstorming sessions...."*

(Participant 3)

This means that management practices that directly justify vulnerability and learning through failure lead to the establishment of a climate in which employees are comfortable enough to be free to experiment, to raise concerns early, and to suggest new types of ideas without the fear of being blamed. This cultural basis is fundamental to the unleashing of creative potential and avoiding expensive project failures at the last stages, which has been long-established in the team learning literature (Edmondson, 2021).

Overall, the management practices have a positive influence on the lab performance in that they offer the structural frameworks (cross-functional hubs), governance regulations (hybrid models), resource fluidity (dynamic reallocation), and cultural basis (psychological safety) that enable the implementation of strategy.

In summary, management practices positively impact laboratory performance by providing the structural frameworks (cross-functional hubs), governance rules (hybrid models), resource fluidity (dynamic reallocation), and cultural foundation (psychological safety) necessary to execute strategy effectively.

4.3 The Challenges of Laboratory Performance

The empirical study shows that the performance of Jianghuai Laboratory can be influenced by a complicated interaction of factors that are not limited to internal management of strategic, training, and operational changes. These issues are structural and interrelated as they are expressed in external environmental forces, structural malfunctions within the institution, and, in the end, ingrained cultural and human elements.

The laboratory is situated in a policy-intensive environment with a strict policy, which produces a primary compliance-agility paradox (Liu & Chen, 2023). The contradiction of this paradox is that of meeting top-down, state-imposed innovation quotas and market-driven commercial bottom-ups. The constantly changing world of automotive technologies regulation (e.g., the EU AI Act, data security regulations) also introduces a new element of externality uncertainty, which has to be constantly adjusted, which puts pressure on the process of existing planning (Furr, 2023).

The core of the laboratory, there still exists a significant gap in alignment between the new agile and interdisciplinary operational structure of the laboratory and its old governance and performance management systems. This difference causes tension, which kills productivity and spirit. One of the significant structural challenges is the Agility-Stability Paradox of Evaluation Systems. The agile and sprint work pace is incompatible with the inflexible, once-a-year cycle of review that is associated with long-term output goals. A strategic pivot occurs, and we are punished for failing to achieve the goal that we already established. This misfit does deter the very adaptive attributes that strategic agility aims to enhance, a typical failure of traditional performance mechanisms to be put into dynamic contexts (Müller et al., 2023).

At the cultural and human level, the issues are about maintaining the ability of the workforce and creating an environment that will allow risk-taking innovation. One of the most important ones is Training Intensity and Workforce Sustainability. The early implementation of the intensive Technical-Strategic Integration Program (TSIP) was, although successful, accompanied by high cognitive load and possible burnout risk, with 65 percent burnout among junior employees reportedly.

Overall, the issues of the Jianghuai Laboratory performance are complex and highly interconnected. Outside policy forces pervert strategic focus, internal organization and functions are out of touch with innovations, and human capital strategies are troubled with sustainability and culture fit.

4.4 Summarizes the Main Findings

The results do give direct responses to the three research questions. Strategic decision-making, which involves rapid planning cycles and changing resource allocation, is a response to RQ1, as it increases the performance of a laboratory in terms of the responsiveness to the market and the speed of project execution (Teece, 2020; Müller et al., 2023). Nonetheless, this beneficial effect is systematically offset by a so-called compliance-agility paradox, in which the need to comply with state-imposed quotas on patents may cause the allocation of resources to non-commercially viable projects, resulting in a two-track system, thus necessarily reducing the efficiency of conversion.

To address RQ2, management practices, specifically, the creation of formal cross-functional mechanisms such as the CFIH and the implementation of hybrid governance mechanisms, improve performance through silo-breaking, faster integrative problem-solving, and moderating the pace of innovation and rigor of compliance (Schmidt & Wagner, 2022; Li et al., 2024). The practices will offer the structural and procedural processes that are required to translate strategic agility into operational results.

As per the RQ3, performance is improved through specialization training programs such as the TSIP, which instill dual-track competencies that introduce regulatory and commercial foresight into the R&D process, leading to the decrease of rework and the speed of time-to-validation (Ngo & O'Cass, 2023; Furr, 2023). This positivity effect was important and meant that the transition to sustainable delivery strategies, including micro-learning, would not lead to workforce burnout.

These fall within the incompatibility of agile workflows with the old performance evaluation systems and sustainability strains of intensive competency development programs. Table 6 below summarizes the key findings, with their thematic origins and overall impact on the performance of the laboratory.

Table 6

Summary of Main Findings

Key Themes	Key Findings	Impact on Performance
Strategic Decision-Making	Adoption of agile, iterative planning cycles (e.g., quarterly sprints) drastically reduces development cycle time and accelerates time-to-market.	Positive
	Dynamic reallocation of resources and decentralized decision-making authority enhance organizational resilience and responsiveness to disruptions.	Positive
	Existence of a "compliance-agility paradox," leading to a dual-track system that separates patent-quota fulfillment from market-driven innovation, creating strategic inefficiency.	Negative
	Excessive focus on short-term, market-responsive agility can deprioritize foundational, blue-sky research, posing a long-term risk to innovation capacity.	Negative
Management Practices	Implementation of formal cross-functional collaboration structures (e.g., CFIH) significantly reduces project delays caused by siloed workflows and accelerates system integration.	Positive
	Hybrid governance models that balance team autonomy with structured oversight for safety/compliance optimize both innovation speed and risk control.	Positive
	Dynamic reallocation of talent and fostering of psychological safety are critical for maintaining project momentum and enabling risk-taking innovation.	Positive

Key Themes	Key Findings	Impact on Performance
Training Programs	Legacy annual review cycles and static KPIs misaligned with agile workflows create an "agility-stability paradox," discouraging adaptive behaviors.	Negative
	Dual-track curriculum design proactively projects, cutting rework cycles and shortening validation time.	Positive
	Structured interdisciplinary training forces knowledge exchange, building shared cognitive ground and increasing integrative innovation output	Positive
	A shift from intensive blocks to adaptive, micro-learning delivery models preserves workforce sustainability and knowledge retention.	Positive
	Initial high-intensity training formats correlated with high burnout risk, indicating a critical sustainability-alignment gap in human capital development.	Negative

Overall, the empirical research demonstrates that the decision-making process of the tactical level, the management practices, and the training programs are strong interactive dynamics of laboratory performance. These effects are positive and consist of agility improvement, integrative performance, and human capital advancement. These synthesized results have formed the basis of the ultimate discussion, conclusions, and practical recommendations made in Chapter Five.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

In the final chapter, the main findings of the study were discussed and the research results summarized. Offering a concluding discussion and interpretation of the results presented in Chapter Four. It will attempt to answer the research questions posed at first by bringing the empirical results together with the theory and review of the literature established previously. This chapter starts with the research, which investigates why this study was conducted and what methods were used to obtain the results. This is followed by a detailed discussion of the key findings on strategic decision-making, training plans and management practices and they are interpreted and connected to existing literature. Then, the chapter acknowledges the limitations of this research honestly and offers fruitful directions for further studies. Finally, it makes practical recommendations for automotive R&D laboratories and gives a conclusion of the study.

5.2 Overview of the study

This study was initiated to address the persistent and globally recognized “high investment, low conversion” paradox within automotive R&D. Nevertheless, even after massive investments around the globe of more than USD 50 billion in automotive R&D each year (International Energy Agency, 2025), there is a considerable gap in translation between the amount of money spent on R&D and the resultant commercial and innovative output (FactSet, 2025). This concern is particularly urgent within the policy-based innovation systems, including those in

China, where the friction between the state-prescribed targets of innovation and the commercialization is applicable to the laboratories, like the Jianghuai Automotive R&D Laboratory (Chen, 2024; Liu, 2023). This is the reason why the study focused on the interconnected motivators of this performance crisis.

The empirical study produced several conclusive results regarding the influence of core variables on laboratory performance.

The research on the collected data yielded several important findings. Agile, iterative decision-making cycles and dynamic resource redistribution made decisions more responsive to market changes and accelerated project execution. However, it was mediated systematically through a compliance-agility paradox, resulting in a dual-track system in which patent-quota projects are separated from market-driven initiatives. The practices employed by management, especially the introduction of the CFIH, helped remove functional silos and accelerate integrative problem-solving, as the number of cross-departmental patents increased. Such practices, at the same time, however, introduced a collaboration-specialization dilemma and a tension in governance between freedom and strict control. The TSIP, which was an excellent example of targeted training programs, proved effective in developing dual-track competencies, minimizing rework in the project's late stages, and accelerating regulatory compliance. There was also an issue with the sustainability of training delivery, and early high-intensity training formats were linked to the risk of burnout, requiring a transition to adaptive and microlearning modules.

5.3 Discussion of the findings

The empirical evidence based on the Jianghuai Laboratory case offers subtle responses to the research questions, showing the effectiveness and the complexities inherent to the application of strategic, managerial, and human capital drivers in a policy-rich automotive R&D setting.

RQ1: The Strategic Decision-Making and Compliance-Agility Paradox.

The study discovered that the strategic decision-making process, characterized by agile, cyclic operation, comprising quarterly planning sprints, responsive resource reallocation, and devolved control, had positive influences on laboratory performance in the market responsiveness and execution speed factors. This was justified by the fact that the shortenings of development cycles by 6 weeks were made as compared to 1 year to redesign a battery module. This observation does not contradict the significant principles of the DCV since the ability to see and grab the opportunities fast remains the most important to execute in turbulent conditions competitively (Teece, 2020; Müller et al., 2023). The iterative nature of the planning processes and decentralized decision-making is also in line with the enablers of higher patent commercialization rates of agile R&D organizations found by García et al. (2021).

RQ2: Management Practices as Enablers and Sources of Structural Tension

The research found that a strong positive influence was found in the intentional management activities, in particular, the establishment of the Cross-Functional Innovation Hub (CFIH), since this enabled overcoming the functional silos and added to the integrative problem-solving. This is supported by the body of management research that dismisses collaborative forms as central to the process of accelerated innovation and minimized project delays due to a lack of departmental alignment (Schmidt & Wagner, 2022).

RQ3: Training Programs Bridging and Exposing Systemic Gaps

The research discovered that dual-track competencies that are essential in the contemporary automotive R&D are constructed by specific training programs, namely, the TSIP. Training minimized late-stage project rework through the strategic-regulatory literacy and the combination of technical expertise and strategic-regulatory literacy, which entailed the proactive incorporation of compliance into the design stage. This observation closely corresponds to the Digital Resource-Based View (Digital RBV) in which training is viewed as a strategic investment that packages human capital with strategic knowledge into a valuable, non-imitable resource (Ngo and O Cass, 2023). The effectiveness of the TSIP to speed up regulatory approvals justifies the focus on compliance-by-design in product development of anything complicated (Furr, 2023).

Summing up, the discussion confirms that strategic decision, management, and training programs are powerful but mutually dependent concerning laboratory performance. Their application to the Jianghuai situation shows that the development of the sphere frequently brings about the development of other contradictions. The fundamental value of the current research is the explanation of these context-specific trade-offs, the compliance-agility paradox, the collaboration-specialization dilemma, and the sustainability-alignment gap in training. It adds to the theoretical frameworks created under other settings, as well as offers a more detailed approach to performance management in policy-intensive car-R&D ecosystems.

5.4 Limitations and Future Research

Although this qualitative case study offers detailed information about Jianghuai Laboratory, there are some methodological limitations. First, both the small sample size and qualitative approach limit its generalizability. According to Saunders et al. (2023), the results of one case study, though rich in detail, cannot be statistically applied to the overall population of automotive R&D laboratories. Second, the sampling frame creates the possibility of bias. The intentional sampling of the participants in one organization in the Chinese setting of a particular policy context might not entirely represent the variation of the experiences of various regions or corporations (Yin, 2024). Lastly, being a taught Master's research project, the study did not have the time and resources to implement a longitudinal design to track the progression of the performance drivers across product development cycles (Grodal et al., 2021).

These restrictions outline definite avenues of inquiry in the future. To strengthen the external validity, the future study ought to use comparative multi-case studies in dissimilar geopolitical and corporate contexts (e.g., the EU vs. North America). A mixed-methods research, combining a wide-scale survey based on the qualitative topics revealed in this research study, would assist in the statistical confirmation of the suggested relationships. However, the most important thing is that longitudinal studies are necessary to determine how long-term and strategic interventions are sustainable and the effects of strategic and managerial interventions and training on conversion rates in R&D.

5.5 Recommendations

Take into account the results, the following recommendations are offered to automotive R&D laboratories and, especially, those that work in the policy-influenced environment:

In Strategic Decision-Making, agile processes must be institutionalized. However, an exceptional blue-sky research portfolio (e.g., funded by a separate money stream or team) can be officially shielded against the lure of commercial imperative, to avert the erosion of underpinning research.

In the case of Training Programs, embrace a long-term, incremental delivery concept. Keep the dual-track curriculum, only use it mostly via micro-learning and just-in-time modules in order to avoid burnout. Incorporate sustained feedback on training workload into the management of programs.

In the case of Management Practices, clarify hybrid governance by defining the decision-making authority of agile and safety-critical workflows. Solve the collaboration-specialization dilemma: more specialized rotations and establish expert-in-residence positions to retain expertise.

In the case of Performance Management Systems, readjustment of evaluation measurements to the agile operating model. Adding dynamic KPIs (e.g., success of sprints), qualitative measures (e.g., contributions of knowledge-sharing, risk mitigation), and making sure that the incentive system does not punish needed strategic pivots.

5.6 Final Remarks

This exploration has explored the convoluted nature of dynamics that form the basis of performance in a modern automotive research and development lab. The data proves that going beyond the widespread high investment, low conversion issue demands even a significant financial outlay; it demands the synergistic, balanced development of strategy, human resources, and organization (Schwab, 2020; Müller et al., 2023). As the history of the Jianghuai Laboratory shows, progress in one field, whether it is strategic agility, integrative management, or competency development, constantly creates new contradictions in others. As an example, although agile processes have increased the rate of commercialization, they have also led to an overstretched portfolio of research at the base (Liu & Wang, 2024). In this way, it is not the discovery of a single solution that opens the door to a new stage of increased innovation output, but rather the continuous intentional management of fundamental trade-offs: between market-based agility and long-term technological discovery, between cross-functional collaboration and ensuring the high level of specialization, and between rigorous upskilling and workforce sustainability (Teece, 2020; Li et al., 2024). Importantly, the integrative framework and contextual understanding that would be developed by this research would offer a beneficial guide to scholars, practitioners, and policymakers who would have to cope with the challenges of innovation in the busy automotive industry in the world.

5.7 Conclusion

This research has unequivocally resolved the old high investment, low conversion paradox of automotive R&D by demonstrating that it is not an isolated solution, but configurationally aligned three of the key drivers, i.e., strategic agility, integrative management, and dual-track human capital development. The study revealed the interrelations of these factors in enhancing the performance of laboratories. In addition, the trade-offs that proved to be vital to the ecosystems where the policies are the core element, such as the compliance-agility paradox and the collaboration-specialization dilemma, are demonstrated between the ecosystems. The work has made a significant contribution as a form of integrative framework that transcends the siloed approaches, which provides practitioners with a systematic channel within which they can act strategically in respect to the balancing of the dynamic capabilities and the resource-based human capital investments to produce the most optimal results as far as innovation is concerned. Last but not least, this research establishes that the translation gap between the cost of research and development and commercial success can only be overcome by viewing it as a complex whole and having a clear policy that has to align the strategy, the structure, and the development of the competencies in the context of complex automotive innovation environments (Teece, 2020; Ngo & O’Cass, 2023).

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