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AGILE IN AUTOMOTIVE: A DOMAIN ANALYSIS

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Abstract

This study examines the implementation of Agile methodologies in the automotive industry through domain analysis based on pilot questionnaire data. The research investigates patterns in Agile adoption across different automotive departments, analyzing responses from 44 industry experts representing various organizational roles. The study aims to identify potential approaches for enhancing operational efficiency and cross-functional collaboration while considering industry-specific constraints such as safety regulations, hardware dependencies, and supplier relationships. Through analysis of questionnaire responses, the research explores how traditional automotive development processes interact with Agile practices, and what adaptations may be needed. The findings suggest several considerations for automotive organizations interested in Agile implementation, while acknowledging the limitations of the pilot study's scope and sample size. This work contributes initial insights to the ongoing discussion of Agile methodology adaptation in hardware-centric industries, particularly in contexts with strict regulatory requirements.

Keywords: *agile, automotive, risk management, project management, survey*

1. INTRODUCTION

Automotive industry traditionally has been a strictly standardized industry, controlled by the main global automotive standard, IATF 16949 (Neves et al., 2021). This certification can be obtained by companies acting in the automotive supply chain after the completion of requirements defined by IATF (International Automotive Task Force).

Global trend of IATF 16949 certifications from the past 20 years shows a slow, moderate growth in EU and America regions, meanwhile a fast, almost exponential growth in China region as presented on *Figure 1*.

The trend can be explained generally by the increased market share of Chinese OEMs of electric vehicles over the period (Original Equipment Manufacturer) furthermore macroeconomic, cultural, industrial, sociocultural and governance factors (Neves et al., 2021). Additionally, the product life-cycle of Asian automakers are less (1.5–2 years) than European automakers (3–4 years) (Sabadka et

al., 2019). Therefore, the speed of innovation to industry application becomes increasingly more important to be successful.

European Union acknowledged the challenges associated with the growth of Chinese automotive performance for the European economy and defined a strategy to improve competitiveness of European automotive sector (Draghi [Part A], 2024). Based on the findings EU needs to improve the productivity of the industry and support a more efficient transformation of research and development results to industrial practice, called „innovation gap" (Draghi [Part B], 2024).

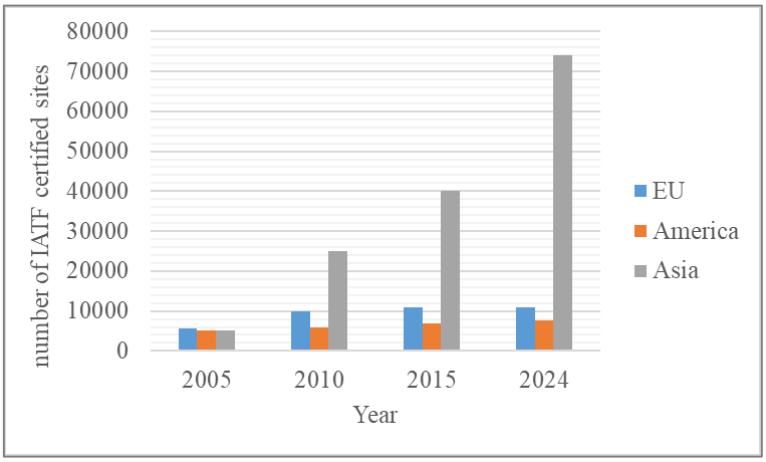

Figure 1. *Number of IATF 16949 certificates issued by regions*

A possible way to improve the innovation gap and support the industrialization of new ideas is to improve the technical, quality and project management aspects of the automotive new product development (Lin et al., 2006), (van Iwaarden et al., 2012). Traditionally the product development in the automotive industry is driven by plan-based "waterfall" project management principles (Goicoechea et al., 2012), (Bhise, 2017), (Kasauli et al., 2020), howerer there is an increasing trend to explore the advantages of agile project management methods (agile project management is an iterative approach to delivering a project throughout its life cycle) (Venczel, T. B. et al., 2024), (Askarpour et al., 2024), (Atzberger et al., 2023), (Christopher, 2000).

This research addresses a critical gap in understanding how the automotive industry can adapt its development processes to meet contemporary challenges. While the traditional waterfall approach has served the industry well during periods of relative stability, the current automotive landscape is characterized by unprecedented disruption. The convergence of electrification, digitalization, and intense competition from Asian manufacturers has created an urgent need to reassess established development methodologies.

The significance of this research lies in three key aspects. First, it provides empirical insights into how industry practitioners view the potential of agile methodologies in an industry that has historically relied on rigid, plan-driven approaches. This is particularly relevant as the automotive sector faces pressure to reduce development cycles while maintaining the stringent quality and safety standards mandated by IATF 16949. Second, the research addresses the practical challenges of implementing agile methods in a highly regulated industry, where any modification to development processes must be carefully balanced against compliance requirements. Third, by focusing on expert opinions from within

the industry, this study offers valuable insights for organizations contemplating the transition towards more flexible development approaches to close the innovation gap with Asian competitors.

The motivation for this research stems from the urgent need to address the European automotive industry's competitiveness challenges, particularly in relation to the rapid advancement of Chinese manufacturers. While previous studies have examined agile adoption in various industries, there is limited research specifically addressing its application in the automotive context, where the stakes of process changes are particularly high due to safety-critical requirements and complex supply chains. Understanding industry experts' perspectives on agile adoption can provide crucial guidance for organizations attempting to balance the seemingly contradictory demands of increased development speed and maintained quality standards.

The target of this study is to understand the opinion of industry experts related to agile in automotive industry. Specifically, the main research questions if there are any trends or patterns formulated by automotive experts which supports the idea to implement agile in automotive industry. Using an online survey data has been collected from 44 automotive industry experts from a representative group for a pilot study. Characteristics of the survey and results are detailed in the following chapters.

2. RESEARCH DESIGN

2.1. Sample characteristics

Data was collected online from respondents between 1st April 2024 and 15th May 2024 using Microsoft Forms (Rhodes, 2022) platform. The research sample consists of 44 evaluations. Sample characteristics are summarized in *Table 1*.

Majority of respondents' company supplies physical hardware (88.7%) and most of the respondents working as engineers (47.7%). Research, Development, Engineering is the most represented department with a total share of 47.7%. Respondents have experience working with customers, only 9.1% answered they never work directly with customers. Most representative country is Hungary, with 75% response percentage. Work experience has been divided to automotive (average 13.5 years) and agile (average 3.6 years) which shows agile in not matured in automotive industry yet based on this sample.

Table 1. *Table caption*

Grouping factors		Number	% sample
Company product is software or hardware.	Software	4	9.1%
	Hardware	39	88.7%
	Other	1	2.2%
Company role level.	Engineer	21	47.7%
	Leadership / Management	13	29.5%
	Director / Executive	10	22.7%
Department.	Research, Development, Engineering	21	47.7%
	Production, Manufacturing	8	18.2%
	Quality Assurance and Compliance	6	13.6%
	Strategy and Business Development	3	6.8%
	Other	6	13.6%

Grouping factors		Number	% sample
Customer collaboration frequency.	Never	4	9.1%
	Very rarely	8	18.2%
	Rarely	5	11.4%
	Occasionally	6	13.6%
	Frequently	12	27.3%
	Very frequently	9	20.5%
Country.	Hungary	33	75.0%
	Turkey	1	2.3%
	Mexico	1	2.3%
	Germany	1	2.3%
	Spain	1	2.3%
	USA	4	9.1%
	Poland	2	4.5%
	UK	1	2.3%
Work experience in automotive industry (years).	Less than 10 years	22	50.0%
	10 years to 20 years	11	25.0%
	More than 20 years	11	25.0%
Work experience working with agile (years).	Less than 10 years	40	90.9%
	10 years to 20 years	3	6.8%
	More than 20 years	1	2.3%

2.1. Survey results

To understand the attitude of the respondents certain questions have been asked related to their general risk attitude and their technological adoption propensity (Berényi et al., 2021). Afterwards, specific questions have been raised related to aspects of automotive and agile. Respondents were asked to rate the statements on a 5-point Likert scale.

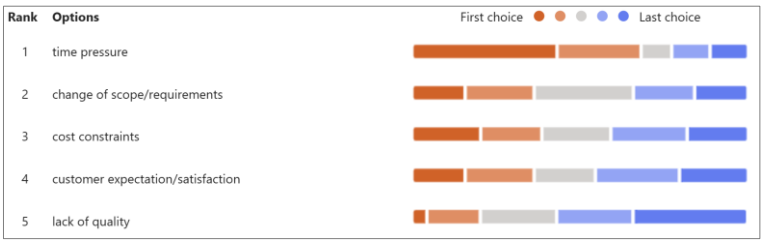

Figure 2. *Summary result of survey question:*
"Please prioritize the constraints that you experience most often in your day-to-day work."

Respondents rated time pressure as their most significant constraint in day-to-day work *(Figure 2)*. This is in line with initial expectation based on the accelerating nature of automotive industry nowadays as described in Introduction. The sample shows a high technology acceptance behavior as represented on *Figure 3*.

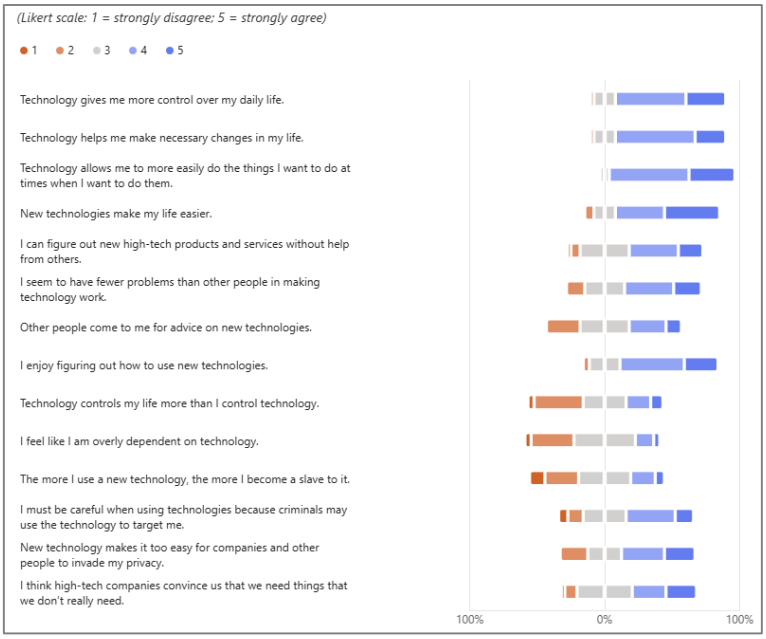

Figure 3. *Summary result of survey question:*
"Please describe yourself based on the following statements."

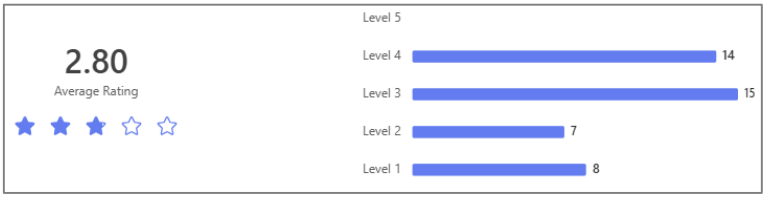

Figure 4. *Summary result of survey question:*
"How familiar are you with the concept of Agile methodology? (More stars equal more familiarity.)"

Respondents rated familiarity with agile *(Figure 4)* to 2,8 on a 5-point scale and none of them gave a top level 5-rating - which suggests there are no experts of agile within the sample based on their self evaluation and furthermore, the chosen automotive experts have and average knowledge of agile.

Based on the free-text responses *(Figure 5)* the participants commonly associated agile with breaking projects into smaller steps (e. g., sprints), fostering collaboration in cross-functional teams, and maintaining a customer-focused approach through continuous feedback and flexibility *(Figure 6)*.

While many highlighted its value as a mindset for dynamic, high-quality project execution, some expressed concerns about potential pitfalls, such as over-reliance on individuals or misconceptions equating agile to traditional linear methods.

Figure 5. *Word-cloud of free text survey question:*
"Please briefly describe your understanding of the main principles of Agile methodology."

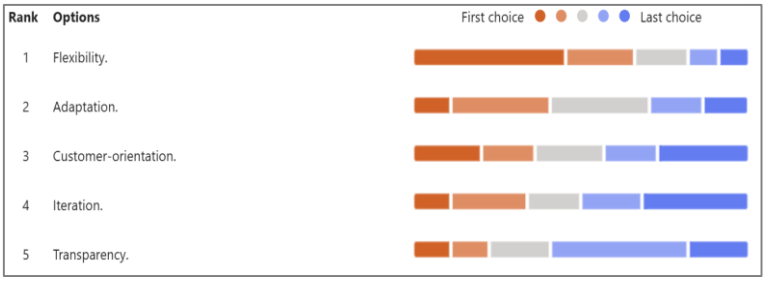

Figure 6. *Summary result of survey question:*
"Please prioritize the words that you most closely associate with Agile."

Respondents rated 2.82 the automotive industry being agile on a 5-point scale *(Figure 7)*, which suggest room for improvement to improve agility of companies within automotive supply chain. There is a visible agreement on the question *"The processes within my team are effective and non-bureaucratic."* as it received the **lowest** overall rating to the question "Please indicate your agreement with the following statements.", see *Figure 8.* On the same figure it is visible that *"Clear priorities are set within my team."* received the second-lowest rating. Respondents identified Tier-1 supplier level to be the most benefiting supply chain level from using agile *(Figure 9)*, followed by OEMs as second.

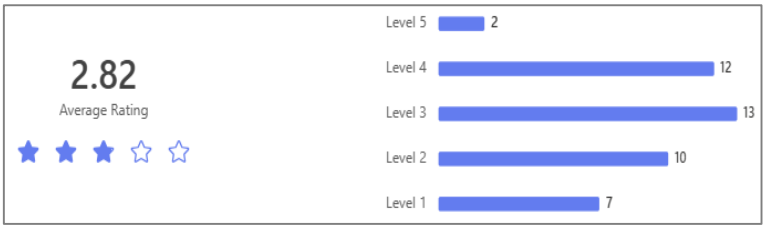

Figure 7. *Summary result of survey question:*
"Do you consider companies part of automotive industry as Agile companies?"

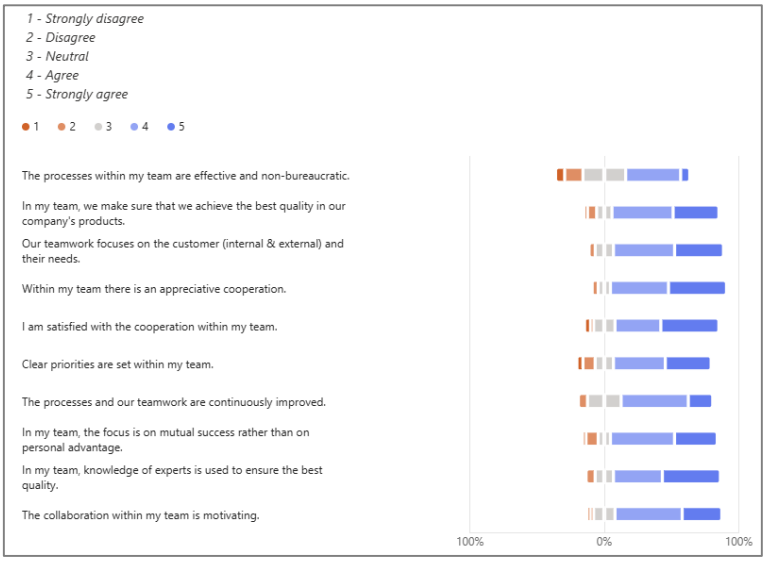

Figure 8. *Summary result of survey question:*
"Please indicate your agreement with the following statements."

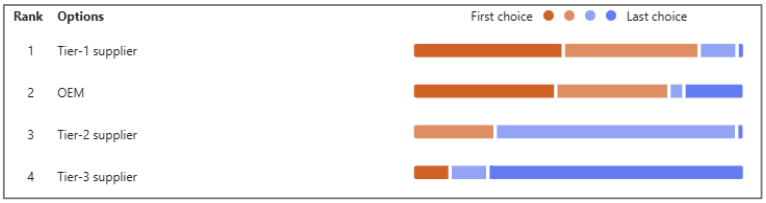

Figure 9. *Summary result of survey question:*
"Rank the automotive supplier levels in terms of potential benefits from implementing Agile."

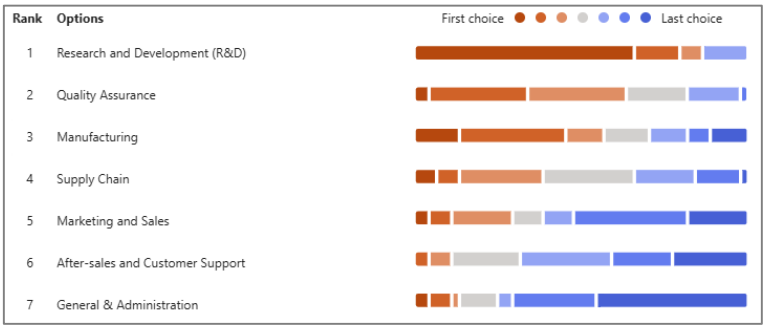

Figure 10. *Summary result of survey question:*
"Rank the following automotive departments based on the perceived benefits of using agile."

Most benefiting department is Research and Development, followed by Quality Assurance and Manufacturing, which suggest based on expert judgement Product Development can benefit mostly from agile *(Figure 10)*.

Asking agreement of automotive related questions, the **lowest** agreement rating have been received for *"Responsibilities are always clear for everybody."*, *"Decisions are made quick and effective."*. **Highest** agreement rating has been received for *"Project nowadays are more complex than in the past."* and *"Automotive suppliers must be flexible to cope with challenges." (Figure 11)*.

Figure 11. *Summary result of survey question:*
"Please rate your agreement with the following statements about the automotive industry."

Figure 12. *Word-cloud of free text survey question:*
"Please briefly describe the advantages or benefits of agile methodology."

The free-text feedback analysis reveals several notable *benefits* of agile methodology *(Figure 12)*. The most frequently cited advantage is its flexibility, enabling teams to adapt quickly to changes in project requirements. Agile responsiveness supports faster decision making, feedback loops, and problem solving. It enhances collaboration by improving communication, transparency, and teamwork, while also focusing on customer satisfaction by aligning closely with customer needs. Additional benefits include higher productivity, risk reduction, and the ability to deliver projects incrementally, allowing for early testing and validation of deliverables. These attributes make agile particularly effective in dynamic and customer-driven environments.

The free-text feedback analysis highlights several key *limitations* of agile methodology *(Figure 13)*. A major concern is its dependency on skilled leadership and highly disciplined team members, making it challenging in cases of inadequate training or experience. Additionally, agile flexibility often leads to unpredictability, increased workload, and a lack of long-term focus. Implementation can be particularly difficult in industries like manufacturing, where mistakes are costly, and in remote work settings, where physical proximity is limited. Finally, insufficient organizational knowledge and resource constraints further impact agile's effectiveness.

Figure 13. *Word-cloud of free text survey question:*
"Please briefly describe the disadvantages or limitations of agile methodology."

3. Summary

The pilot survey based on the feedback of 44 automotive experts revealed interesting insights related to agile in automotive. The automotive industry faces increasing pressure to adapt to rapidly changing market demands while maintaining efficiency and quality standards.

The time pressure reflected as well in the responses as participants concluded it as number one constraint in their daily job. Agile implementation seems not to be limited by technology acceptance behavior as the sample has generally high technology acceptance. Experts closely associate agile with flexibility – however the method has several other characteristics.

Automotive companies are not considered being more agile than average, so there is room for improvement in this area. This gap especially reflected in the feedbacks related to ineffective processes, unclear priorities/responsibilities and slow decision-making in automotive industry. Furthermore, experts agree that automotive projects are more complex nowadays in the past and supplier must be flexible to cope with future challenges, which suggest there are room for improvement in technical management methods, where agile could be a potential improvement direction.

Most benefiting departments of agile can be Research and Development, Quality Assurance and Manufacturing, however detailed future analysis necessary to understand which components of agile could lead to improvements in the specific domains.

There are also challenges associated to implement agile. A major concern it's dependency on skills and discipline, additionally that it can lead to unpredictability on long term.

The above-mentioned conclusions suggest there is a motivation in the automotive industry to implement agile. Therefore, we can answer to the research question – are there any trends/patterns based on automotive experts to implement agile? Certainly, as there is an agreement that automotive will face challenges which requires more effective processes and flexibility. The direction of future studies should be to investigate how agile can be implemented to automotive, especially in product development, furthermore, how to control management processes with agile mindset (e. g., definition of agile KPIs for major processes).

A limitation of the survey that majority of the answers received from Europe, therefore a continued global survey with a higher number of participants could highlight further global trends.

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