



# **Innovation as a Pillar of Sustainable Economy in the Automotive Industry**

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**Abstract**

In today's rapidly evolving automotive industry, innovation stands as the cornerstone of fostering a sustainable economy. This abstract delves into the intricate relationship between innovation and sustainability within the automotive sector. Exploring the pivotal role of innovation, this paper examines how advancements in technology, design, and manufacturing processes contribute to economic viability while addressing environmental concerns. Through case studies and analysis, it investigates how innovative solutions, such as alternative fuels, smart manufacturing, and electric vehicle development, revolutionize the industry's landscape, fostering economic growth while mitigating ecological impact. By emphasizing innovation as a driver of sustainable practices, this abstract highlights the imperative need for ongoing research and implementation of pioneering strategies in the automotive sector to ensure a balanced convergence of economic progress and environmental preservation.

**Keywords/tags (subjects)**

Innovation, Sustainable Economy, Automotive

**Miscellaneous (Confidential information)**

## Contents

<b>1</b>	<b>Introduction.....</b>	<b>3</b>
1.1	Background, motivation, and purpose.....	3
1.2	Research objectives, questions and approach.....	3
1.3	Thesis structure .....	4
<b>2</b>	<b>Literature review .....</b>	<b>4</b>
2.1	Joseph Schumpeter’s theory .....	5
2.2	Schumpeterian theory of the innovative entrepreneur .....	6
2.3	Theoretical Framework .....	7
2.4	Adapted Research Framework.....	8
2.4.1	First Model of the adapted Research Framework.....	9
2.4.2	Second Model of the adapted Research Framework .....	10
<b>3</b>	<b>Research methods and implementation .....</b>	<b>11</b>
3.1	Research context.....	11
3.2	Research design.....	12
3.2.1	Research purpose .....	12
3.2.2	Research approach .....	12
3.2.3	Research strategy/method/s .....	13
3.2.4	Methodological choice .....	13
3.2.5	Time horizon .....	14
3.3	Data collection .....	14
3.4	Data analysis.....	19
3.4.1	Quantitative data analysis .....	19
3.5	Ethical considerations .....	21
<b>4</b>	<b>Research Results.....</b>	<b>22</b>
<b>5</b>	<b>Discussion .....</b>	<b>24</b>
5.1	Limitations, reliability and validity .....	24
5.2	Answering the research questions.....	25
5.3	Dialogue between key results and knowledge base.....	26
5.4	Compliance with research ethics guidelines.....	27
<b>6</b>	<b>Conclusions.....</b>	<b>29</b>
6.1	Key Findings.....	30
6.2	Managerial implications .....	31
6.3	Recommendations for future research.....	33

References .....	35
Figures.....	36
Figure 1 : the original theoretical framework .....	36
Figure 2 : The Adapted Research Framework .....	36
Figure 3: First Model of the adapted Research Framework : Effects on mediator.....	36
Figure 4: Second model of the adapted Research Framework: .....	36
Figure 5 : Result of the effects of mediator.....	36
Figure 6 : Results of the second model of the adapted Research Framework .....	36
Tables.....	37
Table 1: Effect of DT on DTIC.....	37
Table 2: Effect of DT and DTIC on PRDP .....	37

# **1 Introduction**

## **1.1 Background, motivation, and purpose**

The automotive industry stands at a crossroads marked by the pressing need for sustainable solutions amid economic growth. In today's changing landscape of technology and market needs, the industry is faced with challenges related to impact resource management and economic stability. It's crucial to understand this context to grasp the importance of innovation, as a factor in reshaping the sector. This thesis is driven by the need to explore how innovation can play a role in bridging the gap between progress and environmental sustainability in the automotive field. With increasing mobility demands and growing environmental awareness, there's a call to examine how innovative approaches can harmonize these conflicting priorities.

The main objective of this thesis is to investigate how innovation contributes to building an economy within the automotive sector. By delving into advancements, market trends, and environmental requirements, it aims to demonstrate how innovative strategies and practices can drive economic growth while reducing the industry's impact on nature. Through in-depth analysis and real-world examples, this thesis strives to offer insights that inspire research and inform actions towards achieving a balanced blend of economic advancement and environmental responsibility in the automotive industry.

## **1.2 Research objectives, questions and approach**

The aim of this research would be to examine the impact of technological and procedural innovations on the sustainable economy within the automotive industry. The study is, therefore, motivated with the need to understand how some of these innovations help in performance improvement in the economics and sustainability for companies within the sector. One of the key focuses is the recent changes, held to carry relevance as essential innovation in the automotive industry for the sake of sustainability. The study further proceeds to try and establish the impact that these innovations have on different indicators of the economic performance of companies, such as profitability, market share, and operational costs.

These two simple yet profound questions seem to be central for this exploration: What is sustainability in the context of the automotive industry, and what innovative changes serve as pivots

to this particular industry in a direction that is sustainable? And the real impacts on economic performance for companies within the automotive field.

This research is a completely quantitative approach that focuses on the data analysis of sustainable innovations in the automotive sector and their influence on economic performance. In this context, it has to be underlined that the data needed for the present analysis are to be drawn from some rigorous secondary data sources: corporate annual reports, specialized databases on the automotive industry, and a set of academic publications having direct relevance to the subject. The paper will use advanced statistical techniques, especially regression models, to assess the relationship between the adoption of sustainable innovations and economic performance in companies. This strategy tends to focus on valuable insights regarding the strategic significance of sustainable innovations to foster economic growth and competitive promotion in the automotive sector.

### **1.3 Thesis structure**

The thesis is composed of a total of six chapters. This introduction chapter presents the background, motivation, and purpose, in addition to the research objectives, questions and approach. The second chapter introduces the main concepts from the previous work and existing theories, to collect and discuss existing knowledge that helps us to elaborate the research framework. The third chapter details the research design while in the fourth chapter. In the fifth chapter, we conclude from the evidence gathered in the analysis of the results in relation to the initial objectives and research questions. Finally, in chapter 6, we discuss the limitations of this empirical study, how much we answer the research questions and present the future research to deepen the subject.

## **2 Literature review**

Several authors of different currents tried to treat the concept of the innovation, in this part we will proceed to an analysis of the different theories and scientific works, treating the economic innovation. The concept of the innovation gave rise to several literatures of various currents. That of JOSEPH SCHUMPETER, who is considered to be one of the pioneers of the theory of innovation.

## 2.1 Joseph Schumpeter's theory

Joseph Schumpeter (1883-1950) was a great economist, but also a social scientist. He mixed several disciplines in his analyses, just like Marx. His famous theory of "creative destruction" helps explain economic fluctuations and the fundamental role that innovation plays in economic growth. (Tremblay, 2003)

Among the main works of Schumpeter known by "the theory of development", in this framework the author developed the real theory of innovation in which presented his analysis of the link between innovation and economic development

Schumpeter considers that capitalism is a dynamic composed of long movements, growth cycles and crises that follow one another. However, it is precisely innovation, defined as a process of creative destruction, that constitutes the driving force of this dynamic.

In his early work, the author considers innovation as the result of the work of a particular economic agent: the individual entrepreneur who breaks the circular flow of the economy by betting on the future demand for new products or processes, on the opening of a new market, on the use of a new natural resource, or on the organization of an entire sector of the economy (Badillo, 2013 pp. 19-34.)

Schumpeter considered that innovations are conceived during periods of crisis, before they themselves fuel growth. In his later works - those of the second Schumpeter - the author focused on large innovative firms. They replace the individual entrepreneur and small innovative firms, because in the end, only they have the financial means to support innovation.

The definition of innovation is modified by this new approach. Indeed, for the author, innovation becomes the result of routine R&D work performed in large industrial research laboratories. He considers that it is teams with certain highly specialized skills and carrying out a very routine action that are at the origin of innovation. Although Schumpeter's work was a real breakthrough and was widely taken up afterwards - in particular for the definition of innovation as an endogenous process integrating technological and organizational aspects - Schumpeter nonetheless fundamentally opposed the small firm to the large one, without taking into account the complementarity that can exist between the two.

His approach remains far from taking into account the interactive and cumulative nature of innovation and the multiplicity of its sources.

Schumpeter gives great importance to innovation within the firm, and therefore insists that each entrepreneur develop a strategy focused on innovation. The orthodox theory sees the firm and its actions as the result of the inanimate forces of supply and demand, and innovation as a black box, in other words an invisible process in which inputs are simply transformed into outputs.

## 2.2 Schumpeterian theory of the innovative entrepreneur

After having treated the importance of innovation as a strategic axis for the company, Schumpeter comes after to speak to us about the concept of the innovative entrepreneur. The objective of this part is to show how Schumpeter privileged an innovative entrepreneur, Schumpeter does not consider him as a simple owner of a company, but he is a person who experiments and tests the so-called new combinations of resources, with these he can create with his collaborator's new products and services and new methods of production.

For Schumpeter, the entrepreneur is the only one capable of stimulating growth through these innovations. As a kind of adventurer who overcomes social resistance to change, he benefits from a great confidence in his project and its success, from a total absence of complexes, from an ability to accept failure, to test, to re-evaluate and often from an obsession with simplicity. (Diane-Gabrielle Tremblay, n.d.) According to Joseph Schumpeter, creative destruction is a process that is continually at work in economies and that sees the simultaneous disappearance of entire parts of the economy in conjunction with the emergence of new sectors of activity.

According to Schumpeter, "crises are salutary, tilting acquired positions and allowing the exploration of new ideas that generate innovation.

As we have already mentioned, Schumpeter spoke of the innovative entrepreneur, in these analyses presented on the innovative entrepreneur, highlighting two major concepts that are central to these analyses: the circuit and evolution.

In this analysis, we will focus on the second concept. To get out of the circuit, that is to say "from the circuit to the evolution", without going through a new combination of production factors. Adding the point of view of form, evolution is defined as the displacement of a state of equilibrium discontinuous in its pace and economic in its origin, or more briefly as the spontaneous and discontinuous modification of the course of the circuit.

This evolution results from the execution of a new combination which can take five forms:

- 1- The manufacture of a new good.
- 2- Introduction of a new production method.
- 3- The opening of a new market.
- 4- The conquest of a new source of raw material.
- 5- The realization of a new organization.

As a synthesis, the realization of this new combination which characterizes the company, it is first of all the specific function of the entrepreneur. Thus, all the economic dynamics and the evolution of the activities of the firm derive from this fundamental event, which for Schumpeter is the specific function of the entrepreneur, namely the realization of new combinations of factors of production.



Innovation is thus central in Schumpeter's vision and in his conception of the global strategy of the firm. (Diane-Gabrielle Tremblay, n.d.)

Between the still unresolved debates on the distinction between invention and innovation, incremental innovation and radical innovation, research and development and its link with this process, the scientific and technical dimensions and the different types of innovation, innovation remains a controversial term (Carrier and Garrand, 1996). Schumpeter in (1934) identifies five types of innovation, namely:

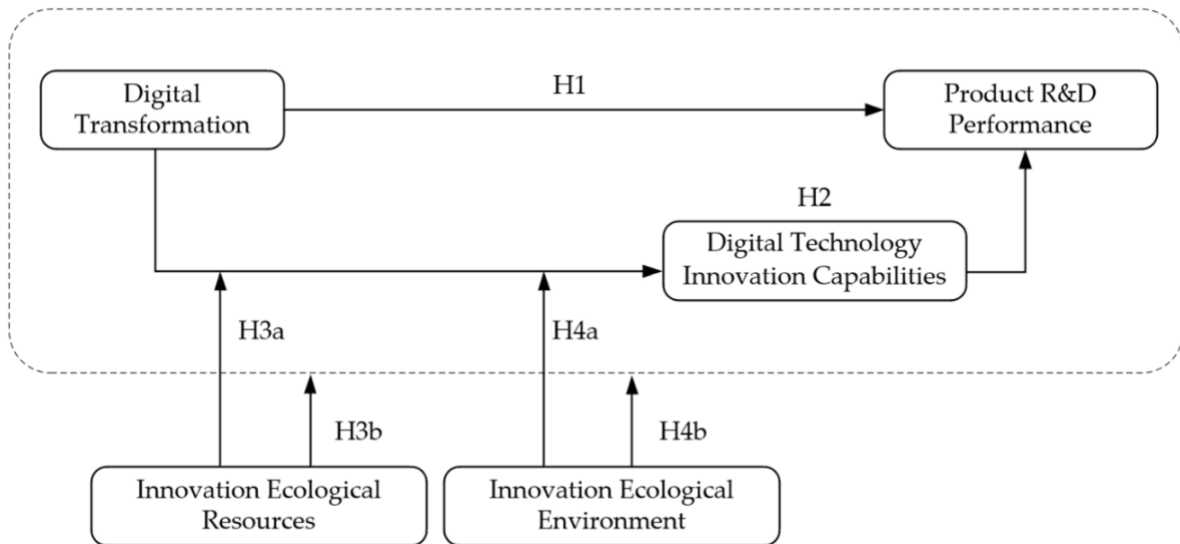
- 1) product innovation: which can be radical/disruptive if it involves entirely new categories of products, or incremental/sustained, if it involves the improvement of existing categories. (Burgelman and Maidique, 1988; Christensen, 1997),
  - 2) process innovation, which involves the introduction of new modes of production,
  - 3) the opening of new outlets and markets,
  - 4) the development of new sources of supply of raw, semi-finished or finished materials  
finished or finished materials
  - 5) the development of a new organization in an industry: These same types have been
- These same types have been taken up by the CAAAQ and the APIA (2007) and completed by the OECD manual integrating marketing innovation, which is aimed more at the service industry.

### **2.3 Theoretical Framework**

The theoretical framework for this study is deeply rooted in the pioneering work of Feng Men (2023), which provides a critical analysis of the intricate interplay between digital transformation and the innovation ecosystem within the automotive industry. This thorough research framework expands the evaluation of product research and development performance, by incorporating aspects of digital transformation. Our study enhances this concept by using a nuanced two method with two linear regression models. These models are carefully designed to analyze the intricacies of the indirect connections related to transformation (DT) digital transformation innovation capability (DTIC) and product R&D performance (PRDP) in automotive companies. The first model focuses on how DT influences DTIC laying the groundwork for exploring how digital transformation initiatives enhance innovation capabilities for cutting edge product development. The goal is to understand how investments in digital transformation lead to innovation capacity thereby boosting an enterprises R&D effectiveness. The second model goes further by examining both the impact of DT on PRDP and the significant mediating role of DTIC. This detailed analysis aims to uncover the relationships between digital transformation processes and their impact on product R&D outcomes.

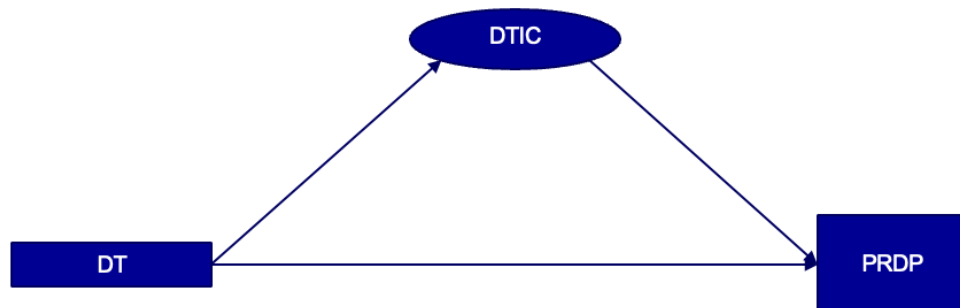
It emphasizes DTIC as an intermediary that not guides but also magnifies the advantages of DT, in tangible R&D enhancements.

**Figure 1 : the original theoretical framework**



## 2.4 Adapted Research Framework

**Figure 2 : The Adapted Research Framework**



Integrating these models furnishes a holistic view of the causal pathways and enables a rigorous evaluation of the mechanisms through which digital transformation exerts its multifaceted effects on product development performance. This dual method also enables the separation of the steps providing a look, at how the operational workings of the innovation environment function, in the realm of digital change.

In our study we have carefully designed a research framework that is divided into two regression models to understand the indirect impact of Digital Transformation (DT), on Product Research and Development Performance (PRDP) while also exploring the mediating role of Digital Technology Integration Capability (DTIC).

Together, these two models furnish a comprehensive narrative of the cascading impact of digital transformation within the automotive industry. They enable us to parse out the direct effects from the more subtle, indirect influences, offering a rich tapestry of insights into the multifaceted nature of digital innovation's role in shaping the future of automotive R&D. This elegantly adapted framework thus stands as a testament to the synergy between digital maturity and innovation prowess, a duality that is now quantifiably linked to R&D performance in the context of our study.

#### **2.4.1 First Model of the adapted Research Framework**

The first of these models is a focused lens on the direct influence that DT exerts on Digital Transformation Innovation Capability (DTIC). This direct path analysis is essential to demystify how the infusion of digital technologies catalyzes the innovative processes within automotive enterprises, further spawning an environment where creativity and technological progressiveness drive R&D activities.

**Figure 3:** First Model of the adapted Research Framework : Effects on mediator

### Model 1: Effects on mediator



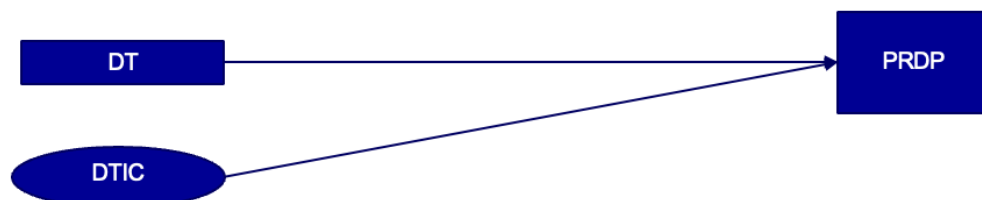
$$DTIC_i = \alpha_0 + \alpha_1 DT_i + \varepsilon_i$$

### 2.4.2 Second Model of the adapted Research Framework

The second model transcends the straightforward relationship, introducing DTIC as a pivotal intermediary variable that mediates the relationship between DT and PRDP. Through this lens, we discern not only the direct thrust of DT upon PRDP but also how DT first invigorates DTIC, which in turn propels the R&D performance to new heights. This mediating role is a testament to the intricate dance between capability and performance, highlighting the nuanced way in which digital transformation investment translates into R&D success.

**Figure 4:** Second model of the adapted Research Framework:

### Model 2: Direct effects



$$PRDP_i = \beta_0 + \beta_1 DT_i + \beta_2 DTIC_i + \varepsilon_i$$

## **3 Research methods and implementation**

### **3.1 Research context**

The automotive sector is currently experiencing a shift due to the increasing emphasis on sustainability and technological progress. This transformation has prompted a focus on innovation as a driver of change influencing how the industry approaches growth and environmental stewardship. Our research takes place within this evolving landscape amidst the transition towards sustainable economies and the demand for environmentally friendly transportation solutions.

Our study contributes to the conversation about sustainability in the industry by investigating how companies are using digital technologies to improve their product research and development outcomes. Specifically we examine how digital transformation, which involves incorporating technology across all business functions is fostering avenues, for innovation and reshaping competition within the sector.

At this moment old school car companies are facing competition, from players, in the market changing consumer tastes and strict regulations pushing for emissions and better resource management. The research is contextualized by these challenges and explores how embracing digital transformation can act as a differentiator and growth enabler for companies.

In this scenario the study focuses on investigating how digital transformation innovation capability (DTIC) acts as a mediator, between transformation initiatives and product R&D performance. The emphasis is on grasping these connections to inform decisions in an industry marked by changes and advancements.

The location and timeframe of the study also have a role in shaping its context. If the study is limited to an area or covers regions this aspect should be acknowledged as it could impact the relevance and generalizability of the results. Likewise highlighting any industry occurrences or milestones during the research period can provide context depth.

## **3.2 Research design**

### **3.2.1 Research purpose**

The aim of this study is to explore practices within the sector and their contribution to sustainable economic development. This preliminary investigation aims to reveal theories and concepts that shed light on how innovation enhances sustainability in the industry while aligning with principles. The evolving and dynamic nature of innovation along with its impact on sustainability presents an issue similar to shifts in fashion trends, over time.

In light of the emerging and sometimes unpredictable factors linked to progress and environmental responsibility in the car industry this study seeks to shed light on these aspects. How they interact.

Through an analysis of how technological progress, government incentives and consumer trends influence the industry's shift towards sustainability this research aims to not comprehend the issue but also spark fresh ideas and theories for future exploration. In this study we will explore new variables or elements, like emerging technologies, market changes and regulatory shifts that are relevant to establishing a sustainable economic framework within the automotive sector. The primary objective is to discuss how innovation can serve as a foundation, for sustainability guiding the industry towards a more environmentally friendly and prosperous path.

### **3.2.2 Research approach**

This study is based on a method, which involves gathering and analyzing data to empirically test a hypothesis or theoretical framework. By following this approach I begin with a hypothesis drawn from existing theories or models related to how innovation contributes to building an economy in the automotive industry.

I believe that the deductive method is crucial, for my research because it offers a systematic way to confirm or question the understanding of how innovation drives sustainability. My hypothesis suggests there is a cause and effect link between adopting practices, in the sector and experiencing subsequent economic and environmental advantages. This method allows for an organized investigation that not only boosts the trustworthiness of the results but also enhances the soundness of the model.

Through an approach I plan to investigate how innovative tactics, like incorporating eco friendly technologies and embracing circular economy principles affect the market success and environmental sustainability of companies in the automotive sector. This research aims to enhance our understanding in this area and provide insights, for industry professionals committed to building a greener tomorrow.

### **3.2.3 Research strategy/method/s**

For my research I've decided to utilize a survey, in the form of a questionnaire as the method. It aligns well with my research topic. Will be effective in collecting the numerical data required. The questionnaire will consist of questions, where participants will be asked to rate their satisfaction on a scale ranging from 1 to 7. A detailed description of the survey design will be provided in the data collection section, chapter 3.2. The data gathered will be numerical enabling analysis using SPSS software.

Choosing research is especially beneficial when aiming to generalize findings to a population. This approach involves gathering data from a sample that mirrors the target population and employing techniques to deduce patterns and trends that can be applied to the group. In the context of my study using surveys is preferred over interviews as it allows for data collection from a number of respondents, which is essential for gaining insights into the viewpoints of professionals, in the automotive industry.

The use of a survey is strategic as it allows for data gathering, from a group highlighting how the industry views innovation as crucial for a sustainable economy. Although not as detailed as interviews the responses give a perspective on the attitudes and beliefs held by automotive professionals. This method is especially useful for understanding how innovation impacts the industrys shift towards sustainability.

### **3.2.4 Methodological choice**

I've chosen to employ a mono-method approach, specifically a quantitative questionnaire, for my research. Consistently using one method ensures uniformity in data gathering and analysis, which bolsters the reliability of my results and minimizes potential biases that could arise from mixed-

methods. After evaluating various options, a single-method exploratory approach using a quantitative survey emerged as the most practical for my needs. It will allow for the swift collection of extensive data. However, it's worth noting that this singular approach might limit the scope of my findings' validity.

### **3.2.5 Time horizon**

This study utilizes a cross-sectional design to collect data at a single point in time from a sample of automotive industry professionals. The simplicity of this design aids in analyzing data from a specific time period, allowing for the identification of patterns or relationships in the data. It provides a snapshot of the population's views on innovation within the automotive sector at this point in time, useful for understanding the current prevalence of particular opinions, practices, or attitudes related to sustainable economic strategies.

In terms of planning, this research design establishes a future marker, a point at which certain processes will be reviewed or deemed complete. For the purpose of this study, it will help to explore hypotheses or theories about the impact of innovation on the automotive industry). Considering the swift advancements in automotive technology and market dynamics, setting a timeframe is essential, as it ensures the research captures a clear picture of the industry during a time of significant transformation.

## **3.3 Data collection**

The research's foundation lies in data collected meticulously through an online survey carried out using Google Forms. The questionnaire aimed to capture perspectives from parts of the workforce within a specific automotive sales company.

To ensure a range of insights the questionnaire was distributed strategically to employees with roles within the company covering everyone from frontline sales personnel to senior management. This inclusive approach sought to provide a view of the company's innovation capabilities and research and development performance based on experiences.

Furthermore the survey reached across boundaries by involving employees, from nationalities. This allowed for data collection that reflects experiences and viewpoints enhancing the depth of analysis.



The diverse group of participants brought together a mix of perspectives, from the company's employees allowing for a chance to explore how cultural differences could shape views, on transformation and its effects.

The survey received, over 100 responses in total showing a sample size that adds credibility to the results. The high response rate indicates interest and engagement from employees on topics like transformation and innovation within the company.

To promote openness and honesty participants were guaranteed anonymity and confidentiality for their responses. The survey included both closed questions for analysis and open ended questions to gather qualitative insights on how employees perceive digital transformation in relation to their work in R&D.

The data collected offer a snapshot of the status of transformation in the organization laying a foundation, for testing hypotheses and exploring how digital transformation innovation capability impacts product R&D performance.

Here's the questionnaire:

DQ1 What is your age group?

11-26 (Gen Z)

27-42 (Millennials)

43-58 (Gen X)

59-68 (Boomers II)

69-71 (Boomers I)

78-95 (Post War)

96-101 (WWII)

DQ2 What's your nationality?

DQ3 What is your gender?

Male

Female

Non-Binary

Prefer not to say

DQ4 What's your position in the company?

Mechanic

Sales

Management

Finance

Human Resources

Prefer not to say

Other

DT1: The car dealership continuous to increase its investment in digital software and hardware.

Strongly disagree 1 – 7 Strongly agree

DT2: The car dealership digital technology integration and application ability is strong.

Strongly disagree 1 – 7 Strongly agree

DT3 : The car dealership promotes digitalisation of management processes.

Strongly disagree 1 – 7 Strongly agree

DT4: The car dealership adopts digital technology to transform and upgrade pre-sale and after-sales services.

Strongly disagree 1 – 7 Strongly agree

DT5: The car dealership develops digital services.

Strongly disagree 1 – 7 Strongly agree

DT6: The car dealership is willing to promote digital skills and management knowledge.

Strongly disagree 1 – 7 Strongly agree

DT7: There is internal consensus in the car dealership that the use of digital technology and digital management is conducive to dealership development.

Strongly disagree 1 – 7 Strongly agree

DSP1: The sales volume of cars and services of the car dealership is higher than that of the same type of competitors.

Strongly disagree 1 – 7 Strongly agree

DSP2: The sale success rate of the car dealership is higher.

Strongly disagree 1 – 7 Strongly agree

DSP3: The cost of sales in the car dealership can be controlled within the budget.

Strongly disagree 1 – 7 Strongly agree

DSP4: The cars and services offered by the car dealership can reach easily the target market.

Strongly disagree 1 – 7 Strongly agree

DTIC1: The car dealership digital equipment investment accounts for a high proportion of the total internal expenditure of the company.

Strongly disagree 1 – 7 Strongly agree

DTIC2: The cost of the car dealership digital technology transformation accounts for a higher proportion of new investment in fixed assets.

Strongly disagree 1 – 7 Strongly agree

DTIC3: Digital technologies transformation are readily accepted by the employees.

Strongly disagree 1 – 7 Strongly agree

DTIC4: Top management puts special emphasis to digital technology.

Strongly disagree 1 – 7 Strongly agree

DTIC5: The car dealership is constantly seeking new digital technologies to support services.

Strongly disagree 1 – 7 Strongly agree

IR1: The Car dealerships can easily obtain needed technology (software and hardware) for digital transformation.

Strongly disagree 1 – 7 Strongly agree

IR2: The Car dealerships can easily obtain the knowledge resources needed for digital transformation.

Strongly disagree 1 – 7 Strongly agree

IR3: The Car dealerships can easily obtain the financial resources required for digital transformation.

Strongly disagree 1 – 7 Strongly agree

IR4 : The Car dealerships can easily obtain skilled human resources (Employees) for digital transformation.

Strongly disagree 1 – 7 Strongly agree

II1: The car dealership is located close to many technological (software and hardware) companies supporting digital transformation.

Strongly disagree 1 – 7 Strongly agree

II2: The car dealership is located in a region with favorable policies for the application of digital technology.

Strongly disagree 1 – 7 Strongly agree

II3: The car dealership is located in a region with better digital technology infrastructure.

Strongly disagree 1 – 7 Strongly agree

II4 : The car dealership represents multiple car manufacturers demanding digital transformation.

Strongly disagree 1 – 7 Strongly agree

### 3.4 Data analysis

#### 3.4.1 Quantitative data analysis

**Table 1:** Effect of DT on DTIC

<b>Model Summary</b>				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,499 <sup>a</sup>	,249	,241	,5189

a. Predictors: (Constant), DT

<b>ANOVA<sup>a</sup></b>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8,922	1	8,922	33,139	<,001 <sup>b</sup>
	Residual	26,922	100	,269		
	Total	35,843	101			

a. Dependent Variable: DTIC

b. Predictors: (Constant), DT

<b>Coefficients<sup>a</sup></b>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,491	,549		4,535	<,001
	DT	,560	,097	,499	5,757	<,001

a. Dependent Variable: DTIC

The regression is significant on the significant level lower than 0.001 (see ANOVA table). Almost 25% of the variability of DTIC is explained by DT (see R Square on Model Summary table). Variable DT has a significant effect on DTIC with the coefficient 0.56. It means that one unit change on DT variable transmits with 0.56 unit change on DTIC variable (See Coefficients table).

**Table 2:** Effect of DT and DTIC on PRDP**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,545 <sup>a</sup>	,297	,283	,46988

a. Predictors: (Constant), DT, DTIC

**ANOVA<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9,233	2	4,616	20,909	<,001 <sup>b</sup>
	Residual	21,858	99	,221		
	Total	31,091	101			

a. Dependent Variable: PRDP

b. Predictors: (Constant), DT, DTIC

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,187	,546		4,004	<,001
	DTIC	,263	,091	,282	2,902	,005
	DT	,362	,102	,346	3,560	<,001

a. Dependent Variable: PRDP

The regression is significant on the significant level lower than 0.001 (see ANOVA table). Almost 30% of the variability of PRDP is explained by DT and DTIC (see R Square on Model Summary table).

Variable DT has a significant effect on PRDP with the coefficient 0.362. It means that one unit change on DT variable transmits with 0.362 unit change on PRDP variable (See Coefficients table).

Variable DTIC has a significant effect on PRDP with the coefficient 0.263. It means that one unit change on DTIC variable transmits with 0.263 unit change on PRDP variable (See Coefficients table).

Additionally, we can calculate indirect and direct effect of DT on PRDP:

Indirect effect of DT on PRDP is  $0,56 \times 0,263 = 0,14728$ ,

Direct effect of DT on PRDP is 0,362,

Total effect of DT on PRDP is  $0,14728 + 0,362 = 0,50928$ .

### **3.5 Ethical considerations**

In conducting research, particularly within the domain of the automotive industry, it is imperative to navigate the ethical dimensions with the utmost integrity and adherence to scholarly standards. The ethical considerations in this thesis are founded on the principles of respect, confidentiality, and the voluntary nature of participation.

**Informed Consent:** At the forefront is the acquisition of informed consent. Participants were provided with detailed information regarding the purpose of the research, the nature of their involvement, and the scope and use of the data being collected. Each participants agreement to participate was based on understanding of their rights and the research implications.

**Anonymity and Privacy Protection;** To ensure the safety and confidentiality of the participants steps were taken to maintain anonymity. No personal details were gathered during the survey and strict confidentiality was upheld in handling, storing and reporting the data. Prior, to analysis information collected via Google Forms was made anonymous to prevent identification in the thesis or any subsequent publications.

**Voluntary Engagement;** Participation in the survey was entirely voluntary giving respondents the freedom to withdraw at any time without facing any repercussions. This option was clearly explained to all participants before they joined.

**Prevention of Harm;** The questionnaire was carefully crafted to steer of personal subjects that could potentially cause distress or harm to respondents. It focused on matters related to their experiences and views on digital transformation within their field.

**Data Usage and Security;** The collected data were solely utilized for the purposes outlined in this thesis. Were not shared with parties. Digital data were securely stored with access limited to the researcher while physical copies were safeguarded under lock and key. Following completion of the thesis all data will be disposed of in compliance, with data protection laws and guidelines set forth by JAMK University of Applied Sciences.

The study was carried out to make an impact, on economic practices in the automotive sector. The intention was not just to advance academic knowledge but to potentially benefit the industry and wider society by fostering more sustainable business practices.

Compliance with Institutional Guidelines: Our research, at JAMK University of Applied Sciences followed all the guidelines without any compromise. Before collecting data we ensured that our research proposal was ethically sound and maintained these standards throughout the study.

Reflection on Ethical Practice: Throughout our research process we were mindful of considerations. Reflected on how our actions and behavior as researchers could affect both the participants and the integrity of our study.

By adhering to these principles we guarantee that our research is conducted responsibly and ethically.

## **4 Research Results**

In our exploration of the impact of transformation in the sales sector we conducted a thorough data analysis that uncovered valuable insights into how digital initiatives influence innovation capabilities and product R&D performance. The foundation of these insights was laid by gathering data through a crafted questionnaire completed by over 100 industry professionals from sectors, within the target organization.

The analysis centered around examining the connection, between transformation initiatives and the capability for transformation innovation (DTIC). The statistical significance of this relationship was confirmed with a p value below 0.001 indicating a level of importance. The data suggested a model where digital transformation efforts accounted for 25% of the variance in DTIC as shown by an R Square value of 0.25. The positive regression coefficient of 0.56 between DT and DTIC implies that innovation capabilities are significantly boosted with increased transformation efforts.

Moving to the influence on product R&D performance (PRDP), the results painted a picture of significant direct and mediating effects. The regression model accounted for 30% of the variability in PRDP, a substantial proportion that speaks to the critical roles of both DT and DTIC. Here, DT emerged as a prominent predictor, with a direct effect coefficient of 0.362 on PRDP, signifying that investments in digital transformation yield notable advancements in R&D performance.



The mediating role of DTIC could not be overlooked, with a significant coefficient of 0.263, delineating its crucial position in the digital transformation narrative. This facet of the research underscored the dynamic nature of innovation capabilities in mediating the pathway from digital transformation to R&D performance.

Further analysis to distill the indirect and direct effects of DT on PRDP unveiled that the indirect impact, via the mediating DTIC, stood at approximately 0.14728, while the direct effect was calculated at 0.362. When integrated, the total effect of DT on PRDP culminated at about 0.50928, underscoring the compound influence of digital transformation efforts.

The empirical evidence garnered through this research fortifies the hypothesis that digital transformation serves as a dual force within the automotive industry, directly enhancing R&D performance and concurrently bolstering innovation capabilities that further mediate this enhancement. These results not only validate the significant impact of digital transformation on innovation and R&D performance but also highlight the strategic imperative for automotive enterprises to invest in digital transformation as a pathway to elevated R&D outcomes and sustained competitive advantage.

Figure 5 : Result of the effects of mediator

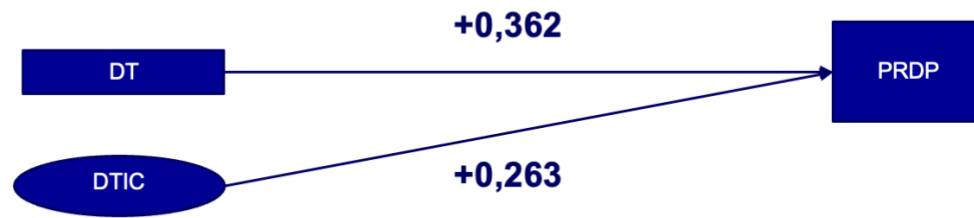
#### Model 1: Effects on mediator



$$DTIC_i = \alpha_0 + \alpha_1 DT_i + \varepsilon_i$$

Figure 6 : Results of the second model of the adapted Research Framework

## Model 2: Direct effects



$$PRDP_i = \beta_0 + \beta_1 DT_i + \beta_2 DTIC_i + \epsilon_i$$

## 5 Discussion

### 5.1 Limitations, reliability and validity

The study navigated within the methodological boundaries set by the choice of a quantitative approach. While this provided a solid statistical foundation, it inherently restricted the depth of narrative data that qualitative methods might have yielded. Moreover the survey was specifically aimed at professionals within an organization potentially limiting the broader relevance of the findings to the industry.

Our research's credibility is established through the administration of our questionnaire. Each participant received questions designed to prevent confusion and analyzed using an analytical approach. Utilizing SPSS software, for analysis further solidified our results in terms of consistency. As we explore this research further it's crucial to pause and reflect on the trifecta comprising limitations, reliability and validity that shape our study's outcomes.

The study worked within the boundaries established by opting for a quantitative approach. While this choice offered a foundation it limited the depth of narrative data that could have been obtained through qualitative methods. Additionally the survey targeted a group of professionals, within an

automotive organization, which may have restricted the broader relevance of the results across the industry.

Our researchs credibility stemmed from administering our questionnaire in a manner. Each participant received the set of questions designed to avoid any ambiguity. Was analyzed using a consistent analytical framework. By utilizing SPSS software for analysis we ensured consistency, which formed a reliable basis for drawing conclusions.

In terms of validity our research was grounded in designing the survey instrument to ensure that the questions aligned with the established framework. We made sure that concepts such as transformation and innovation capability were not defined academically but were also understandable to respondents thereby enhancing the surveys validity. Our analysis relied on methods to strengthen our confidence, in identifying significant correlations and interactions observed.

In the web of this study these factors. Constraints, trustworthiness and accuracy. Are the elements that add depth and richness to our comprehension of the study results. They remind us that while our findings are grounded in rigorous statistical analysis, they are also marked by the contours of our methodological choices. Each finding thus emerges not only as a statement of observed reality but also as a reflection of the research design's inherent characteristics.

## **5.2 Answering the research questions**

The research journey we undertook has led to discoveries, about how transformation, innovation capability and R&D performance intersect in the automotive industry. Each key finding not addresses the research questions we posed. Also engages with existing knowledge providing a modern perspective on Schumpeters timeless insights.

As we delved into the role of transformation our research findings confirmed its significant impact. We have quantified the indirect effects of transformation on innovation capabilities and R&D performance highlighting its multifaceted influence. These results align with Feng Mens propositions from 2023 showing how digital transformation efforts shape innovation within the industry.

Our research reveals that digital transformation initiatives do not operate in isolation; instead they trigger a series of improvements in innovation capacity that ultimately affect R&D performance. This nuanced understanding addresses secondary research inquiries about how transformation influences R&D performance by emphasizing the mediating role of innovation capability, in this process.

The study results also support the idea proposed by Schumpeter that innovation plays a role, in driving activity highlighting the importance of the automotive sectors ability to innovate in the digital sphere, for its growth.

Throughout the study we have consistently followed research practices ensuring that every step, from gathering data to analyzing it has upheld ethical standards. Our research approach has been thorough and respectful of participants rights and data integrity enhancing the trustworthiness and validity of our findings.

This section of the thesis discusses how our research results align with foundations highlighting the academic implications of digital transformation, in the automotive sector.

### **5.3 Dialogue between key results and knowledge base**

The alignment of the studies findings, with established frameworks tells a story, especially when compared to Schumpeter's idea of innovation driving economic vitality. The empirical findings from the dual linear regression models elucidate a significant direct effect of digital transformation (DT) on both digital transformation innovation capability (DTIC) and product R&D performance (PRDP), as well as an indirect effect through the mediating role of DTIC, aligning closely with Schumpeter's emphasis on the innovation process within firms.

The direct relationship observed, where a unit change in DT correlates with a 0.56 unit change in DTIC and a 0.362 unit change in PRDP , resonates with Schumpeterian ideas that innovation is at the heart of economic evolution and growth. This finding underscores DT as an integral element akin to Schumpeter's "new combination of factors of production," where technological

advancements propel forward the innovative capacity of firms, leading to improved product development outcomes.

Furthermore, the study's revelation that DTIC serves as a mediating factor, enhancing the effect of DT on PRDP, encapsulates the Schumpeterian view that the entrepreneur—or in this case, the firm's innovative capabilities—is central to realizing economic growth through innovation. Schumpeter's classification of innovation, which includes new products, new methods of production, and new organizational structures, finds a parallel in the study's findings that digital transformation fosters an environment conducive to such innovative activities.

The research extends Schumpeter's vision by providing empirical support to the assertion that innovation capabilities significantly mediate the relationship between technological advancements and enhanced R&D performance. This is evidenced by the calculated indirect effect of DT on PRDP through DTIC, which adds a quantifiable dimension to the qualitative theories posited by Schumpeter.

Moreover, the adapted research framework's ability to capture the nuances of the indirect and direct impacts of digital transformation offers a contemporary extension to Schumpeter's innovation types, particularly in the context of the digital era where process innovation and organizational changes are heavily influenced by digital technology adoption.

In summary, the dialogue between the study's key results and the knowledge base reveals a harmonious alignment, with the empirical evidence providing a modern counterpart to Schumpeter's theoretical postulates. This synergy not only validates the relevance of Schumpeterian theory in the digital age but also expands upon it, offering fresh insights into the dynamics of innovation and economic growth within the rapidly evolving automotive industry.

#### **5.4 Compliance with research ethics guidelines**

In adherence to the stringent ethical guidelines set forth by the academic and research community, this study has been meticulously designed and conducted with the utmost commitment to ethical research practices. A key focus has been the dedication to respecting the autonomy, privacy and welfare of the research subjects.

**Informed Consent and Voluntary Participation:** The ethical foundation of this research lies in obtaining consent and ensuring participation. Participants were fully informed about the research goals, their role, in it and how their data would be handled. By guaranteeing that participation was both voluntary and well informed participants had the freedom to exit the study at any time without facing any consequences. This empowerment of participants protected their autonomy. Upheld the value of involvement.

**Anonymity and Confidentiality:** The protection of the participants privacy and confidentiality was a focus, throughout the research process. Data collection, through Google Forms was carried out in a way that prevented the gathering of identifying information. The anonymity of responses was rigorously maintained during the handling and analysis of data ensuring that no individual could be identified in the presentation of the studys results or any associated publications.

**Beneficence and Non-Maleficence:** We took care to consider the principle of doing good ensuring that the research would positively contribute to knowledge and the relevant field without causing harm to participants. The survey questions were thoughtfully selected to steer of subjects that could potentially cause discomfort aligning with the principle of avoiding harm.

**Data Handling and Integrity:** The researchs integrity was upheld by following data management practices. The collected data was exclusively used for the research purposes. Only the research team had access, to the data. All electronic records will be securely stored and disposed of in compliance with data protection regulations once the study is completed.

**Compliance with Institutional Standards:** This study adhered fully to the standards set by JAMK University of Applied Sciences. The research proposal underwent review and approval before starting, with a commitment to maintaining these standards throughout the entire research process.

**Ethical Reflexivity:** Continuous reflection on the aspects of the research was integral. Ethical reflexivity ensured an awareness of the implications of every decision and action in the research process. This reflective practice played a role in upholding integrity from start to finish.

By implementing these measures this study not aligns with guidelines but also contributes to advancing ethical research practices, in both business administration and the automotive industry.

## 6 Conclusions

In wrapping up this study we have delved into the exploration of the evolving realm of the automobile sector viewed through the perspective of digital advancement and creativity. Our investigation has been supported by a foundation that incorporates foundational ideas, from Schumpeter and modern perspectives from Feng Men crafting a story that positions innovation as the key driver of lasting economic development, in this crucial industry.

The research methodology, designed with rigor and precision, involved the deployment of a structured questionnaire that effectively harnessed the perceptions and experiences of over 100 professionals from a leading automotive enterprise. The quantitative analysis of this data has provided empirical weight to the conceptual propositions that digital transformation significantly bolsters innovation capabilities, which in turn, positively impacts product R&D performance.

Our findings resonate with the Schumpeterian ethos of creative destruction, demonstrating that digital transformation represents a modern-day embodiment of this concept, fostering the continuous evolution of the industry through innovation. The significant direct effect of digital transformation on innovation capabilities and the subsequent influence on R&D performance aligns with the theorized linkages between technological advancements and economic development.

The study's commitment to ethical research practices has been unwavering, as reflected in the strict adherence to informed consent, confidentiality, and voluntary participation of the respondents. The respect for the participants' rights and the integrity of data collection and analysis procedures has ensured that the study not only complies with but also champions the ethical guidelines of academic research.

As with all research, this study is not without its limitations. The reliance on a quantitative approach and the cross-sectional nature of the design may limit the depth and temporal scope of the findings. However these limitations provide a foundation, for exploration suggesting

opportunities for long term studies or diverse research methods that could expand on the groundwork established by this thesis.

In conclusion this thesis contributes to the pool of knowledge in the business administration and automotive sectors. It serves as a demonstration of the nature of advancements and the lasting significance of Schumpeters theories in todays digital era. By emphasizing the role of innovation in fostering economic development this study adds an essential chapter to the story of how the automotive industry has evolved and paves the way for ongoing academic investigation, into the intersection of technology, innovation and sustainability.

## **6.1 Key Findings**

The main discoveries of this study focus, on the impact that digital transformation (DT) has on both Digital Transformation Innovation Capability (DTIC) and Product Research and Development Performance (PRDP) in the sales sector. The findings, based on data analysis uphold the idea that DT serves as a key driver not only for enhancing PRDP directly but also for indirectly bolstering PRDP by influencing DTIC.

In particular the regression analysis reveals that DT plays a role in boosting DTIC with a coefficient of 0.56. This suggests that for every growth in DT DTIC experiences an increase of 0.56 units. Additionally DT significantly contributes to enhancing PRDP with a coefficient of 0.362 signifying that progress in transformation is closely tied to advancements, in product R&D performance.

Furthermore the significance of DTIC, as a mediator between DT and PRDP is emphasized by an effect of 0.14728 in addition to the effect of DT on PRDP resulting in a total effect of 0.50928. This illustrates a nuanced relationship where DTIC not benefits from DT but also plays a role in translating DT into tangible R&D outcomes.

These results engage with existing knowledge particularly resonating with Schumpeters theory of development through innovation and Feng Mens work (2023) on the impact of the innovation ecosystem on R&D performance in the context of transformation. The modified research framework, utilizing dual linear regression models proves to be a approach for capturing both the direct and indirect impacts of DT on PRDP supporting theoretical propositions and offering



empirical evidence to discussions on digital transformation and innovation in the automotive industry.

In conclusion this study offers insights into the innovation landscape within the sector highlighting digital transformations pivotal role as a catalyst for R&D performance and innovation capacity. These significant findings make an argument for automotive firms to persist in their investments in technologies as a strategic necessity for growth and competitiveness, in an increasingly digitized environment.

## **6.2 Managerial implications**

Based on the discoveries presented in this study there are varied implications, for management especially in the automotive sector undergoing rapid digital evolution that is transforming market dynamics. Here are some valuable strategic insights, for managers derived from the findings of this research;

**Embracing Digital Transformation:** Management needs to view transformation not as an upgrade, in technology but as a crucial strategy. The strong link between transformation efforts and both innovation capacity and R&D performance emphasizes the importance of managers investing in technologies.

**Fostering Innovation Capability:** The key role played by DTIC in enhancing R&D performance underscores the significance of creating an environment that promotes innovation. Managers should focus on building innovation capabilities as an element of their R&D strategies to fully leverage the advantages of transformation initiatives.

**Investment in Technology:** Considering the impact of DT, on PRDP it is recommended that managers consistently allocate resources to technologies. The results of this study indicate that such investments are likely to lead to R&D results thereby strengthening edge.

**Training and Development:** Recognizing the role of DTIC, in enhancing R&D excellence it is crucial for managers to prioritize training initiatives that improve staff members digital skills. This will empower them to make contributions, to the companys innovative projects.

**Strategic Planning:** Moreover leaders must incorporate transformation goals into their plans. The research emphasizes the importance of a strategy that links transformation endeavors with innovation and R&D objectives in order to foster business expansion.

**Resource Allocation:** To make decisions, about where to invest resources it's essential to understand how digital transformation impacts product development and innovation. It's not about investing in technology; it's also about developing the skills needed to make the most of these investments.

**Adaptability and Change Management:** In todays changing industry managers need to be flexible and adept at managing change. Businesses must be ready to embrace technologies that support their growth plans and environmental goals.

**Long-Term Vision:** Having a long range perspective is key for sustaining growth efforts. The findings of this study should encourage managers to see transformation as a journey that requires continuous dedication, rather, than a one time event.

To sum up this study offers managers a justification, supported by data, for integrating transformation extensively into the corporate strategy. The results act as a guide, for utilizing resources to improve innovation and research and development outcomes ultimately driving growth in the automotive sector.

### **6.3 Recommendations for future research**

Based on the findings of this study there are some suggestions, for research in the realm of digital transformation, in the automotive sector. One potential next step could involve carrying out long term studies to track how digital transformation continues to shape innovation and research and development performance over time. This method would reveal lasting impacts and potential changes in how digital transformation influences these areas.

Integrating research methods could enhance our comprehension well. Conducting interviews focus groups and case studies would give a voice to the stories hidden within the data adding depth to the narrative of transformation.

Expanding the research scope to include a range of companies could aid in identifying trends across various market segments company sizes and geographic locations. This approach could lead to applicable findings and shed light on diverse digital transformation experiences, within the industry.

Furthermore conducting analyses with industries undergoing digital transitions could provide valuable insights into sector specific dynamics and the wider impacts of digital transformation across various economic sectors.

Exploring how types of innovation—be it product development, process improvement or organizational restructuring—are influenced by initiatives might reveal strategic focal points for businesses looking to prioritize their digital transformation efforts.

With technologies, like AI, IoT and blockchain maturing it is important to assess their roles in shaping digital transformation and innovation. Understanding the contributions of these emerging technologies can help inform targeted investment strategies.

Researching organizational dynamics offers another avenue for exploration. By studying how a companys culture and structure influence the effectiveness of its transformation endeavors we can gain valuable insights into optimizing these initiatives.

Given the changing expectations of customers upcoming studies might shift towards a customer focused approach delving into the impact of transformation, on customer experiences and satisfaction, within the automotive sector.

The convergence of sustainability and digital advancement is an area exploring further. With the sector shifting towards eco initiatives it's important to delve into how digital progress intersects, with and fosters sustainable innovation.

Moreover studying the policy environment influencing digital transformation endeavors offers a research opportunity. The external pressures and incentives imposed by governments could significantly impact the trajectory of transformation within the industry.

These avenues for exploration not promise to enhance our comprehension of digital evolution but also aim to bridge the gap between academic research and practical industry applications. This can lead to strategic utilization of digital technologies, in the automotive sector and other industries.

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## Figures

Figure 1 : the original theoretical framework

Figure 2 : The Adapted Research Framework

Figure 3: First Model of the adapted Research Framework : Effects on mediator

Figure 4: Second model of the adapted Research Framework:

Figure 5 : Result of the effects of mediator

Figure 6 : Results of the second model of the adapted Research Framework

**Tables**

Table 1: Effect of DT on DTIC

Table 2: Effect of DT and DTIC on PRDP