

**Digital Maturity Measurement Based on the Stages of
Digital Business Transformation
A Study in the Automotive Sales and Aftersales Sector**

A Dissertation
Submitted to the Graduate School of Business
in Partial Fulfillment of the Requirements
for the Degree of
Doctor of Philosophy
in
Business

Irmak Mutlu
Advisor: Assist. Prof. Dr. Erik den Hartigh

Özyeğin University

May, 2023

**Digital Maturity Measurement Based on The Stages of
Digital Business Transformation
A Study in the Automotive Sales and Aftersales Sector**

Approved by:

Assistant Professor Dr. Erik den
Hartigh, Advisor,
Department of Business
Administration
Özyeğin University

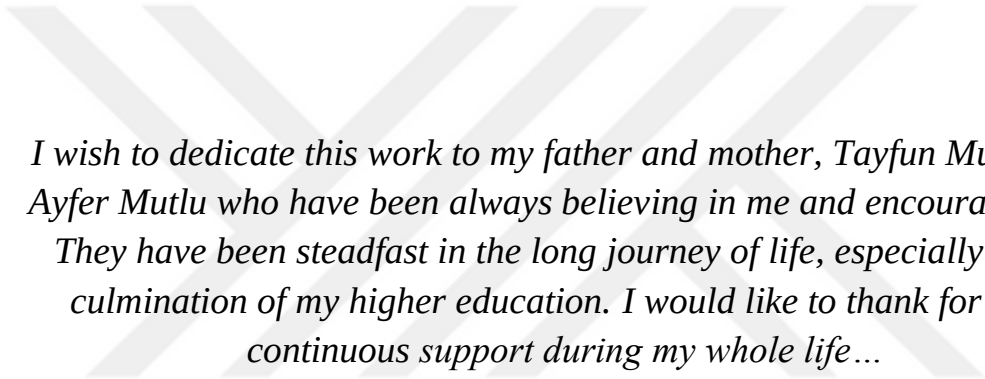
Associate Professor Dr. Çağlar
Üçler,
Department of Aviation and
Aeronautical Sciences
Özyeğin University

Assistant Professor Dr. Ahmet Murat
Fiş,
Department of Business
Administration
Özyeğin University

Professor Dr. Güneş Nezire
Zeytinoğlu,
Department of Management and
Organization
Anadolu University

Associate Professor Dr. Deniz
Tunçalp
Department of Engineering
Management
Istanbul Technical University

Approval Date: 18.05.2023



I wish to dedicate this work to my father and mother, Tayfun Mutlu and Ayfer Mutlu who have been always believing in me and encouraged me. They have been steadfast in the long journey of life, especially in the culmination of my higher education. I would like to thank for their continuous support during my whole life...

ABSTRACT

Digital transformation is the change of socio-economic structures such as business models, supply chains, platforms, or ecosystems as a consequence of the use of digital technology. Consistent with the previous research on understanding digital transformation, the transformational change of organizations, business models, platforms or ecosystems are triggered by digital technology exposure. Therefore, the impact of digital technologies on the digital transformation of companies and internal organizational aspects plays a critical role in literature as well as industrial practice. This transformational change triggered by the technologies raised the question about the digital maturity measurement or readiness assessment. The digital maturity model proposed in this study brings a new approach to both academics and practitioners in digital transformation literature regarding the digital measurement of the companies.

This research mainly aims to answer, “How can the digital maturity level of an organization be measured?”. Research of the digital maturity measurement of organizations structured according to the following four parts: (1) *Stages of Digital Business Transformation*, (2) *Organizational Aspects of Digital Maturity*, (3) *Digital Maturity Index (DMI) Development*, and (4) *Digital Maturity Index for Measurement*. The chapters of the research are structured based on Churchill’s 8 steps for and Digital Maturity Index (DMI) Development and Implementation eight steps [1]. The findings for the four parts are (1) *The stages of digital business transformation*, (2) *Organizational aspects of digital maturity*, (3) *Digital Maturity Index (DMI) as an instrument*, (4) *Digital Maturity Index (DMI) implementation findings*.

The first part focuses on defining and differentiating among core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation and stages' arrangement from digitization to digital transformation. In this part, 5 stages are derived from expert interviews and literature reviews as the progressive stages of digital business transformation. At the end of this part, (i) digital passive, (ii) digitization, (iii) digitalization, (iv) digital transition, and (v) digital transformation have been identified as the digital business transformation stages.

The second part focuses on identification of the digital technology types such as IoT Data, (The Internet of Things), Machine Learning and Artificial Intelligence (ML/AI), and the Cloud etc., all of which have a high impact on the digital transformation of the companies in automotive sales and aftersales sector as well as the extent digital technologies influence the organization's internal digital transformation through components and structures so a company's maturity stage progresses accordingly. Therefore, the scope focuses on what internal organizational aspects should be considered when measuring the digital transformation of the companies. These internal organizational aspects are derived from expert interviews and literature reviews such as *Culture, Data and Analytics, People, Structure, and Organization, Processes and Systems, Strategy, and Technology*. At the end of this part, these six aspects were identified as the internal organizational aspects.

The third part focuses on the digital maturity stages and how to measure the digital maturity stage of an organization. Towards the identification of the stage of digital maturity, a digital maturity measurement tool named Digital Maturity Index (DMI) emerged. This part focuses on the Digital Maturity Index (DMI) design and development

process covering the data collection and measure purification. In this part, all the findings of first and second parts are integrated as an input for the development of the DMI. The process steps cover literature review, expert interviews, and test phases. To investigate the main research questions (RQ), literature review, unstructured, and semi-structured interviews were conducted. The Digital Maturity Index (DMI) developed based on these literature and interview input as well as generated sample items. With the feedback and support of the PhD committee, and the business practitioner the measure is purified. The developed tool and its questions and rubrics were tested twice at the company with the participation of both the business departments and the IT departments. In total, two test workshops were organized and the feedback was gathered from the business and IT side as well as the feedback of the PhD committee. After integrating all the comments, the questionnaire became ready for the roll out. At the end of this part, as a digital maturity measurement tool an index was developed.

The fourth part focuses on validity and reliability assessment of the developed digital maturity model and its business practice empirical implementation after the development of the Digital Maturity Index (DMI) as an instrument. Statistical findings from the empirically tested model are developed. It was complemented with the qualitative interview. This model both theoretically and empirically confirms the proposed hypothetical model's validation. The DMI was introduced to the management. Then, as the next step two workshops were organized to collaboratively define the digital maturity stage of the company. The workshop participants were grouped into four categories: *Managers*, *IT Expert*, *Business Expert* and *Beneficiaries*. The questionnaire was rolled out and data analysis was completed using SPSS as a tool. Furthermore, the results of DMI analysis were presented to the upper management and presented to the

participants in a workshop format. Any feedback coming out of these meetings was integrated into the analysis. As the final step to validate the findings, a 2nd round of interviews was conducted with several experts who also contributed to the DMI implementation phase. Finally, the statistical analysis was completed, and the results integrated, and questions not supported qualitatively and quantitatively not supported questions eliminated and DMI questions were reduced to 31. Finally, at the end of this part, Digital Maturity Index (DMI) as a measurement instrument developed as a norm.

The Digital Maturity Index (DMI) development and implementation process is synchronized with the steps of Churchill's "Procedure for Developing Better Measures" [1]. In parallel to the Churchill procedure, the Digital Maturity Index (DMI) Development and Implementation steps in this research is grouped under eight steps: (1) *Literature review and 1st Round of interview findings*, (2) *DMI development and individual feedback sessions*, (3) *Test phase 1*, (4) *Test phase 2*, (5) *DMI implementation*, (6) *DMI results and qualitative and quantitative analysis*, (7) *2nd round of interview findings and improvement areas*, and (8) *Finalize DMI instrument*. In parallel to DMI Development and Implementation steps, based on Churchill's procedure, the measure development process follows eight steps: (1) *Specify the domain of the construct*, (2) *General sample of items*, (3) *Collect data*, (4) *Purify measure*, (5) *Collect data*, (6) *Assess reliability*, (7) *Assess validity*, (8) *Develop norm* [1].

This research contributes to the literature by delivering a digital maturity measurement model which merges the academic and practitioner contributions and brings a new insight into organization's digital maturity measurement literature. The developed

model was tested at an automotive company, but it was developed considering cross-industry implementation.

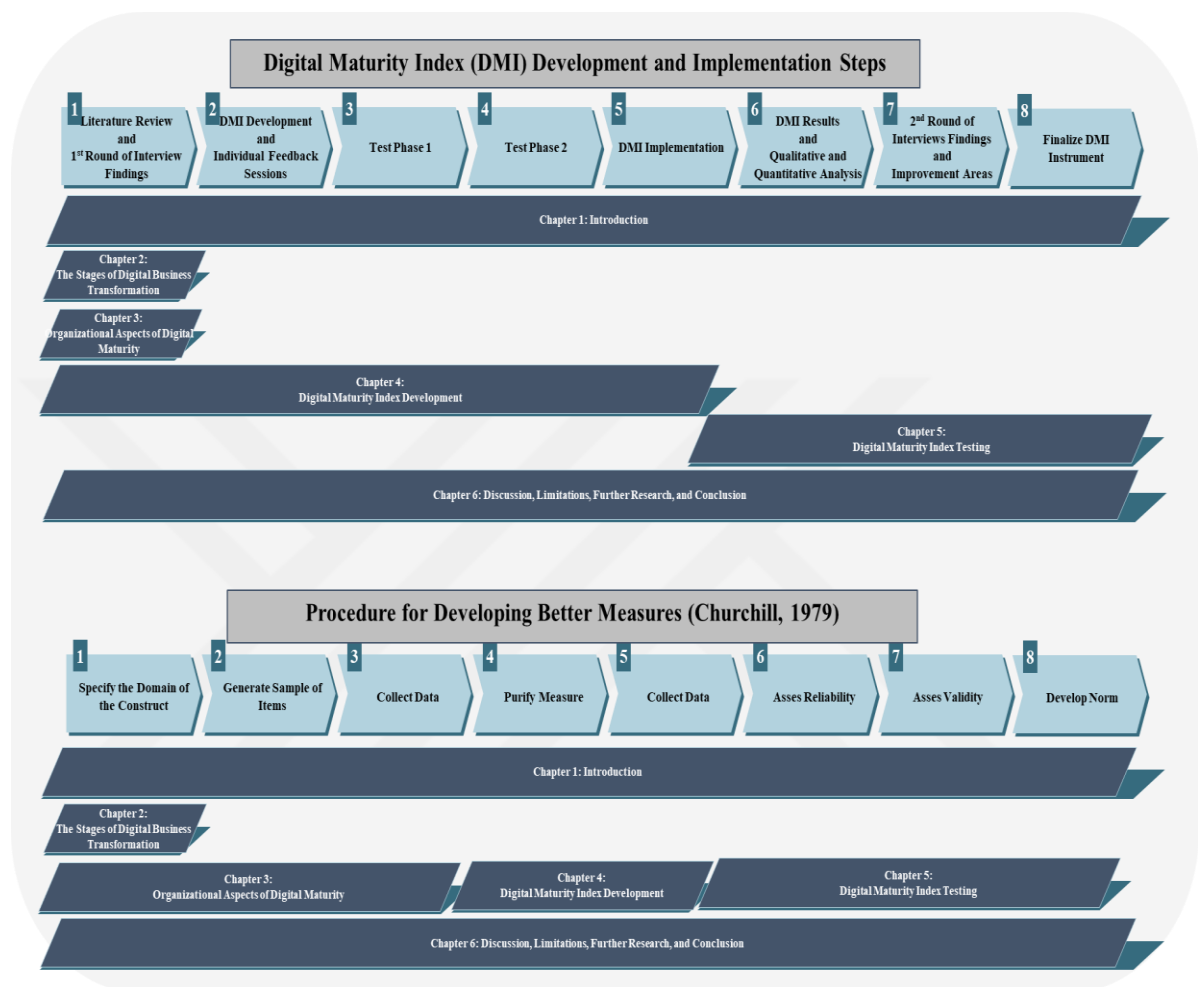


Figure 1: Illustration and Comparison of Dissertation Structure

Keywords: Digitization, Digitalization, Digital Transformation, Digital Technology, Digital Strategy, Digital Maturity Index, Digital Maturity Measurement, Digital Business Transformation, Business Transformation, Maturity Assessment.

ÖZET

Dijital dönüşüm, dijital teknolojinin kullanılması sonucunda iş modelleri, tedarik zincirleri, platformlar veya ekosistemler gibi sosyoekonomik yapıların değişmesidir. Dijital dönüşümün anlaşılmasına ilişkin önceki araştırmalarla tutarlı olarak, kuruluşların, iş modellerinin, platformların veya ekosistemlerin dönüşümsel değişimi, dijital teknolojiye maruz kalma ile tetiklenir. Bu nedenle, dijital teknolojilerin şirketlerin dijital dönüşümü ve şirket içi yönleri üzerindeki etkisi, endüstri pratiğinin yanı sıra literatürde de kritik bir rol oynamaktadır. Teknolojilerin tetiklediği bu dönüşümsel değişim, dijital olgunluk ölçümü veya hazırlık değerlendirmesine yönelik soruyu gündeme getirdi. Bu çalışmada önerilen model, şirketlerin dijital olgunluk ölçümüne yönelik dijital dönüşüm literatüründe yer alan hem akademisyenlere hem de uygulayıcılara yeni bir yaklaşım getirmektedir.

Bu araştırma temel olarak “Bir kuruluşun dijital olgunluk düzeyi nasıl ölçülür?” sorusuna cevap vermeyi amaçlanmaktadır. Kurumların dijital olgunluk ölçümüne yönelik araştırma, Dijital İş Dönüşümünün Aşamaları, Dijital Olgunluğun Örgütsel Yönleri, Dijital Olgunluk Endeksi Gelişimi ve Ölçüm için Dijital Olgunluk Endeksi olmak üzere dört bölüme göre yapılandırılmıştır. Araştırmanın bölümleri, Churchill'in ve Dijital Olgunluk Endeksi (DMI) Geliştirme ve Uygulama sekiz adımı temel alınarak yapılandırılmıştır. Dört bölüme ilişkin bulgular şunlardır: (1) *Dijital dönüşümünün iş perspektifinden aşamaları*, (2) *Dijital olgunluğun şirketsel boyutları*, (3) *Bir araç olarak Dijital Olgunluk Endeksi (DMI)*, (4) *Dijital Olgunluk Endeksi (DMI) uygulama bulguları*.

Birinci bölüm, dijital iş dönüşümünün temel kavramlarını, yani dijitalleşme, dijitalleşme ve dijital dönüşümü ve dijitalleşmeden dijital dönüşüme aşamaların

düzenlenmesini tanımlamaya ve ayırt etmeye odaklanmaktadır. Bu bölümde, dijital iş dönüşümünün ilerici aşamaları olarak uzman görüşmesi ve literatür taramasından elde edilen 5 aşama bulunmaktadır. Araştırmanın birinci bölümünün sonunda, Dijital işletme dönüşüm aşamaları olarak ilk olarak (i) dijital pasif, (ii) dijitalleşme, (iii) dijitalleşme, (iv) dijital geçiş ve (v) dijital dönüşüm belirlenmiştir.

İkinci bölümde otomotiv perakende ve satış sonrası sektöründeki firmaların dijital dönüşümünde etkisi yüksek olan Nesnelerin İnterneti, Veri, Makine Öğrenmesi ve Yapay Zeka, Bulut gibi belirlenen dijital teknolojilerin benimsenmesi, şirketin olgunluk seviyesinin buna göre ilerlemesi için bileşenler ve yapılar aracılığıyla kuruluşun dahili dijital dönüşümünü etkiler. Bu nedenle kapsam, şirketlerin dijital dönüşümünü ölçerken hangi şirket içi boyutların dikkate alınması gerektiğine odaklanmaktadır. Bu dahili şirket yönleri, uzman görüşmelerinden ve Kültür, Veri ve Analitik, İnsanlar, Yapı ve Organizasyon, Süreçler ve Sistemler, Strateji ve Teknoloji gibi literatür incelemesinden elde edilir. Araştırmanın ikinci bölümünün sonunda, iç organizasyonel yönler olarak bu altı boyut belirlenmiştir.

Üçüncü bölüm, dijital olgunluk düzeyine ve bir kuruluşun dijital olgunluk düzeyinin nasıl ölçüleceğine odaklanmaktadır. Dijital olgunluk düzeyinin belirlenmesine yönelik olarak Dijital Olgunluk İndeksi (DMI) adlı bir dijital olgunluk ölçüm aracı geliştirilmiştir. Bu bölüm, veri toplama ve ölçüm saflaştırmayı kapsayan Dijital Olgunluk Endeksi (DMI) tasarım ve geliştirme sürecine odaklanmaktadır. Bu bölümde, birinci ve ikinci bölümlerin tüm bulguları, DMI'nın geliştirilmesi için bir girdi olarak entegre edilmiştir. Süreç adımları literatür taraması, uzman görüşmeleri ve test aşamalarını kapsar. Ana araştırma sorularını araştırmak için literatür taraması, yapılandırılmamış ve yarı yapılandırılmış görüşmeler yapılmıştır. Bu literatüre dayalı olarak geliştirilen Dijital

Olgunluk İndeksi (DMI) ve görüşme girdileri ve madde örnekleri oluşturulmuştur. Doktora komitesinin ve iş uzmanlarının geri bildirimi ve desteği ile ölçüm endeksi yalınlaştırılır. Geliştirilen endeks, soruları ve rubrikleri firmada hem iş departmanlarının hem de bilgi teknolojileri (BT) departmanlarının katılımıyla iki kez test edilmiştir. Toplamda iki test çalıştayı düzenlendi ve doktora komitesinin geri bildirimlerinin yanı sıra iş ve BT tarafından geri bildirimler toplanmıştır. Tüm yorumları entegre ettikten sonra, anket kullanıma hazır hale gelmiştir. Araştırmanın üçüncü bölümünün sonunda, dijital olgunluk ölçüm aracı ve indeksi olarak geliştirilmiştir.

Dördüncü bölüm, bir araç olarak Dijital Olgunluk Endeksinin (DMI) geliştirilmesinden sonra, geliştirilen dijital olgunluk modelinin istatistiksel geçerliliği ve güvenilirliğinin değerlendirilmesine ve iş pratiğindeki ampirik uygulamasına odaklanmaktadır. Ampirik olarak test edilen modelden elde edilen bulgular nitel görüşmelerle desteklenmiştir. Hem teorik hem de ampirik olarak geliştirilen bu model ampirik olarak test edilmiş ve onaylanmıştır. Ampirik bulgular, önerilen varsayımsal modelin geçerliliğini doğrulamaktadır. Uygulamaya başlamadan önce DMI, yönetime tanıtılmıştır. Ardından, bir sonraki adım olarak, şirketin dijital olgunluk düzeyini ortaklaşa belirlemek için iki çalıştay düzenlenmiştir. Çalıştay katılımcıları dört kategoride gruplanmıştır: Yöneticiler, BT Uzmanı, İş Uzmanı ve Son Kullanıcılar. Anket kullanıma sunuldu ve veri analizi SPSS aracı olarak kullanılarak tamamlanmıştır. Ayrıca DMI analizi sonuçları üst yönetime sunulmuş ve bir çalıştay formatında katılımcılara aktarılmıştır. Bu toplantılardan çıkan geri bildirimler analize entegre edilmiştir. Son adım olarak, bulguları doğrulamak için DMI uygulama aşamasına da katkıda bulunan birkaç uzmanla 2. tur görüşmeler yapılmıştır. Son olarak, istatistiksel analiz tamamlanmış ve sonuçlar entegre edilmiş ve niteliksel ve niceliksel olarak desteklenmeyen sorular

elenmiştir. Araştırmanın dördüncüsü bölümünün sonunda, geliştirilen endeks soruları 31'e düşürülmüştür ve bir ölçüm aracı olan Dijital Olgunluk Endeksi (DMI) bir norm olarak geliştirilmiştir.

Tüm bu Dijital Olgunluk İndeksi (DMI) geliştirme ve uygulama süreci, Churchill'in "Procedure for Development Better Measures" (1979) [1] adımlarıyla senkronize edilmiştir. Churchill prosedürüne paralel olarak, bu araştırmadaki Dijital Olgunluk İndeksi (DMI) Geliştirme ve Uygulama adımları sekiz adım altında gruplanmıştır: (1) Literatür taraması ve 1. Tur görüşme bulguları, (2) DMI geliştirme ve bireysel geri bildirim oturumları, (3) Test aşaması 1, (4) Test aşaması 2, (5) DMI uygulaması, (6) DMI sonuçları ile niteliksel ve niceliksel analiz, (7) 2. tur görüşme bulguları ve iyileştirme alanları ve (8) DMI aracının son haline getirilmesi. DMI Geliştirme ve Uygulama adımlarına paralel olarak, Churchill'in prosedürüne dayalı olarak, ölçüm geliştirme süreci sekiz adımı takip eder: (1) Yapının alanını belirtme, (2) Maddelerin genel örneği, (3) Verileri toplama, (4) Ölçümü saflaştırma, (5) Verileri toplama, (6) Ölçümlemeyi sadeleştirme, (7) Geçerliliği değerlendirme, (8) Norm geliştirme.

Bu araştırma, akademik ve uygulamaya yönelik katkıları birleştiren ve kurumun dijital olgunluk ölçüm literatürüne yeni bir bakış açısı getiren bir dijital olgunluk ölçüm modeli önererek literatüre katkıda bulunmaktadır. Geliştirilen model bir otomotiv firmasında test edilmiş ancak sektörler arası uygulama dikkate alınarak geliştirilmiştir.

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank all the people who have supported me during this journey. The greatest thanks go to my advisor Assistant Professor Erik den Hartigh, who served as my PhD Committee Chair. I would not be able to complete this dissertation without his continuous support, patience, wisdom, and intellectual guidance during this long journey.

Other than my advisor, I would like to express my gratitude to my PhD Committee members: Associate Professor Dr. Çağlar Üçler and Assistant Professor Ahmet Murat Fiş, who have steadfastly shared their expertise and supported me by giving feedback for the improvement of my work. Moreover, I would like to thank my previous committee member Dr. Emre Karali for his valuable contributions, and to thank Professor Dr. Güneş Nezire Zeytinoğlu for her insights and valuable feedback on the DMI instrument. Further, I would like to express my gratitude to Professor Dr. Richard Bonnabeau for serving as an editor for my doctoral dissertation, and to express my gratitude to Ozyegin University Graduate School of Business for the scholarship.

Besides internal PhD committee members, also I would like to thank Professor Dr. Güneş Nezire Zeytinoğlu and Associate Professor Dr. Deniz Tunçalp for accepting to be a part of my committee. Besides, I would also like to thank Professor Dr. Mustafa Gökler, Professor Dr. Nükhet Harmancıoğlu, and Professor Dr. Muhittin Oral for being part of my PhD qualifier exam committee. Their valuable and insightful comments and guidance helped me to improve my research.

I would like to thank the directors from the business-side of my research. I really appreciate their steadfast support, guidance, and feedback. In this regard, I am indebted to Koray Bebekoğlu, Kevser Şahin, and Tunc Gömeçli.

Special thanks go to the interviewees and the company of this case study for their contribution and collaboration during the data collection.

Lastly, I would like to thank my brother Dr. Deniz Mutlu for his academic as well as motivational support.



TABLE OF CONTENTS

ABSTRACT.....	iv
ÖZET.....	ix
ACKNOWLEDGEMENTS.....	xiii
LIST OF FIGURES.....	xxiii
I INTRODUCTION.....	1
1.1 Motivation.....	2
1.2 Research Questions.....	4
1.3 Scope.....	5
1.4 Contribution.....	6
1.5 Research Design and Method.....	7
1.6 Overview of the Thesis.....	11
II THE STAGES OF DIGITAL BUSINESS TRANSFORMATION....	13
2.1 Introduction.....	14
2.2 Digitization, Digitalization and Digital Transformation.....	16
2.2.1 Digitization versus Digitalization.....	16
2.2.2 Digitalization versus Digital Transformation.....	17
2.2.3 The Impact of Digital Technology.....	19
2.2.4 Digitization, Digitalization, and Digital Transformation as Stages of Business Transformation.....	20
2.3 Method and Data.....	21
2.3.1 Expert Interviews.....	21
2.3.2 Literature Review for Domain-Specific Ontology.....	23
2.4 Results and Discussion.....	24
2.4.1 Results of Expert Interviews.....	25
2.4.2 Results of Literature Review.....	26
2.5 Discussion.....	29
2.6 Conclusions.....	32
III ORGANIZATIONAL ASPECTS OF DIGITAL MATURITY.....	34
3.1 Introduction.....	35

3.2 Method and Data.....	36
3.2.1 Literature Review.....	36
3.2.2 First Round Expert Interviews.....	40
3.3 Results.....	43
3.3.1 Derivation of Organization Aspects as Dimensions Based on Literature Review.....	43
3.3.2 First Round of Expert Interviews.....	51
3.3.3 Synthesis of Literature Review and Expert Interview.....	56
3.4 Discussion of Organization Aspects.....	64
3.4.1 Culture.....	65
3.4.2 Data and Analytics.....	70
3.4.3 People, Structure and Organization.....	72
3.4.4 Processes and Systems.....	79
3.4.5 Strategy.....	86
3.4.6 Technology.....	93
3.5 Conclusions.....	103
IV DIGITAL MATURITY INDEX DEVELOPMENT.....	106
4.1 Introduction.....	107
4.2 Literature Review.....	108
4.2.1 Digital Maturity Definition and Measurement.....	108
4.2.2 Digital Maturity Measurement Stages.....	110
4.3 Method and Data.....	119
4.3.1 Digital Maturity Index Development.....	120
4.3.2 Digital Maturity Index Development Process Steps.....	122
4.3.3 Digital Maturity Index Model Construct.....	128
4.3.4 Case Setting.....	128
4.3.5 Role of Researcher.....	134
4.4 Results.....	136
4.4.1 Results of Step 1 – Specify the Domain of the Construct (Stages of Digital Business Transformation as Digital Maturity Stages).....	138
4.4.2 Results of Step 2, 3 – Generate Sample of Items and Collect Data (Organizational Aspects of Digital Maturity).....	140

4.4.3 Results of Step 4, 5 – Purify Measure and Collect Data (Digital Maturity Index Questions, Rubrics, Scoring, and Construct Development).....	140
4.5 Discussion.....	142
4.6 Conclusions.....	144
V DIGITAL MATURITY INDEX TESTING.....	145
5.1 Introduction.....	146
5.2 Method and Data.....	146
5.2.1 Digital Maturity Index Implementation.....	146
5.2.2 Digital Maturity Index t0 Measurement and Participants.....	148
5.2.3 DMI Implementation Results, Findings and Improvement Areas..	151
5.2.4 Second Round of Interviews after Digital Maturity Index Implementation.....	151
5.3 Test Results of Digital Maturity Index.....	153
5.3.1 Results of Digital Maturity Index Implementation.....	153
5.3.2 Statistical Results of Digital Maturity Index Implementation.....	161
5.4 Testing the Conceptual Model and Confirmatory Factor Analysis.....	164
5.4.1 Quantitative Metric for Reliability and Quality Indicators of Research (Reliability, Replicability, Validity).....	164
5.4.2 Reliability and Validity Analysis.....	165
5.4.3 Summary Table for Scenarios including Model Fit Indices.....	170
5.4.4 Composite Reliability (CR) and Average Variance Extracted (AVE) Analysis.....	172
5.4.5 Deciding Between Competing Scenarios based on Degrees of Freedom and Chi-square Value.....	175
5.5 Qualitative Results of Second Round of Interviews after Digital Maturity Index Implementation.....	179
5.5.1 General Findings.....	181
5.5.2 Culture Interpretation.....	183
5.5.3 Data and Analytics Interpretation.....	185
5.5.4 People, Structure, and Organization Interpretation.....	188
5.5.5 Process and Systems Interpretation.....	190
5.5.6 Strategy Interpretation.....	190
5.5.7 Technology Interpretation.....	192

5.5.8 Summary of Organizational Aspect and Role Based Interpretation....	193
5.5.9 Brainstorming Workshop Results.....	197
5.6 Discussion.....	203
5.6.1 Discussion of Quantitative Findings.....	203
5.6.2 Discussion of Qualitative Findings.....	205
5.6.3 Synthesis of Quantitative and Qualitative Findings.....	205
5.6.4 Final Digital Maturity Index Instrument.....	210
5.7 Conclusions.....	213
VI CONCLUSIONS, IMPLICATIONS, LIMITATIONS, AND FURTHER RESEARCH.....	214
6.1 Conclusions.....	214
6.2 Scope Framing Based on Contingency and External Organizational Aspects.....	219
6.3 Implications.....	221
6.4 Limitations and Further Research.....	224
APPENDIX A.....	230
BIBLIOGRAPHY.....	329
VITA.....	339

LIST OF TABLES

1 Overview of Conducted Interviews	23
2 Most Expressed Words Constituting The Domain Specific Ontology	28
3 List of Publication Media	39
4 List of Theories.....	39
5 First Round of Interview Question List	42
6 Digital Maturity Model Comparison Developed by Academicians (Academic Journal).....	44
7 Digital Maturity Model Comparison Developed by Academicians (Conference) and Developed by Practitioners (Consulting)	47
8 Outcome of Literature Review - Frequency of Mentioned Organizational Aspects	50
9 Synthesis Chart of Literature Review and 1st Round of Interviews	51
10 Literature Review and Interview Findings Comparison and Grouping.....	57
11 Digital Maturity Model Comparison Chart – Culture	66
12 Digital Maturity Model Comparison Chart – Data and Analytics.....	70
13 Digital Maturity Model Comparison Chart – People, Structure, and Organization	74
14 Digital Maturity Model Comparison Chart – Processes and Systems.....	80

15	Digital Maturity Model Comparison Chart –Strategy	88
16	Digital Maturity Model Comparison Chart –Technology	99
17	Digital Maturity Measurement Stages inc. Academic Journal	113
18	Digital Maturity Measurement Stages inc. Conference Papers and Consulting Articles	117
19	Second Round of Interview Participant List.....	152
20	Second Round of Interview Question List.....	152
21	DMI Participant Split Based on Roles	153
22	DMI Score per Organizational Aspect	154
23	Role vs Organizational Aspect Results.....	156
24	Age vs Organizational Aspect Results	157
25	Education vs Organizational Aspect Results	158
26	Experience vs Organizational Aspect Results	159
27	Frequency vs Organizational Aspect Results	160
28	Descriptive, ANOVA, Indep t-Test Analysis Summary	162
29	Summary Table of Cronbach Alpha Reliability Analysis	166
30	Summary Table for Scenarios including Model Fit Indices	171
31	Summary of Composite Reliability and Average Variance Extracted (AVE) Analysis.....	173

32	Deciding Between Competing Scenarios based on Degrees of Freedom and Chi-square Value.....	176
33	Scenario 3 vs Scenario 4 Comparison	176
34	Scenario 5 vs Scenario 6 Comparison	177
35	Scenario 5 vs Scenario 6a Comparison	177
36	Scenario 5 vs Scenario 6b Comparison	178
37	Scenario 7 vs Scenario 8 Comparison	179
38	Questions with High Variance, Skewness and Discussed During 2 nd Round of Interviews.....	180
39	Summary of Findings of Second Round of Interviews	182
40	Summary of Findings and Quotes of Second Round of Interviews Based on The Roles.....	194
41	Consolidated Findings from Feedback Sessions and Improvement Areas Based on Index.....	200
42	Comparison Chart of Quantitative and Qualitative Findings	206
43	Final DMI Instrument.....	210
44	First and Second Round of Interview Questions	231
45	Comparison Chart of Quantitative and Qualitative Findings	285
46	Example of Data, Categories and Aspect or DMI Dimension.....	300
47	CFA Factor Loadings for DMI Constructs.....	325

48 Composite Reliability and Average Variance Extracted Analysis	326
49 List of Abbreviations	327



LIST OF FIGURES

1 Illustration and Comparison of Dissertation Structure	viii
2 Digital Maturity Index: Digital Transformation Stages and Organizational Aspects	6
3 Logic Used in Thesis	9
4 Chapter 1 at Illustration and Comparison of Dissertation Structure.....	10
5 Five Stages of Digital Business Transformation	29
6 Five Stages of Digital Business Transformation and Definitions	31
7 Digital Maturity Index Filtering Process	38
8 First Round of Interview Data Sources / Clustering Based on Roles, Expertise and Hierarchical Level.....	41
9 Organization Aspects.....	64
10 Phases of Digital Maturity Index Development Process	123
11 Digital Maturity Index – Fragment of Questionnaire	127
12 Digital Maturity Index – Genel Construct	128
13 Venue Triangle	133
14 Procedure for Developing Better Measures by Churchill [1].....	138
15 Digital Maturity Stages.....	139
16 Digital Maturity Index Development Phases and Implementation.....	148

17	Digital Maturity Index Measurement Stage and Participant Groups.....	150
18	DMI Score	154
19	Role Based DMI Results	156
20	Age Based DMI Results	157
21	Education Based DMI Results.....	158
22	Experience Based DMI Results	159
23	Frequency Based DMI Results	160
24	Pie Chart Example for Questionnaire Implementation.....	161
25	DMI Complete Questionnaire Descriptive Statistical Analysis	163
26	Confirmatory Factor Analysis	170
27	First Round of Interviews Cluster Analysis Bubble Chart	283
28	First Round of Interviews Tree Map	283
29	First Round of Interviews Word Count	284
30	Second Round of Interviews and DMI Implementation Findings Tree Map ..	288
31	Second Round of Interviews and DMI Implementation Findings Word Count	288
32	Second Round of Interviews and DMI Implementation Findings Word Count 2	289

33 > 5 times mentioned words during Second Round of Interviews and DMI Implementation	290
34 First and Second Round of Interviews Tree Map.....	291
35 First and Second Round of Interviews Word Count.....	291
36 First and Second Round of Interviews Word Count 2.....	291
37 > 5 times mentioned words during First and Second Round of Interviews and DMI Implementation.....	292

CHAPTER I

INTRODUCTION

From the early 1800s when scientific principles were applied to technological problem solving, production has gone through four major revolutions in rapid succession as noted by Santos and Marthino [2]. These four major revolutions were mainly driven by innovation and mostly led by new technologies. Industry 1.0 was triggered by mechanization and steam power, Industry 2.0 was triggered by mass production and electricity, Industry 3.0 was triggered by computers and automation, and Industry 4.0 was triggered by cyber physical systems. All these revolutions were responsible for the large-scale transformations both in society and industry level [2]. Innovative digital technologies such as Internet of Things (IoT), Artificial Intelligence (AI), Autonomous Robots, Cybersecurity, Additive Manufacturing (3D Printing), Augmented Reality (AR), Big data and analytics, Simulation and Horizontal and Vertical System Integration are considered as the nine pillars of technological advancement and coming in the frontline as the leading digital technologies ([3]; [2]). In addition to this technological progress, concepts such as connectivity, digitalization, real time data and analytic based services and products, digital systems, and agility came into the picture ([4]; [2]). The recent rapid development of AI and its potential to be the Industry 5.0.

In the last decades, the improvement of technology and branching of the new digital technologies have triggered a digital innovation of profound dimensions. This digital transformation is the process where companies are integrating digital technologies in their business model, strategies, products, and services [5]. Digital transformation is

not only the digitalization of the company's processes, but it also drives the cultural, organizational, strategical, and operational change of the company [5]. However, for most of the companies, the digital transformation process and how to become a digitally transformed firm is quite uncertain. Even the definition of digital transformation is interpreted differently. For instance, according to Gartner [6], *“Digital transformation can refer to anything from IT modernization to digital optimization to the invention of new digital business models. The term is widely used in public-sector organizations to refer to modest initiatives such as putting services online or legacy modernization. Thus, the term is more like “digitization” than “digital business transformation.”* While the difference between digitization and digitalization is more consistent, digitalization and digital transformation is less consistent.

Therefore, it is hard for companies to clearly assess which stage they are in the digital transformation process, while not being able to clearly define the digital transformation terminologies. Based on the findings of the recent literature, there is a need for a systematic approach on the introduction of digital technologies, which are triggering Industry 4.0, in the companies, and a comprehensive maturity assessment tool to indicate digital maturity level of the companies during their digital transformation journey [7].

1.1 Motivation

Even though digital transformation is a trendy topic, and it is a top item of C-Suite's and management's agenda, there is no consensus on its meaning, scope and one fit all infrastructure [8]. Therefore, companies are struggling to define the maturity level of their digitalization initiatives and to measure where they are going. In this research, the main motivation is to provide clear steps and guidance to the companies on their digital

transformation journey from internal organizational aspects. By developing Digital Maturity Index as a maturity assessment instrument, this research aims to lead companies on required steps during the digital transformation journey.

The importance of this research can be grouped into three categories: *competitiveness*, *technological innovations*, and *digital maturity assessment*. The first reason behind the research interest is the importance of the topic and the *competitiveness requirements* of the business world. Digital transformation has been a constantly growing topic. Digitalization is not only transforming the products, services, processes, and systems, but also the organization itself and organization culture. Therefore, to remain competitive and even to survive in the long term, companies are changing the form of the products and services towards the more digital, changing the way of reaching the customers through omnichannel approaches and expanding their market by using digital tools. And lastly, they are changing organizational structures and culture.

The second reason is due to *technological improvements and innovations*. As digital technologies are evolving, new technologies are changing the industry dynamics, business models, and the way work is done by providing increases in capability and efficiency. Digital technology appears to be one of the factors which impacts the level of digital transformation. Therefore, as digital technologies evolve, the extent of digital transformation and the impacting areas are also improving.

The third reason is the motivation for the development of a *digital maturity assessment* tool. As the main target, the research provides an assessment instrument for companies to measure the organization's digital maturity level corresponding to the internal organizational aspects. Even though there are already developed digital maturity measurement instruments in literature, the main drive comes from seeing the gap between

the digital maturity instruments developed by academia and the practitioners. In this model, the strengths of both worlds are combined. The instrument is developed based on academic literature review as well as the insights of practitioners. Furthermore, the developed instrument is tested and validated through statistical analysis based on academic and qualitative findings from practice.

1.2 Research Questions

The main research question of this study is defined as: “How can we measure the digital maturity level of an organization?”

The major research question requires the following sub-research questions to address the overall research.

RQ1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?

RQ2: Which internal organizational aspects should be considered when measuring the digital business transformation of the company?

RQ3: How can the digital maturity level of an organization be measured?

RQ4: How can Digital Maturity Index (DMI) as an instrument be validated?

Every sub-research question listed above is answered in separate and consecutive chapters. This research covers the following four parts (1) *The stages of digital business transformation*, (2) *Organizational aspects of digital maturity*, (3) *Digital Maturity Index (DMI) as an instrument*, (4) *Digital Maturity Index (DMI) implementation findings*.

1.3 Scope

The research limitations and scope decisions are limited by several constraints:

(1) Scope is limited by investigating the digital business transformation stages considered only from digitization, digitalization, digital transformation, and digital technology perspectives. (2) Internal digital transformation aspects of the organization are investigated. Excluded from the scope are the external perspectives of digital transformation such as economics, pandemic, politics, macro level strategical decisions, technological investments and external factors which are influencing the companies during the digital transformation journey. (3) The ways of measuring an organization's digital maturity level are investigated. To strengthen this approach, both qualitative and quantitative measurement are utilized. Therefore, the research is neither focusing solely on qualitative research nor quantitative research. (4) The focused case for the development and testing of Digital Maturity Index is based on a company in the automotive sales and aftersales sectors. However, the research includes different parties and perspectives of an automotive sales and aftersales company and a high-tech software development company. (5) The stages of digital business transformation and organizational aspects which configure DMI stages and levels are found and tested during interviews with the experts from different companies and different industries. Therefore, the developed digital maturity index is not only prepared for the measurement of digitalization level of automotive companies. Instead the scope is defined considering cross-industry implementation. Currently, the DMI instrument is tested only in the automotive sales and after sales sectors. Further research could focus on additional validations in other industries.

1.4 Contribution

The model proposed in this study brings a new insight into the organization's digital maturity measurement literature by comparing the models developed by academia, including journal papers and conference papers and the models developed by the practitioners and offering a new measurement instrument called Digital Maturity Index (DMI) which is empirically tested and validated. The goal of the academic research is to contribute to the contemporary developments in the field of Industry 4.0 and Digital Maturity Model or Capability Maturity Model. Industry 4.0 is an emerging topic both in the academic field and also in industrial applications [2].

Intended contributions of this research can be categorized under two groups: *contributions to academic literature* and *to business practice*. This research targets to contribute to literature in four perspectives: (1) This research proposes a clear definition for the digital related concepts: digitization, digitalization, digital transformation.

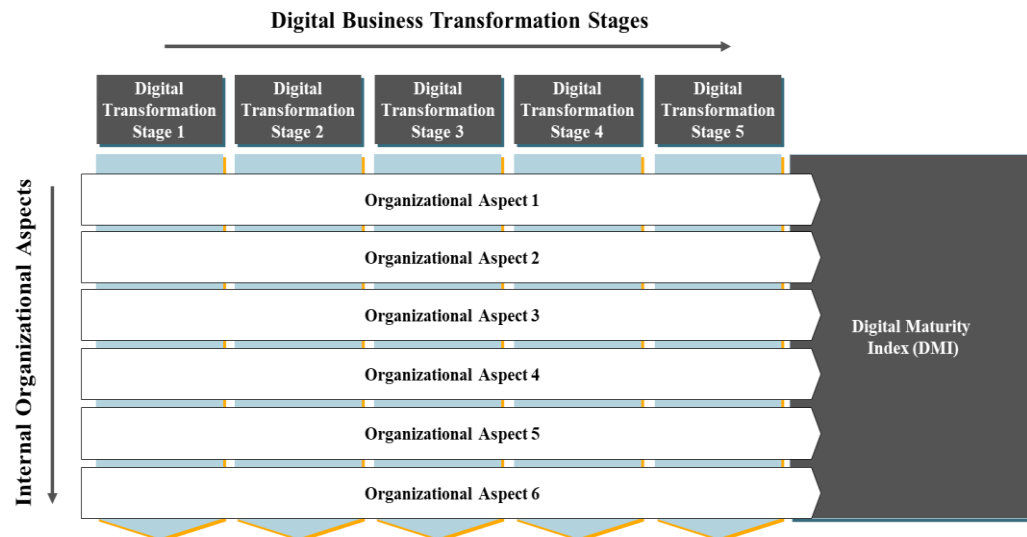


Figure 2: Digital Maturity Index: Digital Transformation Stages and Organizational Aspects

(2) In addition to an academic viewpoint, the intended contributions to the business perspective are foreseen as well. This research contributes to business practice by providing a tool based on detailed and systematic research, which complements consulting studies but creates more ground. (3) The implementation of the index provides clarity and common understanding of the digitalization strategy across the companies, which facilitates pursuing a common goal across all units of the companies. (4) The tool enables the measurement of the digital maturity of all company units based on the same criteria and scale.

1.5 Research Design and Method

The research is structured into four parts in addition to the introduction and the conclusion chapters. The method for each chapter varies based on the research question. (Figure 3)

In the second chapter, the target is set to answer the first research question “*RQ1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?*” through literature review and unstructured interview. The idea of using this mixed method is to combine the strengths of literature and empirical information. The first research question aims to define what digital transformation is and its stages are explained. The research design of how to answer the question is based on literature review and unstructured interviews with industry experts. The result of this macro level analysis prepares the basis for stages of digital business transformation which forms the maturity scale of the Digital Maturity Index and content of the rubrics. Findings of this initial research question structure the maturity level between 1 to 5 of the Digital Maturity Index.

The third chapter answers the second research question of “*RQ2: Which internal organizational aspects should be considered when measuring the digital business transformation of the company?*”. This research question is answered by the blend of both literature review and unstructured interview with the experts. This chapter discusses as well as the digital transformation on the macro level. The second research question aims to define the prominent internal organizational aspects which have an impact on the digital business transformation of companies. The analysis is based on impacts as they relate to technologies and competitiveness. The results of this macro analysis come from the literature review and semi-structured interviews with industry experts. Findings of this research question form the rows of the Digital Maturity Index.

The fourth chapter answers the third research question of “*RQ3: How can the digital maturity level of an organization be measured?*”. This research question is answered by findings from the literature review, semi-structured interviews with experts. Furthermore, this research question is tested with business experts to collect empirical data and feedback. The third research question targets finding a method for measuring the digital maturity of an organization. For this purpose, a tool is developed called Digital Maturity Index based on the findings from the first and second research questions through interviews and literature review. The logic of DMI is simplified in Figure 3. There columns from left to right show the evolutionary stages of digital transformation, whereas rows show the prominent aspects of the companies which are affected during the digital transformation journey. DMI’ rubric content is based on the intersection of the stages and the related organizational aspect. Through these rubrics and mapping, DMI aims to provide companies with guidelines and action plans for successful digital transformation.

The fifth chapter answers the fourth research question of “*RQ4: How can Digital Maturity Index (DMI) as an instrument be validated?*”. Case study *Digital maturity measurement of an automotive sales and aftersales company* method is selected for the fourth chapter as the company which is investigated goes through digital transformation. Therefore, the whole structure starts from the macro level and goes through the industry level to the company level at the end. The fourth part of the research focuses on the digitalization level measurement of a specific company, while the third part of the research focuses on the DMI development. After the DMI implementation through data collection workshops with experts, this part of the research also targets to get feedback from the randomly selected experts who participated in the DMI implementation workshops.

Each chapter targets to answer a research question explaining how a company’s digital maturity level can be measured. The general construct starts from the macro level and narrows down to company level.

Chapter	Research Question	Method	DMI Development and Implementation Steps	Procedure for Developing Better Measures (Churchill, 1979)
Chapter 2	Q1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?	- Literature - Unstructured Interview	Step 1	Step 1
Chapter 3	Q2: Which internal organizational aspects should be considered when measuring the digital business transformation of the company?	- Literature Review - Unstructured Interview	Step 1	Step 1-3
Chapter 4	Q3: How can the digital maturity level of an organization be measured?	- Literature Review - Semi-Structured Interview - DMI Test Phase	Step 1-5	Step 4-5
Chapter 5	Q4: How can Digital Maturity Index (DMI) as an instrument be validated? Case: Digital maturity measurement of an automotive sales and aftersales company	- Semi-Structured interview - DMI Implementation and Data Analysis	Step 6-8	Step 6-8

Figure 3: Logic Used in Thesis

All in all, there are eight major data collection stages: (1) *Literature review and 1st Round of interview findings*, (2) *DMI development and individual feedback sessions*, (3) *Test phase 1*, (4) *Test phase 2*, (5) *DMI implementation*, (6) *DMI results and qualitative and quantitative analysis*, (7) *2nd round of interview findings and improvement areas*, and (8) *Finalize DMI instrument*. (Figure 4).

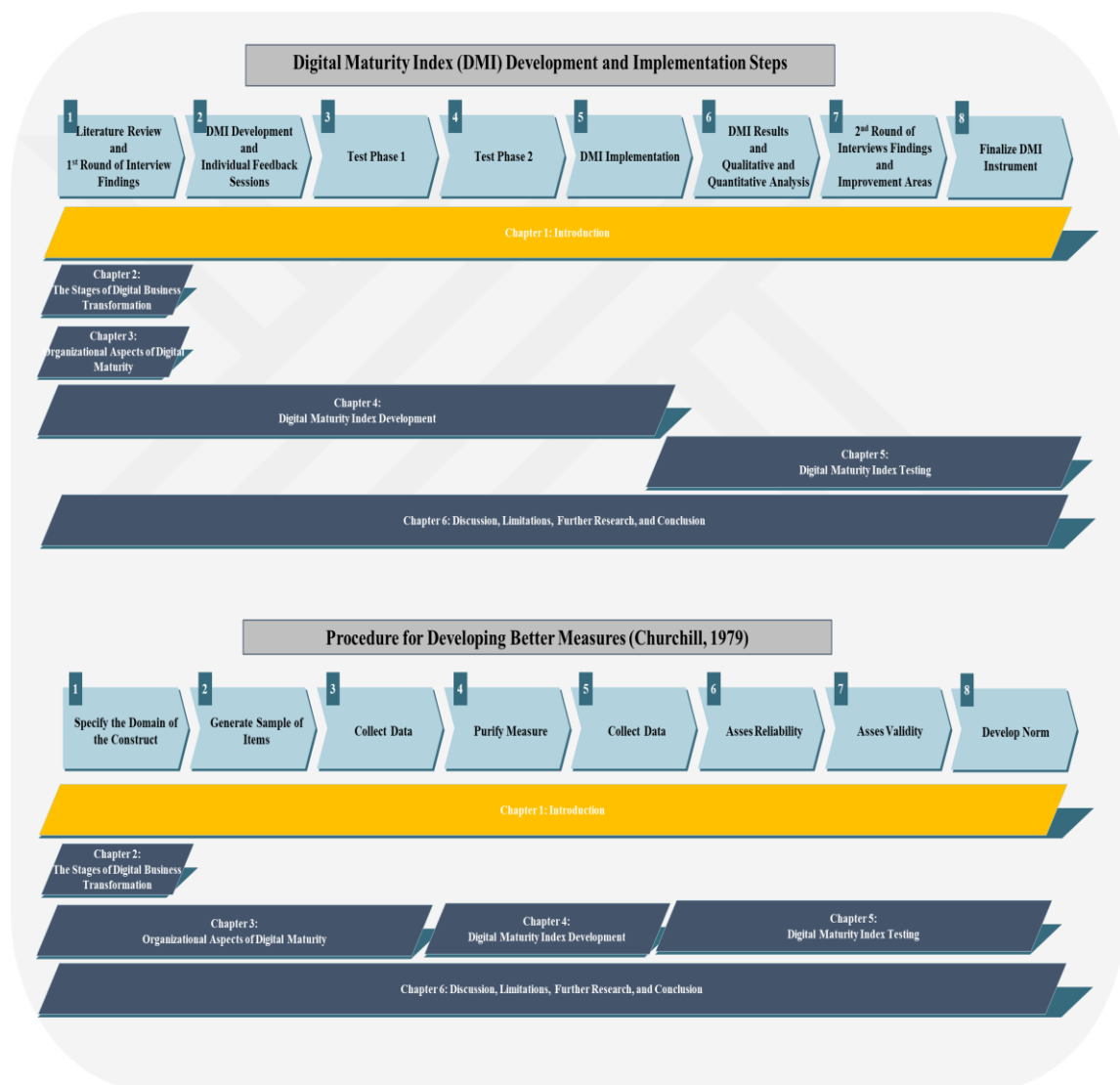


Figure 4: Chapter 1 at Illustration and Comparison of Dissertation Structure

1.6 Overview of the Thesis

The chapters forming this dissertation cover all the steps towards index development, from defining the digital transformation stages and organizational aspects, to construct and rubric development. It starts with the general introduction of the whole dissertation, then it is followed by Chapters 2, 3, and 4 to explain the index development. After explaining the index development process, in Chapter 5 implementation of the index at an automotive company is explained. Following this, based on the data analysis discussion, and limitations and a conclusion chapter is formed. (Figure 4)

a. Chapter 1 – Introduction

Chapter 1 is the general introduction of this dissertation project and gives brief information on the outline, discussions, analysis, and findings.

b. Chapter 2 - The Stages of Digital Business Transformation

Chapter 2 distinguishes digital transformation phases as: (i) digital passive, (ii) digitization, (iii) digitalization, (iv) digital transition and (v) digital transformation. Chapter 2 is an output of both systematic literature review and qualitative interviews with the industry experts where the different stages of digital business transformation are defined and analyzed. Findings of this chapter form the columns of the digital maturity index.

c. Chapter 3 - Organizational Aspects of Digital Maturity

Chapter 3 defines the internal six organizational aspects; (1) *Culture*, (2) *Data and Analytics*, (3) *People, Structure, and Organization*, (4) *Processes and Systems*, (5) *Strategy*, and (6) *Technology* which emerge from the measurement of digital transformation levels of the companies. Chapter 3 is an output of both systematic

literature review and qualitative interviews with the industry experts where internal organizational aspects are affected by the digital transformation initiatives. This chapter forms the rows of the digital maturity index.

d. Chapter 4 - Digital Maturity Index Development

Chapter 4 explains the development process of the digital maturity measurement index. This is based on the five stages defined in the second chapter and the six organizational aspects defined in the third chapter. Chapter 4 is the concept development chapter. It explains the development of the digital maturity index process. The process includes literature review, feedback sessions, and methodology.

e. Chapter 5 - Digital Maturity Index Testing

In Chapter 5, the implementation of empirical results used in further research as a rubric for digital business transformation to use as an assessment tool at an automotive sales and aftersales company. Chapter 5 is the research setting chapter. In this chapter the index implementation results at an automotive sales and aftersales company and the qualitative interviews afterwards are discussed.

f. Chapter 6 – Conclusion

Chapter 6 is the closure chapter which covers the findings of Chapter 2, 3, 4, and 5 and summarizes the discussions, contributions, limitations, and identifies the further research areas.

CHAPTER II

THE STAGES OF DIGITAL BUSINESS TRANSFORMATION¹

Companies use digital technology to transform their business. Digitization, digitalization, and digital transformation have been proposed as stages in this business transformation process. Researchers have also proposed a variety of digital maturity models to assess this transformation. The distinctions and the ontology between the stages of digital transformation are not always clearly defined. Using expert interviews and literature review, this chapter derived a domain-specific ontology from commonly expressed keywords. Based on this, five stages of digital transformation were distinguished and defined: (i) digital passive, (ii) digitization, (iii) digitalization, (iv) digital transition and (v) digital transformation. These five stages may be used in further research as a rubric to assess digital business transformation.

After the general introduction of the whole model, approach, research questions towards development of the Digital Maturity Index Instrument explained in the “*Chapter 1 – Introduction*”, the findings “*Chapter 2 – The Stages of Digital Business Transformation*” aims to define the stages of digital transformation (i) *digital passive*, (ii) *digitization*, (iii) *digitalization*, (iv) *digital transition*, and (v) *digital transformation* by highlighting distinctions based on literature review, ontology, and unstructured interview.

¹ [9] This chapter was published as I. Mutlu, E. den Hartigh and C. Ucler, “Digital Technology and the Stages of Digital Business Transformation,” 2022 *IEEE 28th International Conference on Engineering, Technology and Innovation (ICE/ITMC) & 31st International Association For Management of Technology (IAMOT) Joint Conference, Engineering, Technology and Innovation (ICE/ITMC)*, pp. 1–8, (2022). <https://doi-org.offcampus.ozyegin.edu.tr/10.1109/ICE/ITMC-IAMOT55089.2022.10033256>

This chapter analyzes the first round of interview results and the literature which forms the digital business transformation stages in the Digital Maturity Index construct and concept. The output of Chapter 2 forms the solid basis of the columns of the Digital Maturity Index.

Keywords: *Digitization, Digitalization, Digital Transformation, Business Transformation, Ontology*

2.1 Introduction

Digital technology has revolutionized ways of interaction. Industry dynamics are reshaped so that companies become part of digital platforms and participate in new ways of collaboration and competition. This causes evolution and reinvention of business practices, organization structures, business models, and modes of engagement with stakeholders and with the business environment [10].

Consequently, the use and impact of digital technology in business have gained increased attention in academic and practitioner literature ([11]; [12]; [13]; [14]). Existing literature has used the terms digitization, digitalization, and digital transformation to describe and analyze how the use of digital technologies is changing business processes, business models, behavior and expectations of customers, supply chains and industry structures ([15]; [16]; [17]). In some sectors, such as retail, hospitality, media and taxi transport, the pervasive use of digital technology has already triggered fundamental restructuring of industry structures towards digital platforms and ecosystems [18]. In other sectors, this process is ongoing or is expected to gain further momentum, particularly with the effects of Industry 4.0 on the manufacturing sector.

However, the terms that are used to express these changes, i.e., digitization, digitalization, and digital transformation, have been defined in many ways and are therefore not always clearly distinguished. Despite attempts of generalization ([15]; [14]; [18]; [19]; [20]; [21]), the ontology encompasses interchangeable definitions in the literature. Then, there are attempts to look at digitalization as a process of increasing digital maturity, the stages of which have likewise been conceptualized in many ways ([22]; [23]; [24]; [25]; [26]; [2]; [4]; [27]) and are consequently not clearly distinguished.

Even though this transformation process is a trend topic in companies, and a top item on C-Suite's and management's agenda, there is no consensus on its progress and stages. Therefore, companies are struggling to define in which stage or how "ready" or "mature" they are, and what sort of actions to take next. There is therefore a clear need to better distinguish between the related concepts and to qualify those concepts as stages in business transformation. Hence the following research questions are set for this chapter:

1. *What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation?*
2. *If so, how can these concepts be arranged as stages of digital business transformation?*

The structure of this chapter is as follows: first the existing distinctions between digitization, digitalization and digital transformation are discussed and it is argued that they are indeed stages in a digital business transformation process. Then, data and methods are described including expert interviews confirming the lack of differentiation between the core concepts and literature review visualizing keywords describing the domain specific ontology for the key terms. Then, five stages of digital business

transformation are distinguished as (i) digital passive, (ii) digitization, (iii) digitalization, (iv) digital transition and (v) digital transformation, which are finally discussed.

2.2 Digitization, Digitalization and Digital Transformation

Below, the distinctions between (a) digitization and digitalization and (b) digitalization and digital transformation are discussed and unclarities identified. Then, the influence of digital technology as a General-Purpose Technology is discussed to propose a fundamental distinction between digitalization and digital transformation, where digitization, digitalization, and digital transformation may be seen as successive stages in companies' business transformation processes.

2.2.1 Digitization versus Digitalization

Tilson et al. [11] described digitization as a technical process and digitalization as a sociotechnical process that applies digital techniques to social contexts, such as businesses. Brennen and Kreiss [28], with reference to the Oxford English Dictionary, seconded this, by defining digitization as “the material process of converting individual analogue streams of information into digital bits” and digitalization as “the way in which many domains of social life are restructured around digital communication and media infrastructures”. Gobble [29] followed Brennen and Kreiss' [28] definition of digitization but defined digitalization as “the use of digital technology, and probably digitized information, to create and harvest value in new ways” [28:56], which is basically followed and confirmed by recent literature ([28]; [30]).

Most of the practitioner's literature also follows this distinction, with some notable exceptions. Ross [31], for example, understands digitization as a change in business processes, though not of business processes: “Digitization involves standardizing

business processes and is associated with cost cutting and operational excellence”. Brown et al. [32], Bughin et al. [33] and Van Zeebroeck et al. [34] use ‘digitization’ to capture all three concepts.

2.2.2 Digitalization versus Digital Transformation

The distinction between digitalization and digital transformation is more problematic. The major problem is a considerable overlap between the descriptions of digitalization and digital transformation, where usually digital transformation is seen as “more intense digitalization”.

Digital transformation is “broader than digitalization as a way to move to digital business” and it requires far more bridges to be built in an encompassing digital transformation strategy” [35: 8]. Gobble states that “[digitalization] ... allowed to grow and take root, leads to digital transformation—the complete remaking of the business around the new opportunities and new demands presented by digital technology” [29:57]. The words ‘complete remaking’ suggests a fundamental distinction but are not further explained.

Vial’s comprehensive literature study of ‘digital transformation’ defines it as “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” [14:118]. As a definition, this is fine, but it does not help in distinguishing digitalization from digital transformation. The distinction, if any, would be in the significance of the changes, which is a gradual distinction only. The same is true for the comprehensive paper of Gong et al. [19:12] who aim at developing a unified definition of digital transformation as “a fundamental change process, enabled by the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity and redefine its value proposition for

its stakeholders.” But “fundamental”, how? And is the innovative use of digital technologies or the leverage key resources and capabilities really distinguishing? Here, too, the definition is fine, but it does not help us to distinguish digitalization from digital transformation.

Another problem is that distinctions between digitalization and digital transformation are sometimes made based on an arbitrary factor that is not grounded in literature or earlier research. Irniger [36] emphasizes ‘integration of applications’ as the crucial aspect of digital transformation. Bloomberg [37] emphasizes customer-drivenness and Savić finds the crucial distinction in the change in company culture [13:37]. Saarrikko et al. [16] see digitalization as socio-technical and digital transformation as socio-cultural. In their research they also detect that among industry experts, there is considerable unclarity about the distinctions. While these are all important differences, none of these studies argues systematically why the factors they identify are unique to digital transformation.

Mergel et al.’s definition study is more helpful because it distinguishes the three concepts and deeply argues the transformative aspects of digital transformation, summarizing them as “... the cultural, organizational, and relational changes ...” [15:12]. The contribution of Verhoef et al. [17] holds the middle, distinguishing digital transformation by change of business models, change of business logic of a company, deep use of IT, interactions across company borders, leveraging core competencies and strategic changes. They summarize it as “... digital transformation is a company-wide phenomenon with broad organizational implications in which, most notably, the core business model of the firm is subject to change through the use of digital technology” [17:895]. While their definition addresses core aspects of transformational change, i.e., the business model and business logic, it focuses strongly on company-internal processes

and it is compounded with non-transformational changes such as strategy, use of IT, and core competencies.

2.2.3 The Impact of Digital Technology

Digital technology can be regarded as a general-purpose technology (GPT) as defined by Bresnahan and Trajtenberg [38:84] because it has: "... the potential for pervasive use in a wide range of sectors and by their technological dynamism. As a GPT evolves and advances it spreads throughout the economy, bringing about and fostering generalized productivity gains."

It is known that GPT's have an impact on the social structure of business and society ([11]; [39]). The combination of binary data expression, computers, communications technology, and connectivity creates the potential of a GPT ([11]; [12]; [36]).

The increased and pervasive use of digital technology has several consequences, mainly removing traditional cost, time and space frictions and enabling new forms of industry organization and mediation by enabling separation of information storage, transmission, and processing ([11]; [33]; [40]). A main reason for this is that modern information systems enable loose coupling of business functions and first of all they do not necessarily follow physical reality but can shape physical reality. In this context Baskerville et al. [41] speak of 'ontological reversal': whereas in the past it was the physical reality that dictated what information systems would look like, it may presently be the reverse. The consequences are that "... digitizing has the potential to remove the tight couplings between information types and their storage, transmission, and processing technologies—potentially shattering the dominant service model and the stability of the industrial organization" [11:749]. In other words, it enables a change in social structures

or configurations of the value system or industry, thereby unleashing the full potential of digital technologies.

Thus, digital platforms or digital ecosystems emerge, that go beyond digitalized versions of existing production processes or supply chains: they are different social structures in which fulfilment, data sharing, innovation and market making come together in modular, loosely coupled ways. Such changes in social structures are already observed in various industries. The most visible examples are the digital platforms and digital ecosystems, such as eBay, Amazon, Airbnb or UBER, and digital technology also enables what Benkler [42] referred to as ‘social production in the digitally networked environment’: a radical decentralization of traditional industries with high-profile examples such as bitcoin, replacing conventional currency, or social networks and the blogosphere, replacing traditional news sources and publication outlets.

2.2.4 Digitization, Digitalization, and Digital Transformation as Stages of Business Transformation

Based on our review above, a clear consensus on the distinction between digitization and digitalization can be detected: digitization is a technical process, converting analog into digital, whereas digitalization is a socio-technical process, using digitized data and information to automate business processes. Viewed like this, digitalization clearly builds further on digitization, not as “more of the same” but as fundamentally different.

No such consensus yet exists on the distinction between digitalization and digital transformation. Based on the concept of digital technology as a GPT, we propose the changes in social structure of industries as the fundamental distinction between digitalization and digital transformation. See in this way, digital transformation builds

further on digitalization, not as “more of the same”, but as fundamentally different from digitalization. And the fundamental difference is in the change of social structures.

In this way, digitization is a prerequisite for digitalization which is, in turn, a prerequisite for digital transformation. The notion of digitization, digitalization, and digital transformation as stages in companies’ business transformation processes is well-illustrated in Sandberg et al.’s case study of ABB [28]. Therefore, digitization, digitalization, and digital transformation may be regarded as successive stages in companies’ digital business transformation processes. However, the distinctions between these phases must be clarified and validated.

2.3 Method and Data

To answer the research questions, two methods were used: expert interviews and a literature review aimed at defining domain-specific ontology.

2.3.1 Expert Interviews

The work was initiated by the need of a major automotive company, and five of the experts interviewed are related to the automotive value chain. To avoid bias in the answers, a control group of four experts was selected across various industries. Consequently, in total nine interviews were conducted with digitalization experts (see Table 2) from four different company types namely as automotive, banking, e-commerce ‘digital natives’, and software in four different countries (Austria, Germany, Netherlands, and Turkey). Interviewees were selected based on preliminary clustering to gain a better understanding of data from various expertise, hierarchical, and management levels. The first cluster of three interviewees consisted of ICT experts or implementers, designers, and developers of digitalization related processes. The second cluster of six interviewees

consisted of mid-level managers and business experts who are the product owners or who are running digital initiatives in their business area. The interviewees had an average industry experience of ten years. The interviews were of semi-structured type guided by and testing the results of the literature review, and they did take approx. forty minutes each. Following interview questions (IQ) were used during the interview:

1. What is technology?
2. What is digital technology?
3. Which technologies are you aware of?
4. What is digitization from your perspective?
5. What is digitalization from your perspective?
6. What is digital transformation from your perspective?
7. What is happening in the sector?
8. Do you see a relationship between technology and what's happening on your company?
9. Which technology options will enable a company's digital transformation journey?
10. Were you involved in digital transformation projects? Do you consider this project successful or a failure? Please explain?
11. Do you have the appropriate skills and in-house resources to embark on this journey?
12. Is digital transformation a controversial topic? If so, why?

Table 1: Overview of Conducted Interviews

	Interviewee Role	Expertise Category	Company	Duration
1	Business Product Owner & Data Analyst	Implementers / ICT Expert	Automotive Industry*	49 min
2	Business Manager	Mid-Level Mgmt. / Business Experts	E-Commerce	38 min
3	Business Product Owner	Implementers / ICT Expert	Automotive Industry*	43 min
4	Business Product Owner	Implementers / ICT Expert	E-Commerce (Digital Native)	24 min
5	Business Manager	Mid-Level Mgmt. / Business Experts	E-Commerce	54 min
6	Technical Product Owner	Mid-Level Mgmt. / Business Experts	Software Industry*	33 min
7	Business Manager	Mid-Level Mgmt. / Business Experts	Digital Payment (Banking Industry)	43 min
8	Business Manager	Mid-Level Mgmt. / Business Experts	Automotive Industry*	48 min
9	IT Manager	Mid-Level Mgmt. / Business Experts	Software Industry*	42 min
* Companies that are part of the automotive value chain				

The purpose of the study was explained to the participants. Interviews were digitally recorded. The names of the companies, information and interview responses were kept confidential and are only presented anonymized or in the aggregate to protect interviewees' identity.

2.3.2 Literature Review for Domain-Specific Ontology

A semi-structured approach was used to review the existing literature on digitization, digitalization, and digital transformation. It started with a Web-of-Science search on the

key term “digital transform*” (719 hits, January 2022) and on the combination of the key terms “digi*”, “digitali*”, and “digital transform*” (142 hits, January 2022), limited to academic journal papers, including pre-published results in management science, computer science and engineering, and multi-disciplinary papers categories, where conference papers were excluded. The hits were filtered to include only (a) papers that either explicitly deal with definitions of the relevant terms and/or the distinctions between them, or (b) papers that present a stage-wide model related to digitalization and digital transformation. The set of papers were enriched by reading them and adding any references that met out two filter criteria. This yielded a set of 30 papers. A comprehensive literature review with descriptive statistics is not in the scope of our research, because several good reviews are already available (see e.g., [14]; [19]; [20]; [21]; [30]; [28]). Instead, the review is used to develop a domain-specific ontology.

Consequently, papers were checked on salient words or expressions used to describe or distinguish the digitization, digitalization, and digital transformation and/or the stages of a digital transformation process. In most cases these are words or expressions derived from the paper text. In a few cases, where it contributes to the understanding, authors’ findings from tables or word clusters were used. The words or expressions were plotted initially into the stages of digitization, digitalization, and digital transformation. However, it was found that additional stages were required to indicate no or very limited digital efforts and as a stage between digitalization and digital transformation, which are labeled as digital passive and digital transition respectively.

2.4 Results and Discussion

In this section, findings of the interviews and the literature review are discussed and analyzed. Based on the literature review, a domain specific ontology is visualized, and

five stages of digital business transformation emerge. Following these findings, each stage is described.

2.4.1 Results of Expert Interviews

The major finding from the interviews is that there is a lack of differentiation among digital business transformation concepts and confusion about the terminology. Even experts have a different understanding of the core digital business transformation concepts, and they are using the terms interchangeably. For instance, digitization, digitalization, and digital transformation have been used interchangeably by the interviewees.

Digitization was mainly perceived by the interviewees as the online and data driven way of executing processes substituting human work/ interaction. It was described as in association with digits rather than physical concepts, converting from a physical source to digital format, e.g., converting a document to a pdf file via scanner.

Digitalization was perceived on a higher level, described as the conversion of a manual or physical process to digital process on a digital platform. However, some of the interviewees also associated digitization as the conversion of the current business structures or current business processes, which implies the adaptation of technology for technology driven processes.

Digital transformation was described as data driven, benefiting from artificial intelligence (AI) for automation. Several interviewees mentioned that digital transformation requires a new mindset. Then, stakeholders were involved in the transformation process as well. It was mentioned that the landscape is changing. So, all

company operations must be adapted to digital transformation, changing the way how business is done.

2.4.2 Results of Literature Review

The major finding from the literature review is that two more stages need to be identified: next to digitization, digitalization, and digital transformation there would be a stage before digitization, that we label *digital passive* and a stage in between digitalization and digital transformation that we label *digital transition*. The results of the literature review are presented in Table 3. It shows the words and expressions that are mentioned in the literature for each of the stages of digital business transformation. Reflecting on this, it can be seen that:

- *Within the stages*, words and expressions to characterize (i) digital passive, (ii) digitization and (iii) digitalization are mostly consistent with the definitions of the concepts (see section II). Stage (i) digital passive is mostly understood as “no digital activity”, though sometimes seen as the starting phase of digital activity. Stage (ii) digitization conforms to its definition as converting analogue to digital, and strongly carries the meaning of the starting phase of the digital business transformation process. Stage (iii) digitalization conforms to its definition as using the potential of digitalization with limited changes in social structures, and it carries the meaning of continuing the digital business transformation process.
- *Within the stages*, the words and expressions that characterize (iv) digital transition and (v) digital transformation are much less consistent. Stage (iv) digital transition carries some meanings that are more related to (iii) digitalization, such as *transformation*, *end-to-end* or *advanced*, as well as meanings that are more related to (v) digital transformation, such as *decoupling* or *exploration*. It seems that

whereas many papers identify the necessity of this ‘in-between’ stage, there is little agreement on exactly what happens in that stage. Stage (v) digital transformation seems to suffer from its ‘buzzword’ status. It carries many meanings that are consistent with its definition of changing socio-technical structures, such as *pivotal, rethink, extending beyond, changing nature* or *game changer*, but it also carries a load of more conventional meanings such as *innovation, use of technology, value chains, e-commerce* or *optimizing*.

- *Between the stages*, the distinctions between (i) digital passive, (ii) digitization, and (iii) digitalization are mostly consistent, because the clusters of associated words and expressions show little overlap.
- *Between the stages*, the distinctions between (iii) digitalization, (iv) digital transition and (v) digital transformation are much less consistent, because there are many overlaps in the words and expressions used to characterize those stages.

This delivers five different clusters, describing consecutive stages.

Table 2: Most Expressed Words Constituting The Domain Specific Ontology

<i>Digital Passive</i>	<i>Digitization</i>	<i>Digitalization</i>	<i>Digital Transition</i>	<i>Digital Transformation</i>
- Analog - Physical processes - Incomplete - Traditionally organized - Digitally developing (CMMI 1) - Unpredictable - Reactive - No concerted efforts - Low or no implementation - No step to transform - No, unspecific, or sporadic digital initiatives	- Analog 0 or 1 or Binary - Promote & Support - Digital awareness - Potentiality - Converting analog to digital - Moving from manual to digital - Paperless office - No change of business models - Operational - Performed - Roadmap - Portfolio - Laggards - Digitize peripheral processes - Researchers / Research on practices - Technical process - No collaboration - Optimize processes - Addition of a technological channel of delivery - Digitally developing (CMMI 2) - Projects - Managed - Strategic imperative - Agile - Blockchain - Technical process - Decoupling of form, function, and access - Precondition - Modular architecture - Device digitization - Pilot actions - Implementation initiated - Some benefits - Identify part of business to be digitalized - Initiating - Decide to move - Taking initial steps - Converting analog information and processes to digital ones - Change of analog to digital tasks - Integration of IT with existing tasks - Cost-effective resource configurations using IT - Central IT led pilot projects	- Digitalization of physical processes - Create & build - Commit to transform - Digital acquirement - Use of digital create value in new ways - Digital value proposition - Managed - Business process digitalization - Digital Twin - Replacers or Enablers - Digital processes - Strategy but no priority - Beginners - Implement changes - Include technology in producing and delivering services - Facilitate new ways of delivering services - Organizational and cultural process - Support but no change - Ongoing establishment and maintenance of technology - Automated [Digital] technology as support - Synergy within organization - Communication with [digital] technologies - New ways of workplace communication and collaboration - Use of digital to create revenue - Use of digital to improve business - Use of digital to replace/transform business processes - Expanding the range of goods and services and the range of buyers that sellers can reach - Decreasing the search costs - Providing data about customer preferences - Beyond mere digitizing of existing processes - Digitally developing (CMMI 3) - Organized (actions and goals aligned) - Pro-active - Sociotechnical process - Leveraging digitized products or systems - Develop new procedures, business models, or offerings - Base service digitization and integration - Partial implementation - Enhances competitiveness - Automating business processes - Investments - Technology led - Optimization and cost reduction - Enabling - Implementing initiatives - Organizational agility - Use digital technologies - Change business model - New revenue and value-producing opportunities - Moving to a digital business - Digital products - Sociotechnical phenomenon - Adoption of digital technologies - Digital variants of products and services - IT or IS enabled transformation - Integration between technologies, products and customer usage - Use IT or digital technologies to alter existing business processes - Organization of new sociotechnical structures with digital artifacts - IT as enabler - Optimize processes / Efficiency - Create additional customer value - Enhance user experiences - Decreased error rates - Existing organizational identity	- Transforming - User-centered & elaborated processes - Digital collaboration - Established - Business process integration - Change management - Predictable - Integration - Data-driven decisions - Advanced - Integrated services - Synergy between [digital] technologies and existing ones IoT, Blockchain, 3D printing - Digitally mature (CMMI 4) - Quantitatively measured and controlled - Synergies - Involve competencies and people from outside organization - Decoupling service and content - Advances implementation - Clear economic returns - Integrated systems - Business model led - Exploration of new opportunities - Integrated across the organization - End-to-end capabilities	- Digital business models - Data-driven enterprise - Networked business processes - Strategy - Pivotal / pioneering - Rethink what a product is - Rethink what a company is / scope of the firm / challenges very existence of a business - Transformation of corporate structures - Innovating - Disruptive - New business models / new business logic / experimentation with / reconfiguration of - New operating models - Fundamental change - Innovative use of digital technologies - Strategic leverage of key resources and capabilities - Radical improvement - Redefine value propositions - Leaders - Successful transformation - Innovators - New practices - Complex and multifaceted process - Change in culture - Ongoing change process - Extends beyond the sector - Person-centered - Whole organization / company-wide - Synergy across company borders - Synergy across multiple units - Digital Twin - Change in leadership, in mindset and attitude towards risks - New ways of working - Changes in control and power - Changing nature of knowledge - Robots and machine learning - Digitally mature (CMMI 5) - Reshaping segments and industries - Rethink role and value of data - Change in how to create value - Digital economy / economic growth - Global value chains - Quality of life - E-commerce - Game changer - Beyond use of technologies - Sociocultural process - New organizational forms and skill sets - Beyond IT-enabled change - Platform Ecosystem - Applying Industry 4.0 concepts and technologies - Creating a digital company - Customer at the center - Optimizing / fine-tune - Increase performance - Advancing practice - Digital change agent - Technology-driven - Major changes in business, people, and society - Cumulative impact of digital technologies - Not organization-centric - Long-term development in project portfolio - Leverage / use digital technology - Respond to environmental changes - Integration of technology and business - Improve strategic agility - Enhance customer experience - Digital innovation - Servitization - IS/IT-enabled organizational transformation

Consolidated from 30 papers ([13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [2], [27], [29], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53])

2.5 Discussion

Based on the arguments in section 2.2, digital business transformation can be seen as a process of consecutive stages. This was also tested during the expert interviews by questioning the interviewees utilizing the ontology for most frequent words associated to these stages. Next to the existing stages of digitization, digitalization, and digital transformation, two stages were added: digital passive and digital transition. Each stage is the successor of the previous stage. Therefore, the following five stages are proposed as the stages of digital business transformation (Figure 5).



Figure 5: Five Stages of Digital Business Transformation

Stage 1: Digital Passive: In a few cases, it was found that it was useful to add a stage to indicate no or very limited digital efforts, which are labeled “digital passive”. According to the findings, digital passive can be mentioned as the initial stage of forming digital transformation.

Based on the findings from expert interviews and literature review, this stage can be defined as “*Business and IT case by case work on digital issues just based on request and they are not coordinated. Target technologies and digital vision are not defined by organization.*”

Stage 2: Digitization: Digitization refers to creating a digital representation of physical objects. In other words, digitization is about converting something non-digital into a digital representation or artifact. Essentially it refers to taking analog information and encoding it into binary digits “0s” and “1s”, through which way computers can store,

process, and transmit such information, which was an internalized ontology as seen during the interviews.

Digitization is not changing the process itself but only changes its form from analog to digital [5]. Consequently, it has no direct business value, but it is an enabler to create business value by delivering the basis for business cases.

Based on the findings from expert interviews and literature review, at this stage *“Digitization can be defined as the conversion of analog information to digital format. Processes are digitized but digital initiatives are taken by business divisions or IT separately”*.

Stage 3: Digitalization: According to IBM, digitalization is defined as *“Digitalization digitizes entire aspects of a business, producing customer experiences that support individuals’ needs or wants”* [55:15]. This means that digital technologies and digitized data are leveraged to improve existing- or even enable new-business processes. The interviewees expressed this as using digital technologies conversion of a process into digital sources, tools and online platforms.

Based on the findings from expert interviews and literature review, this stage can be defined as *“Digitalization as using digitized data and information to automate existing operations. Business divisions and IT developed competencies”*.

Stage 4: Digital Transition: In a few cases, it was found useful to add a stage between digitalization and digital transformation, because the interviewees were describing integration as a process of change which has to be managed. So, this is labeled “digital transition”. Based on the findings from expert interviews and literature review, this stage can be defined as *“Transition stage from digitalization towards fully digital*

transformation. The culture of digital orientation exists. Digital technologies are used, and data and information are collected and analyzed for decision making”.

Stage 5: Digital: There is a digital transformation when the usage of digital technologies is transforming business activities and competencies so that the business model is reconceptualized. Consequently, it leads to a strategic digital reinvention, delivering innovative products and experiences ([24]; [55]), which is reimagining new ways of interacting within the value chain. Due to digitization and digitalization process, data is made available and accessible for use across various platforms. Digital transformation is the process of deriving new business models and applications which integrate the data gathered from all digitized applications and processes. This was also commonly designated as a disruptive rethinking of the organization during the interviews. Based on the findings from expert interviews and literature review, this stage can be defined as *“Digital transformation as the change of socio-economic structures (such as business models, supply chains, platforms, or ecosystems) as a consequence of the use of digital technology”.*

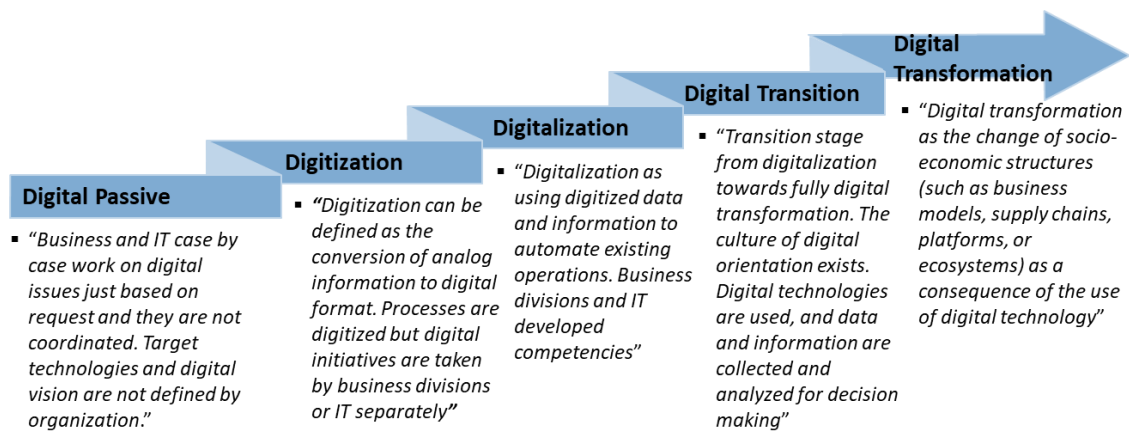


Figure 6: Five Stages of Digital Business Transformation and Definitions

2.6 Conclusions

This work was undertaken due to perceived ambiguity in the distinctions between the core concepts of digital business transformation: digitization, digitalization, and digital transformation. It intended to investigate two research questions: 1) *What are the differences between the core concepts of digital business transformation i.e., digitization, digitalization, and digital transformation?* and 2) *how can these concepts be arranged as stages of digital business transformation?*

Answering research question # 1 based on the research, it was found that there are fundamental distinctions between related concepts quantifying stages of digital business transformation. The words and expressions to characterize digital passive, digitization and digitalization are mostly clear and consistent. The words and expressions to characterize digital transition and digital transformation are all over the place. The distinctions between digital passive, digitization and digitalization are mostly clear and consistent. However, the distinctions between digitalization, digital transition and digital transformation are not always clear. It is found from the literature review that emerging consensus on the fundamental difference between digitization and digitalization that digitization is a technical process, whereas digitalization is a socio-technical process using digitized data and information to automate business processes. It is also found that there is no consensus on the difference between digitalization and digital transformation.

Answering research question 2, based on the findings of the literature review, using keywords describing the domain specific ontology, it is concluded that the digital business transformation is progressing in stages, where one stage is the successor of the previous stage. Specifically, this process starts from (i) *digital passive* to (ii) *digitization*, over (iii) *digitalization*, and (iv) *digital transition* to (v) *digital transformation*. Our

findings underline the evolution of business models and processes through the developments in digital technology and its complexity.



CHAPTER III

ORGANIZATIONAL ASPECTS OF DIGITAL MATURITY

There are several organizational aspects such as culture, systems, processes, supply chains, etc. that help to run a business. For the successful digital business transformation of a company, these aspects need to be considered and carefully monitored and managed by the leaders. In this chapter, based on the findings from the expert interviews and as well as the literature review, (1) *Culture*, (2) *Data and Analytics*, (3) *People, Structure, and Organization*, (4) *Process and Systems*, (5) *Strategy*, and (6) *Technology* is categorized as the major organizational aspects which are considered as being part of the successful digitalization transformation of the companies. The findings and the discussion of this chapter aim to be one of the pillars of the Digital Maturity Index (DMI) Design and Development phase and form the dimensions which forms the organizational aspect model.

The findings “*Chapter 2 – The Stages of Digital Business Transformation*” suggested based on the domain specific ontology and the literature review, business models are evolving, and the digital business transformation is progressing as stages starting from (i) *digital passive* to (ii) *digitization*, over (iii) *digitalization*, and (iv) *digital transition* to (v) *digital transformation*. Chapter 3 aims to analyze the first round of interview results and the literature which form the columns of the Digital Maturity Index construct, concept, and organizational aspect model. The output of Chapter 3 forms the solid basis for the columns of the Digital Maturity Index.

Keywords: *Digitization, Digitalization, Digital Transformation, Technology, Digital Technology, Digital Transformation Enabling Technology, Digital Strategy, Organization Aspects, Culture, Data and Analytics, People, Structure, Organization, Processes, Systems, Technology.*

3.1 Introduction

For the successful digital transformation of companies, company leaders are identifying the fundamental areas where changes are needed, and improvements can be made ([33]; [56]). This leadership approach towards determining the enabling areas for the successful digital transformation and identification of core processes at the digital transformation journey indicates the organizational aspects of digital transformation. Company management level focuses on changing the mindset of its employees, organizational culture, and processes before the implementation of the digital technology and the related tools and how to implement them [57]. Therefore, in this chapter, the aim is to investigate what organizational aspects can be considered for a successful digital transformation of a company.

The main motivation for this chapter is described by the following research questions:

RQ2: Which internal organizational aspects should be considered when measuring the digital business transformation of the company?

The internal organizational aspects which are identified in this research are based on the findings from the first round of interviews and the literature review. The logic of this chapter is formed by first describing the findings from the literature review, and then

comparison with the interview results, that are both indicating the organizational aspects of the model construct.

Through synthesizing the findings from the literature review and the combination of the first round of interview findings with the industry experts and the discussions with academicians on this area, 6 constructs are identified: (1) Culture, (2) Data & Analytics, (3) People, Structure and Organization, (4) Processes and Systems, (5) Strategy, and (6) Technology categories.

3.2 Method and Data

This research is organized qualitative research to gather in depth information from the industry experts through expert interviews and conducting literature review. The research is designed in three rounds. The first round is designed as literature review. The second round is designed as an unstructured interview format to collect general understanding data on digital transformation and technology. The third round is formed by collecting data revisiting the literature based on the information gathered from the industry experts to confirm the expert findings and literature review matches with each other. Therefore, qualitative research is designed as “*Literature Review*” and “*Expert Interviews*”.

3.2.1 Literature Review

Detailed (systematic) review of previous and related research conducted based on the search query of “digital maturity”, “maturity measurement”, “digital readiness”, “maturity model”, “digital maturity assessment”, “(digital) organization”, “(digital) strategy”, “(digital) culture”, “(digital) technology”, “(digital) processes”, “(digital) leadership”, and “digitization”, “digitalization”, “digital transformation”. However, the

search queries were done systematically throughout the research by searching the answers in the practice and coming back to the academic literature, and again going back to practice, and repeating the process. Therefore, the general research timespan can be identified as from 2018 to 2022.

During the literature review articles' publication date was narrowed down between 2015 to 2023. The publication focus was only on English. The research disciplines were narrowed down by "Business & Management", "Computer Science", "Information Technology", "Science", and "Technology". Furthermore, resource types were selected as "Academic Journals", "Conference Materials", and "Reports". As the result 69,606 papers found on Academic Journals, 1,553 articles found as Conference Materials, and 1,408 papers marked as Reports. The Web of Science (WOS) research covered the following citation indexes, Scopus, Art & Humanities Citation Index, Science Citation Index, Social Sciences Citation Index. Based on these search criteria, the following subjects received the highest hit numbers; "digital technology" with 17,489, "digital transformation" with 2,959, "artificial intelligence" with 2,102, "digital technologies" with 1,923, "industry 4.0" with 1,874, "digitalization" with 1,840 and "technology" with 1,773.

In these articles, several research papers are focusing on providing literature review on various facets of digital transformation such as concepts and impacts. Some empirical and applied science related research papers are focusing on clarifying digital transformation related processes in different industries and sectors such as automotive, healthcare, aerospace, and financial services. Moreover, several others are focusing on the components of digital transformation such as strategy, agility, leadership, organization, employees, supply chain, implementation, and challenges.

168 articles including journal papers, conference papers, and consulting were found as the primary articles. Among 168 articles, 18 articles are selected which deal with the digital maturity measurement, digital assessment, and maturity models with various focuses such as maturity model comparisons, aspect definitions, empirical tests with the industries, maturity scaling, and questionnaires.

These 18 articles are basically grouped under 2 main categories by whom they were produced and 3 sub-categories where they were published. Two main categories are grouped based on who produces them; developed by the academicians and developed by the practitioners. Academic papers cover where they were published in academic journals or at conferences. The other category of practitioner papers covers the consulting articles (Figure 7).

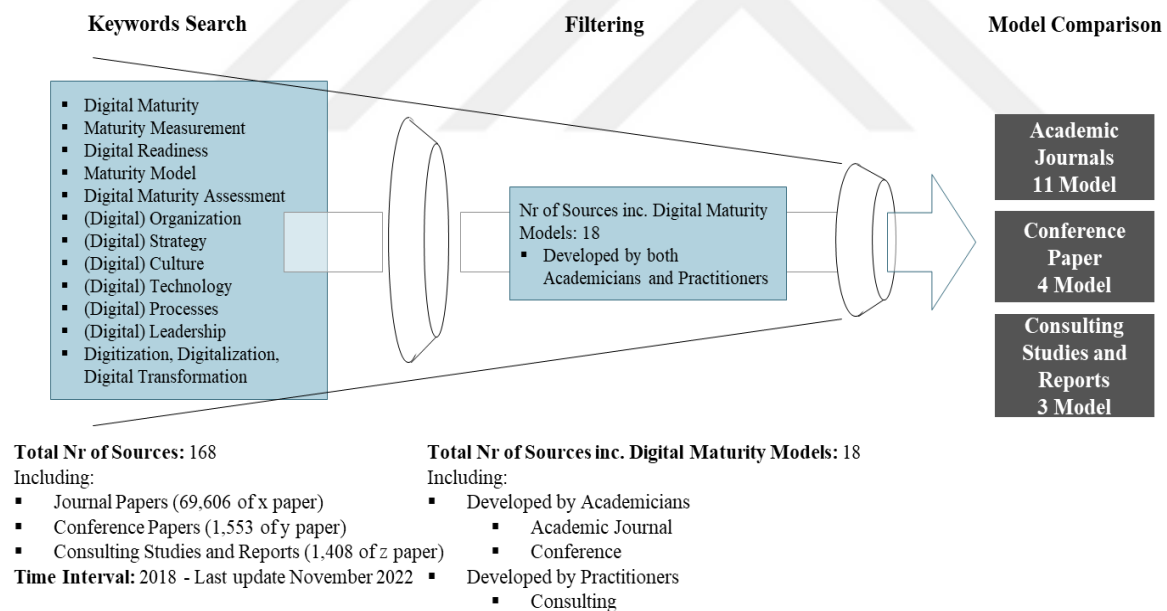


Figure 7: Digital Maturity Index Filtering Process

These 18 articles were published in the following journals and conferences:

Table 3: List of Publication Media

List of Publication Media
Electronics Journal
Applied Sciences Journal
Journal of Manufacturing Technology Management
Sciencedirect, Procedia Manufacturing Journal
Information & Management
Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis
Computers in Industry Journal
Emerald Insight Management Decision Journal
Journal of Manufacturing Technology Management Emerald Publishing Limited
Technology Innovation Management Review
Mediterranean Conference on Information Systems (MCIS)
ISPIM Innovation Conference
IEEE International Conference on Engineering, Technology and Innovation
IEEE Conference on Business Informatics (CBI)

Furthermore, based on this research field relevant theories mentioned by authors of 18 articles were listed. The list includes only the theories which are specifically mentioned in the selected articles. List of theories used by the authors are as follows (Table 4):

Table 4: List of Theories

Theories or Literature Mentioned in The Papers
Digital transformation
Maturity Models (IS research)
Digital Maturity Models (DMM)
Digital innovation
Digital transformation
Maturity level / maturity stage - Capability Maturity Model
IT Strategy and Business Strategy
Transformation roadmap

Punctuated Equilibrium (Romanelli & Tushman, 1994) Continuous Change (Brown & Eisenhardt, 1997)
Digital barriers Traditional strategic models (management models, implementing radical change)
Innovation
Industry 4.0
Digital readiness and maturity models
Business Process Management (BPM)
Business process capability / maturity model
Digital transformation capability / maturity assessment models
Industry 4.0 concepts and enabling technologies.
Industry 4.0 maturity models
I4.0 Organizational Assessment Models / Literature Review on I4.0 Maturity Models / I4.0 Maturity Models Analysis
Multi-Attribute Decision Modeling

3.2.2 First Round Expert Interviews

Under the scope of the first round of interviews, 9 interviews conducted with the digitalization experts from different industries from automotive industry to banking, and from high-tech industry to digital native-born organizations from Turkey, Germany, Netherlands, and Austria.

The interviewee selection has been done based on preliminary clustering to have a better understanding by gathering data from various experts at hierarchical and management levels: Information and Communication Technology (ICT) Experts / Implementers / IT Experts, Mid-Level Management / Business Experts, High-Level Management / Heads of Departments, and Beneficiaries / End-Users.

The first cluster of three interviewees consisted of ICT experts or implementers, designers, and developers of digitalization related processes. The second cluster of six

interviewees consisted of mid-level managers and business experts who are the product owners or who are running digital initiatives in their business area. The interviewees had an average industry experience of ten years. The interviews were of semi-structured type guided by and testing the results of the literature review, and they took approximately forty minutes each.

	Automotive Industry	Banking Industry	High Tech Industry	E-Commerce / Digital Native
Implementers / ICT Experts (Experts)	• 2 interviews • 1 Data Analyst • 1 Agile Product Owner	• No interview	• No interview	• 1 interview
Mid-Level Mgmt	• 1 interview	• 1 interview	• 2 interviews • 2 Agile Product Owner & ERP manager	• 2 interview

Country Information: Turkey, Austria, Netherlands, Germany
Location Information: Istanbul, Izmir, Amsterdam, Vienna
ICT: Information and Communication Technology

Figure 8: First Round of Interview Data Sources / Clustering Based on Roles, Expertise and Hierarchical Level

Rationale of Using Unstructured Interview: To collect general and comprehensive perceptions and data from the industry experts, as the initial research format, unstructured interview was selected.

Construction of Interview Question List: In the first interview round, main research questions focused during the unstructured interviews are: What is digital transformation? and What is digital technology? The list of the interview questions was prepared based on the findings from the initial literature review on digitization, digitalization, digital transformation, technology, and digital technology.

The questionnaire for the interviews is designed as more generic and conceptual questions. The questionnaire includes 15 interview questions. The first half of the interview questions are related to the Digital Transformation topic in general and the second half of the questions are related to Digital Technologies in general. The question set is prepared to be wide in scope. However, during the interviews, questions focused more on the industry and the discussions were detailed. The list of the first round of interview questions can be found below. (Table 5)

Table 5: First Round of Interview Question List

Digital Transformation Related Interview Questions (IQ)	Digital Technology Related Interview Questions (IQ)
1. What is digitization from your perspective? 2. What is digitalization from your perspective? 3. What is digital transformation from your perspective? What do you understand from digital transformation? 4. What is happening in the sector? 5. Do you see a relationship between technology and what's happening at your company? Do you see any influence at all? 6. What technology options will enable the company's digital transformation journey? 7. Were you involved in digital transformation projects? Do you consider this project successful or failure? How? 8. Do we have the appropriate skills and resources in-house to embark on this journey? 9. Is digital transformation a controversial topic ? If so, why?	1. What is technology? 2. What is digital technology? 3. Which technologies are you aware of? 4. Are you implementing those technologies? 5. Which technology do you think has the highest impact at your industry? 6. How and why do you select that or those technologies?

Structure of First round of interviews: The purpose of this study was to gain a better understanding of the digital transformation of the companies and the digital technology impact on them. Each interview lasts around forty minutes to one hour. During the interview, the participant had the option to skip the questions, or ask counter questions. The interviews were recorded, and the informed consent form also received from the research participants.

3.3 Results

3.3.1 Derivation of Organization Aspects as Dimensions Based on Literature Review

The selected 18 sources which consist of Digital Maturity Models are grouped into two main categories: *developed by academicians* and *developed by practitioners*. Sources developed by the academicians grouped under two sub-categories: *Academic Journals* and *Conference Papers*. Sources developed by the practitioners were grouped under *Consulting* research or study sub-category. Out of 18 resources, 11 papers are published in academic journals, 4 papers published as conference papers and 3 sources published as consulting research.

The initial group of selected papers published in the academic papers are DMAT Model [58], Maturity Model [7], Industry 4.0 Maturity Model [2], Digital maturity of an organization [59], Multi-Attribute Assessment of Digital Maturity [60], Strategy archetypes for digital transformation - BPM Model [61], Digital Transformation Maturity [62], Digital Transformation Capability Maturity Model (DX CMM) [27], Digital transformation of SMEs: a four levels approach [25], A Digital Readiness Check for

Industry 4.0 [63], and Digital Maturity Model for Telecommunications Service Providers [23].

The second group of selected papers are published in the proceedings of academic conferences. They include Digital Maturity Model (DMM) [22], Digital Maturity Models for Small and Medium-sized Enterprises [64], Digital Leadership Extended Dimension Model [46], and Exploratory Digital Transformation Maturity Model [65].

The third group of selected studies or consulting research developed by the practitioners are BCG Digital Acceleration Index (DAI) ([66]; [67]), KPMG Digital Readiness Assessment (DRA) [68], and Deloitte Digital Maturity Model (DMM) [69].

Digital Maturity Model Comparisons are summarized in Tables 6 & 7 based on the number of total dimensions, model name, author, publication information, and dimension checklist based on literature review.

Table 6: Digital Maturity Model Comparison Developed by Academicians (Academic Journal)

Digital Maturity Model Comparison										
Developed by Academicians (Academic Journal and or Conference)										
Academic Journal										
		DMAT Model (Aagaard et al., 2021)	Maturity Model (Amaral and Peças, 2021)	Multi-Attribute Assessment of Digital Maturity (Borštnar & Pucihar, 2021)	Strategy archetypes for digital transformation – BPM Model (Fischer et al., 2020)	Digital Transformation Maturity (Teichert, 2019)	Digital Transformation Capability Maturity Model (DX CMM) (Gokalp, Martines 2021)	Digital transformation of SMEs: a four levels approach (Garzoni et al., 2020)	A Digital Readiness Check for Industry 4.0 (Lassnig et al. 2021)	Digital Maturity Model for Telecommunications Service Providers (Valdez-de-Leon 2016)
Dimension Nr		6	6	7	6	15	4	3	4	7
Model Name		DMAT Model	A Framework for Assessing Manufacturing SMEs Industry 4.0 Maturity	Multi-Attribute Assessment of Digital Maturity	Strategy archetypes for digital transformation - BPM Model	Digital Transformation Maturity	Digital Transformation Capability Maturity Model (DX CMM)	Digital transformation of SMEs: a four levels approach	A Digital Readiness Check for Industry 4.0	Digital Maturity Model for Telecommunications Service Providers
Author		(Aagaard et al., 2021)	(Amaral and Peças, 2021)	(Borštnar & Pucihar, 2021)	(Fischer et al., 2020)	(Teichert, 2019)	(Gokalp & Martines, 2021)	(Garzoni et al., 2020)	(Lassnig et al., 2021)	(Valdez-de-Leon 2016)
Publication		Electronics Journal	Applied Sciences Journal	Electronics Journal	Information & Management	Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis	Computers in Industry Journal	Emerald Insight Management Decision Journal	Journal of Manufacturing Technology Management Emerald Publishing Limited	Technology Innovation Management Review
Dimension List Based on Literature Review	Culture, Culture and Expertise, Digital culture	x		x	x			x		
	Data, Data & technology									
	Strategy, Digital Strategy, Vision, Business strategy is driven by digital	x		x	x	x		x	x	x
	Organization, Digital Organization & processes	x	x			x		x		x
	Organization and Culture									
	Process, Digital Process, Digitize the core processes, Production Process	x	x				x	x		
	Technology, Digital Technology, Information Technology	x	x	x	x	x	x	x		x
	Cloud First									
	Customers, Partners, Customer Insight & Experience, Digital customers & channels	x				x				x

	People, Workforce, Human Resources, Employees, People Focus, Digital People and Capabilities, People and Culture		x	x	x		x		x	
	Digital Skills					x				
	Products, Services, Product Innovation		x			x				
	Change, Changing ways of working		x							
	Smart Factories									
	Leadership, Management, Leadership identification			x		x				
	Operation, Operations and Processes					x				X
	Governance, Strategic Governance, Transformation Management, Digital governance				x	x	x			
	Business Models, Digital Business Model			x		x				
	Method				x					
	Innovation					x				X
	Ecosystem, Digital Ecosystem, Integrating ecosystems					x				X
	Compliance & Security					x				
	Initiation of business transactions								x	
	Supply Chain								x	
	Process Digitization									
	Collaboration, Strategic Alignment									
	Competency Network									
	Trusting Relationships									
	Complexity Management									
	Boundary Spanners									
	Expectation Management									
	New digital growth									
	Role of informatics			x						

Note: Consolidated list from [58], [7], [60], [61], [62], ([27]; [4]), [25], [63], [23] papers

Table 7: Digital Maturity Model Comparison Developed by Academicians (Conference) and Developed by Practitioners (Consulting)

		Digital Maturity Model Comparison						
		Developed by Academicians (Academic Journal and or Conference)				Developed by Practitioners (Consulting)		
		Conference				Consulting		
		Berghaus (Digital Maturity Model (DMM) 2016)	Digital Maturity Models for Small and Medium-sized Enterprises (Williams et al., 2019)	Digital Leadership Extended Dimension Model (Gudergan et al., 2021)	Exploratory Digital Transformation Maturity Model (Gollhardt, 2020)	BCG Digital Acceleration Index (DAI)	KPMG Digital Readiness Assessment (DRA)	Deloitte Digital Maturity Model (DMM) (2018)
	Dimension Nr	9	6	9	5	6	7	5
	Model Name	Digital Maturity Model (DMM)	Digital Maturity Models for Small and Medium-sized Enterprises	Digital Leadership Extended Dimension Model	Exploratory Digital Transformation Maturity Model	BCG Digital Acceleration Index (DAI)	KPMG Digital Readiness Assessment (DRA)	Deloitte Digital Maturity Model (DMM)
	Author	(Digital Maturity Model (DMM) 2016)	(Williams et al., 2019)	(Gudergan et al., 2021)	(Gollhardt, 2020)	(BCG 2018)	(KPMG 2018)	(Deloitte 2018)
	Publication	MCIS 2016 Proceedings Mediterranean Conference on Information Systems (MCIS)	ISPIM Innovation Conference	2022 IEEE International Conference on Engineering, Technology and Innovation	2020 IEEE 22nd Conference on Business Informatics (CBI)	-	-	-
Dimension List Based on Literature Review	Culture, Culture and Expertise, Digital culture	x			x		x	
	Data, Data & technology					x	x	
	Strategy, Digital Strategy, Vision, Business strategy is driven by digital	x	x		x	x	x	x
	Organization, Digital Organization & processes	x					x	
	Organization and Culture							x
	Process, Digital Process, Digitize the core processes, Production Process		x			x		
	Technology, Digital Technology, Information Technology	x	x					x
	Cloud First			x				
	Customers, Partners, Customer Insight & Experience, Digital customers & channels	x					x	x
	People, Workforce, Human Resources, Employees, People		x	x			x	

Focus, Digital People and Capabilities, People and Culture							
Digital Skills							
Products, Services, Product Innovation	x	x					
Change, Changing ways of working					x		
Smart Factories							
Leadership, Management, Leadership identification		x	x				
Operation, Operations and Processes				x			x
Governance, Strategic Governance, Transformation Management, Digital governance	x			x		x	
Business Models, Digital Business Model							
Method							
Innovation							
Ecosystem, Digital Ecosystem, Integrating ecosystems				x	x		
Compliance & Security							
Initiation of business transactions							
Supply Chain							
Process Digitization	x						
Collaboration, Strategic Alignment	x		x				
Competency Network			x				
Trusting Relationships			x				
Complexity Management			x				
Boundary Spanners			x				
Expectation Management			x				
New digital growth					x		
Role of informatics							

Note: Consolidated list from [22], [64], [70], [65], BCG DAI ([66]; [67]), KPMG DRA [68], Deloitte DMM [69] papers

Commonly highlighted dimensions are marked and placed in the checklist to observe the frequency which indicates the importance of the dimension in digital maturity measurement and readiness assessment. (Table 8)

Based on the maturity model literature review and ontology analysis, the aspects pointing out the same dimensions are listed and grouped together. “*Culture*” dimension is grouped as *Culture, Culture and Expertise, Digital culture, Leadership, Management, Leadership identification, Change, Changing ways of working, Competency Network, Trusting Relationships, Complexity Management, Boundary Spanners, and Expectation Management.*

“*Data and Analytics*” dimension grouped as *Data, Data and technology.*

“*People, Structure and Organization*” dimension grouped as *People, Workforce, Human Resources, Employees, People Focus, Digital People and Capabilities, and People and Culture.* “*Processes and Systems* dimension grouped as *Process, Digital Process, Digitize the core processes, Production Process, Customers, Partners, Customer Insight & Experience, Digital customers & channels, Operation, Operations and Processes, Ecosystem, Digital Ecosystem, Integrating ecosystems, Smart Factories, Method, Supply Chain, Initiation of business transactions, and Process Digitization.*

“*Strategy*” dimension grouped as *Strategy, Digital Strategy, Vision, Business strategy is driven by digital, Collaboration, Strategic Alignment, Governance, Strategic Governance, Transformation Management, Digital governance, Innovation, Business Models, Digital Business Model, and New digital growth.*

“*Technology* dimension grouped as *Technology, Digital Technology, Information Technology, Compliance and Security, Cloud First, and Role of informatics.*

Table 8: Outcome of Literature Review - Frequency of Mentioned Organizational Aspects

Frequency of Mentioned Organizational Aspects Based on the Prioritized Articles

		Outcome of Literature Review - Frequency of Dimension
Dimension List Based on Literature Review	Strategy, Digital Strategy, Vision, Business strategy is driven by digital	14
	Technology, Digital Technology, Information Technology	12
	People, Workforce, Human Resources, Employees, People Focus, Digital People and Capabilities, People and Culture	10
	Culture, Culture and Expertise, Digital culture	8
	Organization, Digital Organization & processes	7
	Process, Digital Process, Digitize the core processes, Production Process	7
	Governance, Strategic Governance, Transformation Management, Digital governance	7
	Customers, Partners, Customer Insight & Experience, Digital customers & channels	6
	Products, Services, Product Innovation	6
	Leadership, Management, Leadership identification	5
	Operation, Operations and Processes	5
	Ecosystem, Digital Ecosystem, Integrating ecosystems	4
	Data, Data & technology	3
	Change, Changing ways of working	2
	Innovation	2
	Business Models, Digital Business Model	2
	Collaboration, Strategic Alignment	2
	Compliance & Security	1
	Initiation of business transactions	1
	Supply Chain	1
	Process Digitization	1
	Organization and Culture	1
	Cloud First	1
	Digital Skills	1
	Smart Factories	1
	Method	1
	Competency Network	1
	Trusting Relationships	1
	Complexity Management	1
	Boundary Spanners	1
	Expectation Management	1
	New digital growth	1

Note: Consolidated list from 18 papers

3.3.2 First Round of Expert Interviews

Findings from the initial interview are grouped under the following categories: (1) *Technology Differentiation Types*, (2) *Technologies Based the Sector*, (3) *Strategy and Technology Linkage*, (4) *Sociological Perspective*, (5) *Enablers of Digital Transformation*, (6) *Controversiality*, (7) *Industry Nature and Technology Usage*, (8) *Drivers of Technology Usage*, (9) *Digital Transformation Impact of Organizational Aspects*, (10) *Customer Behavior*, (11) *Industry Dynamic Changes*, (12) *Information, Data, and Cyber Security*, (13) *Data Driven Decision Making*, (14) *Digitalization Benefit and Nature*

In total 9 interviews were conducted with experts from different industries. While some findings from different experts point out the same points, some of them show different aspects. Findings from the initial interview are grouped under following categories:

Table 9: Synthesis Chart of Literature Review and 1st Round of Interviews

Table 9: Synthesis Chart of Literature Review and 1st Round of Interviews			
Overview (Part 1)			
Category	Interview Quotes	Expert Interview Findings	Aspects
(1) Technology Differentiation Types	Quote 14: "Technology is humm .. I would say human made machine or algorithm or program-based way of thing doing anything that you could made it easier" Quote 24: "So when I think of technology, I think of 2 different types. One is analog technology and the other is digital technology" Quote 33: "Software is software, but everything you automate it is information technology. One line of code goes to information technologies, 5000 lines of code goes to information technologies. Any integration tool also falls within information technology. In fact, when it comes to information technology, it seems to me like software and the integrated things around it. The part that goes from hardware to software. It doesn't stay in hardware anymore or it is in soft environment. Therefore, all of them can be considered as information technology." Quote 36: "In the technology side, there are lots of trends. Especially when we are entering in 2021, there are three let's say important topics. One of them is people centricity. All of the processes and the new trends are aiming to Centrifify people. Second one is location independence. Because as the effects of the current pandemic, people need to work from various locations. And have to reach business lines from different locations. So, location independence is the second trend. Then there is also resilient delivery which means that you can just deliver your products in a more flexible way, and you use AI, data, and hyper automation"	Technology Differentiation Types The mentioned technology differentiation types can be grouped into two categories: Analog Technology vs Digital Technology differentiation, and Hardware vs Software differentiation. One interviewee mentioned that hardware is being transformed to be software. The example that was given the cloud systems. For instance, in the past, while all the data was stored on physical servers located in room within the company or at a special location with special protection areas, now they are being converted to the cloud environment or hybrid solutions are under discussion.	Technology
(2) Technologies Based the Sector	Quote 15: "I think I am aware of mobile technologies because I am using smart phone. I am using a computer; I am using cars. Those technologies of which I am aware. Algorithm based, ai based technologies like big data, analysis" Quote 25: "In my sector I think fundamental technologies that we use. One is obviously telecommunications; you know we have an app that we connect users. So that kind of connectivity is one. We need to have GPS technology because it is transportation. We also have distinct functions that use different technologies like ML to analyze enormous amounts of data. It is not just a sector thing; it is a business intelligence thing. Or we have video chat technology to talk to our customers." Quote 32: "Cloudification is one of the issues of detachment from the physical environment" Quote 35: "Bitcoin and blockchain for the production company is not important for my opinion."	Technologies Based the Sector Furthermore, technologies are important for the sector that are being investigated. Technology types mentioned by the interviewee vary based on the industry background. Mentioned technological trends are IoT, RPA, ML/AI, digital twin, automation systems, 3D printing, Virtual Reality, Augmented Reality, Automated Guided Vehicles (AGV), Autonomous Vehicles, Telecommunications, apps technology, ML/AI, BI, video chat technology, virtual conversation support, fintech, internet, mobile phone, big data, algorithms (for adjusting lowest price), electronic payment, robotic process, marketing data collection tools, mass emailing, search advertising, banners, AdWords, products with voice control, social platforms, rocket, wheel, TV, connectivity, 5G, social media, mobile platforms, ecosystems, cloud, hyper-automation, resilient delivery, automated drive, AI, glass technology, VR, payment systems, e-commerce, m-commerce, databases as tools, UX/UI, IOS, Android, e-wallet, database technology (oracle, SQL), Blockchain, GPS, Token solutions, Info-Tech. Especially, 5G, hyper automation, resilient delivery and info-tech are interesting technologies which are highlighted by the interviewees coming from high-tech industries.	Technology
(3) Strategy and Technology Linkage	Quote 4: "In the high-tech industry, company strategy is being shaped by the technological trends" Quote 5: "In the past, business was driving technology. Now technology drives business."	Strategy and Technology Linkage Another interesting point which is highlighted is the link between strategy and technology. According to the interviewees, in the high-tech industry, company strategy is being shaped by technological trends. In the past, business was driving technology. Now technology drives business.	Strategy

(4) Sociological Perspective	Quote 31: "When we graduated from the first university, only mechanical engineers and computer engineers were working on the web and app. Now psychologists, biologists, computer and industrial engineers are employed."	Sociological Perspective Another interesting point came out from the sociological perspective. In the past, engineers were working on technology related topics. Now, other professions such as biologists and psychologists are also working on that topic. This was an example given to point out societal, professional changes.	Culture People, Structure and Organization
(5) Enablers of Digital Transformation	Quote 9: "The technology helped the rise of ecommerce" Quote 16: "I think most successful skill is to be open and to be data driven practical and to follow all the changes and advents to be on the top of your sector. For that sense, be open be up to date and alert and open. Otherwise, you are going to miss out. " Quote 22: "I would say curiosity. You need to be curious. about innovative technologies. What can we do more for the customer to create the value? What can we do for the company to shorten the processes to be more valuable? I would sum all of these terms on behalf of curiosity. For the skills I would say that one. For the resources, you need an IT company. You need a high ability IT team. And the team which is more aware about the IT structure. It is not enough to have a team do marketing; a team can do sales. They need to be aware of the technology." Quote 23: "I think technology is the main driver of the change what is happening. I would say technology is enabling."	Enablers of Digital Transformation Several topics are mentioned as enablers of digital transformation. Three important points are mentioned: management support, communication, and required skills and resources. According to the interviewees digital transformation can only be achieved when the company's mindset is ready to transform, willingness to allocate budget, and ability to clearly communicate with the support of management. Therefore, the management should clearly communicate the goal. In addition to management support and clear communication, employee competencies and skills are brought onto the agenda. Curiosity is the most mentioned skill to be successful on the digital transformation journey. The importance of collective intelligence is indicated as one of most important enablers of Digital Transformation. Other required skills and resources mentioned for successful digital transformation are problem solving, programming language, curiosity, sharing knowledge, research abilities, analytic thinking, collective intelligence, technical expertise, data, language, strong commitment, good people, openness, open mindedness, data driven, high ability IT team, HR-multi skill employees, agile, company willingness to adapt and transform, readiness, clear communication.	Strategy Technology Culture People, Structure and Organization
(6) Controversiality	Quote 26: "I think there are some contexts where it would be controversial. For example, privacy could be an important thing." Quote 27: "That is a big transformation, which is a big change. It can be controversial one because people do not want you suddenly to start interacting with them in a different way." Quote 28: "Depending on where you live, maybe laws are not protecting well the customer data very much or people do not agree with how you use the data whether you are showing them adds or selling your data to third parties. So there can be controversial elements there. So obviously there are security issues that you think about providing services digitally. So I can definitely think about several ways where it can be controversial."	Controversiality Controversiality concerns and Digital Transformation pitfalls discussed by several interviewees. Many areas where there is skepticism are privacy issues, data security, information security and cyber security topics. Another perspective indicated the physiological point. Fear of losing jobs due to replacement with technology. Another perspective was on the ethical issues and use of big data. Lastly, it is mentioned that some business models cannot be transformed to digital.	Processes and Systems Data and Analytics

(7) Industry Nature and Technology Usage	Quote 13: "Which technology do you have the highest impact in your industry? I would say internet and fintech. Because if financial institutions were not on par with digital advancements, then people would not be comfortable with making purchases online and give their credit cards. I would say internet and financial institutions on top" Quote 21: "Technology with the highest impact on the industry. I would say IoT technology. Now vehicle has an internet. So, this helps to connect to the cloud. Now you can connect to your vehicle anytime anywhere. Material of the product. Now we have more composite parts for the automotive. So, the vehicles are lighter. IoT is the future of the industry. The industry wants to go there. The second one is the material las especially important. I would say robotic processes. In the industry lots of things are going with robotics. The pandemic showed us that it is very important to produce a car with a robot. Because you know human can be sick but robots cannot be sick. It is also very important to check the processes with the robots. It is also feasible with the robots. It is very important for automotive industry to have AI and ML in your processes. Because of the increase of the digital software of the vehicles. Everything is digital on the vehicle. You need some AI on your product. Because you cannot generate everything in your vehicle. So if you have any AI know how vehicle can learn itself and create value for the customer"	Industry Nature and Technology Usage Several interviewees mentioned the linkage between industry nature and technology usage. One highlighted point is the higher technological product, the higher level of digitalization. For instance, when there is a complicated production process such as in the aerospace industry, the necessity to utilize more complex technological devices, or digital technology is higher. Another point highlighted is the industry's nature and the company's business model are common factors of technology usage. Digital native organizations are looking more from ecosystem, payment, and application perspective. Hardware or any "owned-products – such as cars, apartments, devices, etc." are not considered. Therefore, the nature of the business model might have also an effect on the level of technology usage.	Technology
(8) Drivers of Technology Usage	Quote 12: "Everyone is more and more comfortable with making purchases online and that comes with technology"	Drivers of Technology Usage Interviewees pointed out the drivers of the technology usage. Efficiency, cost effectiveness, customer buying behaviors, etc. are mentioned as main drivers of the technology usage.	Technology
(9) Digital Transformation Impact of Organizational Aspects	Quote 34: "With the pandemic, the acceleration in the technology sector has increased incredibly. Because people now have to do some things from virtual platforms, mobile platforms and online due to the end of physical contact" Quote 37: "There are a lot of things you can achieve using possibilities of technology. So digital transformation is you know for business digital transformation looking for what you do today and compare it to the different possibilities that are currently enabled by the latest technology and adapting to it. Not just the technological possibilities but also your stakeholders as a business acquire new preferences and habits. Basically, technology is affecting everything, and digital transformation is looking at how your landscape is changing and adapting your operations your proposition how you work as a business to this new reality."	Digital Transformation Impact of Organizational Aspects In addition to the technology impact on the companies' digital transformation, several experts mentioned that digital transformation has also affect on the organizational aspects, or 7s principles of the company: Strategy, Structure, Systems, Shared values, Style, Staff, Skills. Digital Transformation also affects the 7s principles of the company varies among the sectors.	Processes and Systems Culture People, Structure, Organization Strategy
(10) Customer Behavior	Quote 8: "People more and more accustomed to make the purchases them online and customer go online. Customer behaviour is changed, and they are more open. So, it is a good way of tacking to the market. You know the demand in end customer, It does help with sales growth"	Customer Behavior A couple of experts mentioned the changing customer behavior. Customer behavior changed with higher access and interaction to technological devices. People's buying behavior has been affected by technology, especially web and application usage in the e-commerce sector.	Processes and Systems Culture
(11) Industry Dynamic Changes	Quote 6: "We are a selling company. Whereas right now, because of digitalization and digital transformation of our age, we moved towards ecommerce where we are using market places, all other big marketplaces as a way of having new stores to sell in where we can access to millions of other users who are not connected to prior dealers or stores and we can just go retail and sell anyone who goes and online who want to purchase our products. So, I think digital transformation help to grow in that sense where we have access to many household where we used not enter." Quote 7: "We are launching our own ecommerce website where we want even to rely on these marketplaces and agencies in between we will have our own website directly sell to retail customers any product or services in our marketing mix." Quote 10: "for the purchase of domestic appliances you used to go to store. They are available	Industry Dynamic Changes The experts also mentioned the changes in the industry dynamics. As the interviews conducted from experts from automotive, high-tech, banking, commerce, and transportation industries, they gave some examples from the industry that they come from. For instance, for the digital banking industry, there is a clear distinction between M-Commerce and E-Commerce. This distinction became clearer after higher accessibility to mobile devices. The higher access to mobile devices changed the nature of digital commerce. As the consumers got used to access and usage of mobile devices, the accessing to the laptop and ordering products online through websites converted to ordering products directly on mobile device just one click. Therefore, the nature of online retail shifted from e-commerce to m-commerce.	Strategy

	there. Whereas now we do not need to physically put your inventory anywhere or any marketplace that I just described" Quote 18: "Maybe automotive industry could be one of the most affected sectors in the world from digitalization. Competition is extremely high. Costs are remarkably high. The industry wants to transform because of the environmental issues. They want to change their business model. They cannot produce internal combustion engine (ICE) anymore, so they need to transform their businesses. Also, the behaviour of the customers is changing. New generation does not want to have any vehicle. So, companies would try to find new way to attract the young customers. Digitalization is the important weapon. For the companies because they want to spend more time on these digital things. When they are driving, they want to be always connected. Vehicles should be smarter than ever. It could be autonomous vehicle or connected vehicles. This is transforming the industry" Quote 19: "Most of the companies making partnerships with each other. And also they are making partnership with the IT companies. They are looking for another partner outside of the industry. Aim is to increase their effect on digitalization. I think in 5 years what could be more important for the customer, connected services. Connected services will be more important. I mean it could be the most valuable thing to purchase a vehicle, but they do not know to make a connected car. So, they are making for partnerships. So that is why we can see more competitors in the automotive industry who are not producing vehicles. Because digitalization could be more important than making a car."	Another industry example came from the automotive industry. According to the experts, the automotive industry is going through the most radical change throughout its existence via digital transformation. Through Industry 4.0, the automotive industry is shifting towards mobility service provider. Towards this, customers' demand and means of mobility have been changing in the automotive industry. Further industry examples came from the retail sector, importing, distribution, reselling chain is being transformed to marketing, sales, after sales.	
(12) Information, Data, and Cyber Security	Quote 20: "Now we can talk about the privacy. Lots of companies want to use the blockchain technology to protect data privacy. Now everything is on the cloud. Your data and vehicles data will be on the cloud. That is, we are talking about the connected vehicles. Everybody is talking about blockchain technology to protect the data. They are rethinking about the processes, which is more secure, valuable, profitable".	Information, Data, and Cyber Security By digitalization, digital transformation, and the usage of digital technologies, information, data, and cybersecurity topics came into the picture. Especially for digital banking and e-commerce industry, data security is a major topic for what precautions need to be taken.	Data and Analytics
(13) Data Driven Decision Making	Quote 29: "In the past few years, a lot of companies are using social platforms to reach customer or to advertise their products. Mass mailing is a must. People no longer give advertisements on newspapers." Quote 30: "Footprints of the customers convey data. Because you are able to keep track of the customers that come to your website. You try to catch a customer or just to a spectator. But the person does not have to buy from you but the person comes to your website and looked at a particular page. You try to catch his or her attention, again and again. So that you can turn him or her into a customer. So there you have digital footprint that is usually tied to their IP addresses is very important. It is not a 100% accurate tool. However, it helps to turn visitors to customers"	Data Driven Decision Making Most of the experts highlighted the importance of data in the new digital age and mentioned the digital transformation and data relevance. According to several interviewees, several necessities came out with more data generation and higher access to data. For instance, the necessity to produce value added products based on data and the necessity to make business decisions based on data. One of the interviewees claims that data driven business decisions need to be taken in the digital age. Furthermore, in the retail industry, via e-commerce and m-commerce, access to a larger customer base is made possible. Mass emailing, search engines, banners, AdWords are the new form of digital advertising in comparison to conventional marketing. Through digital advertising, digitization of footprints conveys data. Due to increased access to a larger customer base, the collected data volume increased. Thus, higher volume of data collection enabled the data analytics studies and made the customization possible.	Data and Analytics
(14) Digitalization Benefit and Nature	Quote 17: "The digital transformation is very helpful to shorten the processes and increase the return on investments."	Digitalization Benefit and Nature Interviewees also mentioned the benefits that digitalization brought. For instance, one point came from the system perspective. According to the expert, end to end (E2E) automatization is achieved by digitalization. Efficiency and cost effectiveness are also mentioned by the experts as the main benefits gained from digitalization.	Strategy

3.3.3 Synthesis of Literature Review and Expert Interview

During the systematic literature review, it is observed that several aspects are named differently, even though they highlight similar points. For instance, culture, culture and expertise, digital culture is named differently in different sources while all pointing in the same direction as summarized in the highlights of Table 10 and sharing the same direction as the DMI dimensions. These aspects are grouped together, and their highlights are summarized in the following table. To support the literature findings, the quotes from the first round of interviews pointing out in the same direction and their fit to the DMI dimensions summarized in the following Table (Table 10).

Table 10: Literature Review and Interview Findings Comparison and Grouping					
		Frequency of Dimension	Literature Review Highlights / Ontology	First Qualitative Interview Findings	Fit to DMI Dimension Based on Grouping
Dimension List Based on Literature Review	Culture, Culture and Expertise, Digital culture	8	1) Digital affinity 2) Readiness to take risk 3) Error culture / No blame culture	Quote 3: "Digital Transformation is an idea, I think. So, you can't transform to digital, if you cannot think digital. This is not a process, it is a mindset If you can think that you can transform digital, then truly you can do it. It is an idea. If you are ready to make something over digital sources, then this is the digital transformation. You should think that what I can do to improve my processes. That is why the transformation of the process's digital is a mindset, it is an idea. You need to be aware of that" Quote 8: "People more and more accustomed to make the purchases them online and customer go online. Customer behavior has changed, and they are more open. So, it is an effective way of tackling the market. You know the demand in end customer, It does help with sales growth" Quote 11: "Digitization in my perspective, is going to a stage in which everything is more online, everything is more databased, AI, algorithm based. So, it just helps in less human driven more data driven more online more AI based execution I would say." "So what is digitalization from your perspective?" "Yeah, I think I explained my perspective in here, in the previous question. Or no?"	Culture
	Leadership, Management, Leadership identification	5	1) Agility 2) Leadership 3) Decision-making 4) Risk taking		
	Change, Changing ways of working	2	1) The change of the paradigm of the enterprise 2) A new and less certain way of doing business		
	Competency Network	1	1) Digital leaders' dependency on partners 2) Support to implement digital transformation		
	Trusting Relationships	1	1) A trust culture enables employees to perform at their highest levels 2) Trust increasing productivity and efficiency		
	Complexity Management	1	1) Complexity management		
	Boundary Spanners	1	1) Leaders and CDO's need to be boundary spanners		
	Expectation Management	1	1) Output-orientated utilization is key		
	Data, Data & technology	3	1) The management of data 2) Data management from strategy to governance, 3) Data management from digital platforms to artificial intelligence, and the future-readiness of the world-class technology function, plus Develop Ops, cyber security, and internet of things	Quote 20: "Now we can talk about privacy. Many companies want to use blockchain technology to protect data privacy. Now everything is on cloud. Your data and vehicles data will be on the cloud. That is, we are talking about connected vehicles. Everybody is talking about blockchain technology to protect data. They are rethinking about the processes, which is more secure, valuable, profitable". Quote 27: "That is a big transformation, which is a big change. It can be controversial one because people do not want you suddenly to start interacting with them in a different way." Quote 28: "Depending on where you live, maybe laws are not protecting well the customer data very much or people do not agree with how you use the data whether you are showing them adds or selling your data to third parties. So, there can be controversial elements there. So obviously there are security issues that you think about providing services digitally. So, I can definitely think about several ways where it can be controversial." Quote 29: "in the past few years, a lot of companies are using social platforms to	Data & Analytics

			reach customer or to advertise their products. Mass mailing is a must. People no longer put advertisements on newspapers. " Quote 30: "Footprints of the customers convey data. Because you are able to keep track of the customers that come to your website. You try to catch a customer or just to a spectator. But the person does not have to buy from you, but the person comes to your website and looked at a particular page. You try to catch his or her attention. Again and again so that you can turn him or her into a customer. So there you have digital footprint that is usually tied to their IP addresses is very important. It is not a 100% accurate tool. However, it helps to turn visitors to customers"	
People, Workforce, Human Resources, Employees, People Focus, Digital People and Capabilities, People and Culture	10	1) Focus essentially on the skillset 2) What the company is actively doing in order to develop their capabilities 3) The employee's willingness to change 4) Worker contribution 5) Educational offerings, to raise process awareness for successful BPM as a common baseline for digital transformation 6) Roles 7) Expertise 8) Capabilities 9) The competencies of the employees 10) The qualities of company's employees 11) Employee culture (engagement, accepting changes) 12) HRM (digital competences, talent management, education & training) 13) Involvement of employees 14) The communication from managerial staff towards employees 15) HR skills development 16) Organizational structure management 17) Sustainable learning management 18) Organizational change management	Quote 16: "I think most successful skill is to be open and to be data driven practical and to follow all the changes and advents to be on the top of your sector. For that sense, be open be up to date and alert and open. Otherwise, you are going to miss out." Quote 22: "I would say curiosity. You need to be curious. about innovative technologies. What can we do more for the customer to create the value? What can we do for the company to shorten the processes to be more valuable? I would sum all of these terms on behalf of curiosity. For the skills I would say that one. For the resources, you need an IT company. You need a high ability IT team. And the team which is more aware about the IT structure. It is not enough to have a team do marketing; a team can do sales. They need to be aware of the technology." Quote 31: "When we graduated from the first university, only mechanical engineers and computer engineers were working on the web and app. Now psychologists, biologists, computer and industrial engineers are employed."	People, Structure, and Organization
Organization and Culture	1	1) Autonomy 2) Communication 3) Collaboration		
Digital Skills	1	1) Digital skills 2) Digital expertise 3) Digital experience and interest 4) ICT competencies of employees 5) Data empowered decision making 6) Openness to new technologies 7) Employees access to digital skills/expertise needed		

Organization, Digital Organization & processes	7	1) Digital team set-up 2) Organizational agility 3) Partner network	Quote 3: "Digital Transformation is an idea, I think. So, you can't transform to digital, if you cannot think digital. This is not a process, it is a mindset. If you can think that you can transform digital, then truly you can do it. It is an idea. If you are ready to make something over digital sources, then this is the digital transformation. You should think that what can I do to improve my processes. That is why the transformation of the process's digital is a mindset, it is an idea. You need to be aware of that" Quote 8: "People more and more accustomed to make the purchases them online and customer go online. Customer behaviour is changed, and they are more open. So, it is a good way of tacking to the market. You know the demand in end customer, It does help with sales growth" Quote 26: "I think there are some contexts where it would be controversial. For example, privacy could be an important thing." Quote 34: "With the pandemic, the acceleration in the technology sector has increased incredibly. Because people now have to do some things from virtual platforms, mobile platforms and online due to the end of physical contact" Quote 37: "There are a lot of things you can achieve using possibilities of technology. So digital transformation is you know for business digital transformation looking for what you do today and compare it to the different possibilities that are currently enabled by the latest technology and adapting to it. Not just the technological possibilities but also your stakeholders as a business acquire new preferences and habits. Basically, technology is affecting everything, and digital transformation is looking at how your landscape is changing and adapting your operations your proposition how you work as a business to this new reality."	Processes and Systems
Process, Digital Process, Digitize the core processes, Production Process	7	1) Digital marketing communication 2) Automation 3) Data-driven business 4) Digitalization of business processes through technology to cut costs and increase productivity 5) Integration of processes at different intra-company, inter-company, levels, and across the entire value chain 6) Establishing and maintaining a quantitative management of processes 7) Improvement of the process performance 8) Data-driven decision-making 9) Enabling machines to autonomously adapt to the predicted status 10) Business process digitalization 11) Business process vertical integration 12) Business process horizontal integration 13) Data-driven decision management 14) Quantitative performance management 15) Self-optimized decision management 16) Business process integration toward life cycle 17) Quantitative process improvement		
Customers, Partners, Customer Insight & Experience, Digital customers & channels	6	1) Involvement and engagement of customers, partners, and stakeholders 2) Customer benefit from digitization 3) Personalization of products/services 4) Utilizing digital services to engage customers 5) Customer value 6) Digitization of customer touchpoints 7) Creating value out of data 8) Customer participation and empowerment		
Operation, Operations and Processes	5	1) Process digitization and 2) Process automation 3) Flexibility/agility of processes 4) Bringing processes to an industrialized standard 5) Operations excellence		

Ecosystem, Digital Ecosystem, Integrating ecosystems	4	1) Partner ecosystem development 2) The organization works as a part of a digital ecosystem 3) Digitization/integration of vertical/horizontal value chains 4) Digital connection with the business network, API 5) Interoperable technology platforms 6) New/highly customizable solutions configured by end-users		
Smart Factories	1	1) Digital modeling of installations and equipment 2) Equipment infrastructure with embedded systems 3) Integrated information, communication and operation systems 4) Data acquisition through sensors 5) Autonomous equipment and artificial intelligence		
Method	1	1) Methods and IT to enable and support company-wide BPM activities		
Initiation of business transactions	1	1) Digitalization in the initiation of business transactions are the most advanced		
Supply Chain	1	1) The lowest degree of digitalization in the SC 2) Companies share data and information already via digital platforms 3) Automated processes and interconnected databased systems are rather rare		
Process Digitization	1	1) Digital marketing communication 2) Automation 3) Data-driven business		

Strategy, Digital Strategy, Vision, Business strategy is driven by digital	14	1) Pattern of deliberate competitive actions to offer digitally enabled businesses, processes, products, and services 2) Strategic vision 3) Transformation roadmap 4) The strategy needs to be led from the top, with a strong, clear and inspiring vision of how emerging technologies can create a new future with shared value 5) Organizations should create roadmap based on their vision 6) The portfolio should be designed based on the strategic objectives, enterprise worth, and risk 7) The projects should be managed by identifying, establishing, and controlling activities 8) Finding the most appropriate supplier and maintaining the relationship essential in the journey 9) Involvement of employees and the communication from managerial staff towards employees regarding the digitalization process 10) Representing the vision, governance, planning, and management processes that support the implementation of the digital strategy 11) The vision, ambition level, priorities & alignment, and digital roadmap of an organization 12) Digital Transformation strategy development 13) Portfolio management 14) Project management 15) Financial resources and supplier management	Quote 4: "In the high-tech industry, company strategy is being shaped by the technological trends" Quote 5: "In the past, business was driving technology. Now technology drives business." Quote 6: "We are a selling company. Whereas right now, because of digitalization and digital transformation of our age, we moved towards ecommerce where we are using market places, all other big marketplaces as a way of having new stores to sell in where we can access to millions of other users who are not connected to prior dealers or stores and we can just go retail and sell anyone who goes and online who want to purchase our products. So, I think digital transformation help to grow in that sense where we have access to many household where we used not enter." Quote 7: "We are launching our own ecommerce website where we want even to rely on these marketplaces and agencies in between we will have our own website directly sell to retail customers any product or services in our marketing mix." Quote 10: "for the purchase of domestic appliances you used to go to store. They are available there. Whereas now we do not need to physically put your inventory anywhere or any marketplace that I just described" Quote 17: "The digital transformation is very helpful to shorten the processes and increase the return on investments." Quote 18: "Maybe automotive industry could be one of the most affected sectors in the world from digitalization. Competition is extremely high. Costs are remarkably high. The industry wants to transform because of the environmental issues. They want to change their business model. They cannot produce internal combustion engine (ICE) anymore, so they need to transform their businesses. Also, the behaviour of the customers is changing. New generation does not want to have any vehicle. So, companies would try to find new way to attract the young customers. Digitalization is the important weapon. For the companies because they want to spend more time on these digital things. When they are driving, they want to be always connected. Vehicles should be smarter than ever. It could be autonomous vehicle or connected vehicles. This is transforming the industry" Quote 19: "Most of the companies making partnerships with each other. And also they are making partnership with the IT companies. They are looking for another partner outside of the industry. Aim is to increase their effect on digitalization. I think in 5 years what could be more important for the customer, connected services. Connected services will be more important. I mean it could be the most valuable thing to purchase a vehicle, but they do not know to make a connected car. So, they are making for partnerships. So that is why we can see more competitors in the automotive industry who are not producing vehicles. Because digitalization could be more important than making a car."	Strategy
Collaboration, Strategic Alignment	2	1) Teamwork 2) Knowledge management 3) Flexible working 4) Strategic alignment and governance to establish a digital strategy 5) Strategic alignment to ensure agility, collaboration, and digital expertise		
Governance, Strategic Governance, Transformation Management, Digital governance	7	1) Governance 2) Performance measurement 3) Management support		

Products, Services, Product Innovation	6	1) Business model, 2) Innovation capabilities, 3) Digital value chain		
Innovation	2	1) More flexible/agile way of working 2) Development of disruptive business models 3) Using agile methods 4) Involving customer into innovation process 5) Funding innovation 6) Innovation conducted regularly		
Business Models, Digital Business Model	2	1) Development of new and disruptive business models, 2) Integrated customer solutions across supply chain, digital product/service portfolio, network and data 3) Digital initiatives are generating value 4) Business models are expanding		
New digital growth	1	1) Developing new digital products and services 2) Pilots and venture capital 3) Incubator programs		
Technology, Digital Technology, Information Technology	12	1) Agile project management 2) Integrated architecture 3) IT-expertise 4) IT strategy management 5) Requirement definition 6) Enterprise architecture development 7) Infrastructure management 8) Data governance 9) Agile software development 10) Security management 11) Enterprise architecture integration 12) Data analytics 13) Enterprise architecture maintenance	Quote 9: "The technology helped the rise of ecommerce" Quote 12: "Everyone is more and more comfortable with making purchases online and that comes with technology" Quote 13: "Which technology do you have the highest impact in your industry? I would say internet and fintech. Because if financial institutions were not on par with digital advancements, then people would not be comfortable with making purchases online and give their credit cards. I would say internet and financial institutions on top" Quote 14: "Technology is humm .. I would say human made machine or algorithm m or program-based way of thing doing anything that you could made it easier" Quote 15: "I think I am aware of mobile technologies because I am using smart phone. I am using computer, I am using cars. Those technologies of which I am aware. Algorithm based, AI based technologies like big data, analysis"	Technology

Compliance & Security	1	1) IT security 2) Digital security 3) IT compliance within organization and towards stakeholders 4) Assessing risk factors 5) Risk management 6) Intellectual Property 7) Optimizing value-chain network for compliance 8) Avoid unauthorized access	Quote 21: "Technology with the highest impact on the industry with the highest impact on the industry, I would say IoT technology. Now a vehicle has an internet. So, this helps to connect to the cloud. Now you can connect to your vehicle anytime anywhere. Material of the product. Now we have more composite parts for the automotive. So, the vehicles are lighter. IoT is the future of the industry. The industry wants to go there. The second one is the material has especially important. I would say robotic processes. In the industry lots of things are going with robotics. The pandemic showed us that it is very important to produce a car with a robot. Because you know human can be sick but robots cannot be sick. It is also very important to check the processes with the robots. It is also feasible with the robots. It is very important for automotive industry to have AI and ML in your processes. Because of the increase of the digital software of the vehicles. Everything is digital on the vehicle. You need some AI on your product. Because you cannot generate everything in your vehicle. So if you have any AI know how vehicle can learn itself and create value for the customer" Quote 23: "I think technology is the main driver of the change what is happening. I would say technology is enabling." Quote 24: "So when I think of technology, I think of 2 different types. One is analog technology and the other is digital technology" Quote 25: "In my sector I think fundamental technologies that we use. One is obviously telecommunications; you know we have an app that we connect users. So that kind of connectivity is one. We need to have GPS technology because it is transportation. We also have distinct functions that use different technologies like we would have ML to analyze enormous size of data. It is not just a sector thing; it is a business intelligence thing. Or we have video chat technology to talk to our customers." Quote 32: "Cloudification is one of the issues of detachment from the physical environment" Quote 33: "Software is software, but everything you automate it is information technology. 1 line of code goes to information technologies, 5000 lines of code goes to information technologies. Any integration tool also falls within information technology. In fact, when it comes to information technology, it seems to me like software and the integrated things around it. The part that goes from hardware to software. It doesn't stay in hardware anymore or it is in soft environment. Therefore, all of them can be considered as information technology." Quote 35: "Bitcoin and blockchain for the production company is not important for my opinion." Quote 36: "In the technology side, there are lots of trends. Especially when we are entering in 2021, there are three let's say important topics. One of them is people centricity. All of the processes and the new trends are aiming to Centrifuge people. Second one is location independence. Because as the effects of the current pandemic, people need to work from various locations. And has to reach business lines from different locations. So, location independence is the second trend. Then there is also resilient delivery which means that you can just deliver your products in a more flexible way, and you use AI, data, and hyper automation"
	Cloud First	1) Cloud first is the predominant digital strategy	
Role of informatics	1	1) % of investments in IT 2) Planned investments 3) IT department	

Note: Literal Text from 18 papers and Quotes from Qualitative Interviews

According to the findings of the literature review and expert interviews, the most prominent clusters of organization aspects are culture, data and analytics, people, structure and organization, processes and systems, strategy, and technology. These findings are also supported by the qualitative interviews with the experts. By merging the output of the findings of the mixed method, the following construct of organizational aspects which constitutes the basis of the digital maturity index. (Figure 9)

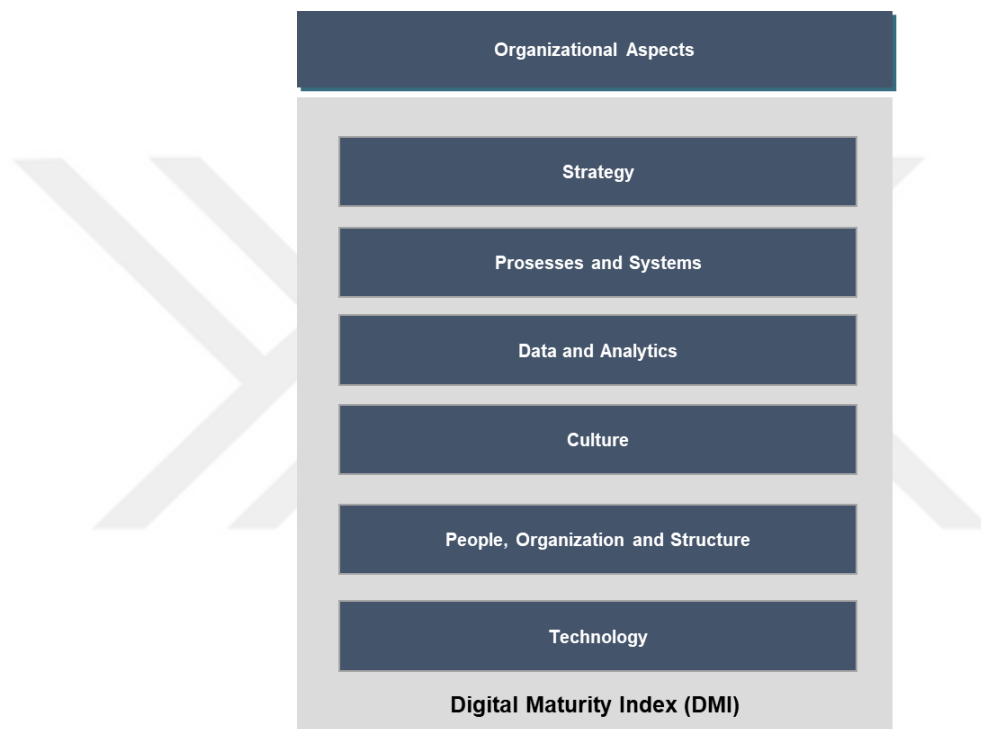


Figure 9: Organization Aspects

3.4 Discussion of Organization Aspects

The articles which are not integrated to the DMI comparison but from utilized ones are integrated within each dimension. Based on the organization sub-systems, it is utilized from the components of McKinsey's 7-S Framework [71] introduced in the late 1970s to address the critical role of coordination, rather than structure, in organizational effectiveness [71]. In this research, it was focused on 6 constructs namely, (1) Culture,

(2) Data and Analytics, (3) People, Structure and Organization, (4) Process and Systems, (5) Strategy, and (6) Technology.

3.4.1 Culture

The first organizational aspect of successful digital transformation is the culture aspect. It is described in different maturity models by different terminologies and organizational aspects such as *Culture*, *Culture and Expertise*, *Digital culture*, *Leadership*, *Management*, *Leadership identification*, *Change*, *Changing ways of working*, *Competency Network*, *Trusting Relationships*, *Complexity Management*, *Boundary Spanners*, and *Expectation Management*.

For instance, “*Culture*”, DMAT Model [58], Digital maturity of an organization [59], Strategy archetypes for digital transformation – BPM Model [61] and Exploratory Digital Transformation Maturity Model [65] highlighted *Culture* as a critical dimension, while Multi-Attribute Assessment of Digital Maturity [60] mentions *Organization culture*, Digital Transformation Maturity [62] mentions Digital Culture, Digital transformation of SMEs: a four levels approach [25] highlighted the *Cultural value*, Deloitte Digital Maturity Model (DMM) [69] mentioned *Organization and Culture*. Therefore, Culture, Culture and Expertise, Digital culture dimensions are grouped as *Culture* aspect.

Furthermore, Digital transformation’s impact on the company culture is defined by Osmundsen, Iden, and Bygstad [72] as “Embracing digital transformation is not straightforward, and there is much to consider before and during digital transformation. One aspect is the organizational culture, which can have an effect on the process and outcome of a digital transformation. For a successful digital transformation, the organization as a whole must adopt a supportive culture in which joint business and IT

initiatives can flourish... An organization that values openness to change fosters a willingness to accept, implement, promote, and establish a change-oriented mindset, is essential for mastering digital transformation. These findings propose an organizational culture emphasizing agility (rather than control) in order to support digital transformation, including internally and externally driven values.”

Furthermore, it is also claimed that participating in change processes can reduce employee resistance and increase the engagement of employees from all levels.

Lastly, according to McKinsey Global Survey on digital transformation, “companies should make the *technology-supported changes* that differentiate successful digital transformations from the rest. These changes fall into the following categories: having the right, digital-savvy leaders in place, building capabilities for the workforce of the future, empowering people to work in new ways, giving day-to-day tools a digital upgrade, communicating frequently via traditional and digital methods” [73]. Supporting this survey, Mugge et. al. [46] state that “digital maturity is achieved through *commitment, investment, and leadership*. Digitally mature companies set realistic priorities and commit to the *hard work of making digital maturity happen*. Leaders need to realize that maturation is a natural process, but it will not happen automatically. Digital maturity entails learning how to respond appropriately to the *emerging digital competitive environment*.”

Table 11: Digital Maturity Model Comparison Chart – Culture

Table 11: Digital Maturity Model Comparison Chart – Culture									
	Developed by Academicians (Academic Journal and or Conference)						Developed by Academicians (Academic Journal and or Conference)		Developed by Practitioners (Consulting)
	Academic Journal						Conference		Consulting
	DMAT Model (Aagaard et al., 2021)	Digital maturity of an organization (von Leipzig et al., 2017)	Multi-Attribute Assessment of Digital Maturity (Borštnar & Pucihar 2021)	Strategy archetypes for digital transformation - BPM Model (Fischer et al. 2020)	Digital Transformation Maturity (Teichert 2019)	Digital transformation of SMEs: a four levels approach (Garzoni et al., 2020)	Digital Maturity Model (DMM) (Berghaus et al., 2016)	Exploratory Digital Transformation Maturity Model (Gollhardt 2020)	Deloitte Digital Maturity Model (DMM) (2018)
Dimensions	Six dimensions: Strategy, Culture, Organization Processes, Technology and, Customers and Partners	8 dimensions: Strategy, Leadership, Products, Operations, Culture, People, Governance, Technology	7 dimensions: Digital technology, Management, Human resources, Strategy, Digital business model, Role of informatics organization culture	Six Core Elements of BPM Framework: Strategic alignment, Governance, Method, Information Technology, People, Culture	15 common elements: Digital culture, Technology, Operations & Processes, Digital Strategy, Organization, Digital Skills, Innovation, Customer Insight & Experience, Governance, Vision, Digital Ecosystem, Leadership, Compliance & Security, Products & Services, Business Models	3 groupings: - Digital technologies adopted - Cultural value - Digital technologies impact (for strategy, processes and organization	The final nine dimensions of the DMM are (1) customer experience, (2) product innovation, (3) strategy, (4) organization, (5) process digitization, (6) collaboration, (7) information technology, (8) culture & expertise, and (9) transformation management.	Five revised focus areas: culture, ecosystem, operations, governance, and strategy are characterizing the digital transformation maturity of a company.	5 dimensions: Customer, Strategy, Technology, Operations, Organization & Culture
Dimension Nr	6	8	7	6	15	3	9	5	5
Model Name	DMAT Model	Digital maturity of an organization	Multi-Attribute Assessment of Digital Maturity	Strategy archetypes for digital transformation – BPM Model	Digital Transformation Maturity	Digital transformation of SMEs: a four levels approach	Digital Maturity Model (DMM)	Exploratory Digital Transformation Maturity Model	Deloitte Digital Maturity Model (DMM)
Author	(Aagaard et al., 2021)	(von Leipzig et al., 2017)	(Borštnar and Pucihar 2021)	(Fischer et al. 2020)	(Teichert 2019)	(Garzoni et al., 2020)	(Digital Maturity Model (DMM) 2016)	(Gollhardt 2020)	(Deloitte 2018)
Publication	Electronics Journal	Sciencedirect, Procedia Manufacturing Journal	Electronics Journal	Information & Management	Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis	Emerald Insight Management Decision Journal	MCIS 2016 Proceedings Mediterranean Conference on Information Systems	2020 IEEE 22 nd Conference on Business Informatics (CBI)	-

Dimension definitions – Culture	Culture: Digital culture of the company and can be seen as an emerging set of values, practices and expectations regarding the way people act and interact digitally and within the contemporary network society in business and as individuals	Culture: Customer centricity, hierarchy vs., network, openness	Organization culture: covers autonomy, communication, collaboration	Culture: Addressing the people involved and creating an inclusive process-oriented culture, fostered individual involvement and openness supporting creativity and risk-taking in collaborations. Consequently, both factors also contribute to digital expertise and organizational agility.	Digital Culture: Attributes enhancing digital transformation efforts: risk-taking, test & learn, no-blame culture, customer centric, open to change, agile, autonomy of employees, ...	Cultural value: Awareness, consciousness, competencies	Customer Experience: Experience design	Culture: culture refers to the leaders' and employees' attitudes towards digital interaction and preferences to digital solutions, i.e., digital culture and the acceptance of idea pitching.	Organization & Culture: Defining and developing an organizational culture with governance and talent processes to support progress along the digital maturity curve, and the flexibility to achieve growth and innovation objectives 1) Culture 2) Leadership & Governance 3) Workforce Enablement 4) Organizational Design & Talent Management

(Note: Literal Text from [57], [58], [59], [60], [61], [24], [21], [64], [68] papers

When the ontology and the literature review findings of 18 (digital) maturity models “*Culture, Culture and Expertise, Digital culture*” dimensions consolidated, main points emerged for this aspect to be covered are (1) *Digital affinity*, 2) *Readiness to take risk*, and 3) *Error culture / No blame culture*.

Furthermore, in the ontology and the literature review findings of “*Leadership, Management, Leadership identification*” dimensions findings are as (1) *Agility*, (2) *Leadership* (3) *Decision-making*, and (4) *Risk taking*.

Moreover, the ontology and the literature review findings of “*Change, changing ways of working*” dimensions findings emerged as (1) *Digital leaders’ dependency on partners* and (2) *Support to implement digital transformation*.

Additionally, the ontology and the literature review findings of “*Competency Network*” dimensions findings are (1) *Digital leaders’ dependency on partners* and (2) *Support to implement digital transformation*.

Finally, the ontology and the literature review findings of “*Trusting Relationships*” dimensions findings are (1) *A trust culture enables employees to perform at their highest levels* and 2) *Trust increasing productivity and efficiency*; findings of “*Complexity Management*” dimensions findings are emerged as (1) *Complexity management*; findings of “*Boundary Spanners*” dimensions findings are (1) *Leaders and CDO’s need to be boundary spanners*; findings of “*Expectation Management*” dimensions findings are (1) *Output-orientated utilization is key*. Therefore, these points are covered in the scope of this research under *Culture*.

3.4.2 Data and Analytics

The second organizational aspect of successful digital transformation is the “Data and Analytics” aspect. It is described in different maturity models by different terminologies and in organizational aspects such as *Data*, *Data and technology*.

For instance, “*Data and Analytics*”, BCG Digital Acceleration Index (DAI) and KPMG Digital Readiness Assessment (DRA) mentions *Data and Technology* as a dimension.

Moreover, according to Ebert and Duarte [74: 1], “Digital Transformation is driven by a flood of software technologies. Embedded electronics such as microdevices with sensors and actuators connected through the IoT facilitate ubiquity. Data analytics, cloud storage and services, convergent interactivity and cognition, augmented reality with visualization and simulation, pattern recognition, machine learning, and AI are facilitating a convergence of IT and embedded systems. Underlying these, we’ve identified enabling methods, techniques, and tools, such as agile development for flexible systems, blockchains and Hyperledger to ensure security and trust in distributed transactions, and microservices and open APIs supporting software architectures.”

Table 12: Digital Maturity Model Comparison Chart – Data and Analytics

	DIGITAL MATURITY Model Comparison	
	Developed by Practitioners (Consulting)	
	Consulting	
	BCG Digital Acceleration Index (DAI)	KPMG Digital Readiness Assessment (DRA)
Dimensions	6 dimensions: 1) Business strategy is driven by digital 2) Digitize the core 3) New digital growth 4) Changing ways of working 5) Data & technology 6) Integrating ecosystems	7 dimensions: 1) Digital strategy 2) Digital governance 3) Digital culture 4) Digital customers & channels 5) Digital Organization & processes 6) Technology & data management 7) Digital people & capabilities
Dimension Nr	6	7
Model Name	BCG Digital Acceleration Index (DAI)	KPMG Digital Readiness Assessment (DRA)

Author	(BCG 2018)	(KPMG 2018)
Publication	-	-
Dimension definitions Data and Analytics	Data & technology: The management of data – from strategy to governance, from digital platforms to artificial intelligence, and the future-readiness of the world-class technology function, plus Develop Ops, cyber security, and internet of things	

Note: Literal Text from BCG DAI ([65]; [66]), KPMG DRA [67] papers

The main points found in the ontology and the literature review findings from 11 (digital) maturity models *Data*, *Data and technology* and their consolidated dimensions to be covered are (1) *The management of data*, (2) *Data management from strategy to governance*, and (3) *Data management from digital platforms to artificial intelligence, and the future-readiness of the world-class technology function, plus Develop Ops, cyber security, and internet of things*. Therefore, these points are covered in the scope of this research under Data and Analytics.

Furthermore, data aspect is highlighted in the literature as “Data empowered decision making” and as “Creating value out of data” under customer insight and experience dimension under digital skills in Digital Transformation Maturity model proposed by Teichert [62].

Data is also considered as “Data acquisition through sensors and Autonomous equipment and artificial intelligence” under Smart Factory dimension of Industry 4.0 maturity model proposed by Santos & Martinho [2].

Moreover, data is associated with supply chain dimension of A Digital Readiness Check for Industry 4.0 proposed by Lassnig et al. [63: 9] as “Companies share data and information already via digital platforms and Automated processes and interconnected databased system”. Lassnig et al. [63: 9] describes supply chain and data perspective as “The study identifies the lowest degree of digitalization in the SC – compared to other business areas. In general, many companies share data and information already via digital

platforms; however, automated processes and interconnected databased systems are rather rare.”. Furthermore, Berghaus & Back [22] categorizes “Data-driven business” under process digitization in DMM model.

Lastly, the Digital Transformation Capability Maturity Model (DX CMM) proposed by Gökalp & Martinez ([4]; [27]), data is covered under the Information and Technology category. Gökalp and Martinez ([4:5]) define information technology as “An IT strategy should be developed that is aligned with the organization’s DX strategy for migration to the desired future environment. The IT requirements for each DX project should be defined: the development, integration, and maintenance of a standardized enterprise architecture (EA), including hardware, software, data, and business process layers; management of infrastructure such as IoT devices, servers, and so on; collecting, storing, analyzing, and distributing data; management of data analytics; development of applications based on agile software development principles; and IT security management. These processes are all fundamental to the DX journeys of organizations.” Their IT dimension covers the following items: IT strategy management, Requirement definition, Enterprise architecture development, Infrastructure management, Data governance, Agile software development, Security management, Enterprise architecture integration, Data analytics, Enterprise architecture maintenance Gökalp and Martinez ([4: 5]).

3.4.3 People, Structure and Organization

The third organizational aspect of successful digital transformation is the “People, Structure and Organization” aspect. It is described in different maturity models by different terminologies and organizational aspects such as *People*, *Workforce*, *Human*

Resources, Employees, People Focus, Digital People and Capabilities, and People and Culture.

For instance, “*People, Structure and Organization*” described by DMAT Model of Aagaard [58] as Organization, by Maturity Model of Amaral & Peças [7] as 2 aspects of People and Organizations; by Industry 4.0 maturity model of Santos & Martinho [2] as 2 aspects of *Organizational strategy, structure and culture* and *Workforce*; by Digital maturity of an organization model of von Leipzig et al. [59] as People; by Multi-Attribute Assessment of Digital Maturity Model of Borštnar & Pucihar [60] as *Human resources*; by Strategy archetypes for digital transformation – BPM Model of Fischer et al. [61] as *People*; by Digital Transformation Maturity of Teichert [62] as *Organization* and *Digital Skills*; by Digital Transformation Capability Maturity Model (DX CMM) of Gökalp & Martinez ([4];[26]) as *Workforce management*; by A Digital Readiness Check for Industry 4.0 of Lassnig et al. [63] as *Employee*; by Digital Maturity Model for Telecommunications Service Providers of Valdez-De-Leon [23] as *Organizations*; by Digital Leadership Extended Dimension Model Gudergan et al. [70] as *Leadership identification* and *People Focus*; by Deloitte Digital Maturity Model (DMM) [69] as *Organization and Culture*.

Moreover, Digital transformation’s impact on the company structure and organization is defined by Lanzolla, et al. [75: 343] as “Digital transformation influences firms’ processes to create output, challenges existing organizational designs, and generates new business champions. Intrigued by the thrust and speed of technology adoption, researchers have started speculating on adapted and new organizational forms.” They also further supported that “Organizations may introduce the position of Chief Digital Officer, such changes increase complexity, shift power within the top

management team, and create new tasks and reporting lines. Scholars have begun questioning the fit of existing organizational design paradigms.”

Furthermore, the relationship between digital transformation and organization design are analyzed, from the perspective of the role of organizational structure, decision, and control. According to Lanzolla, et al. [75:344] “robotics adoption has been transforming organizational control and task allocation. The increase in robots has an effect corresponds to changes in organizational design, associated with a *decrease in the number of middle managers* and a *positive shift in the low- and high skilled labor forces*. These changes may also have implications for the *span of control*.”

Additionally, Lanzolla, et. al [75:343] claimed that “Digital transformation influences firms’ processes to create output, challenges existing organizational designs, and generates new business champions. Intrigued by the thrust and speed of technology adoption, researchers have started speculating on adapted and new organizational forms.”

As Mugge et. al. [46] and [51] state digital transformation is forcing companies to *rethink the role and value that data* have in their business models. Furthermore, digital transformation requires a fundamental change in the *organization’s underlying mindset, systems, and tools* to reposition parts of, or the entire *organization* ([52]; [48]).

People: Finally, Solberg et al., [76: 105] are observing the employee engagement necessities for the successful digital transformation journey. According to them, “Employees’ beliefs about technological change, their “*digital mindsets*,” are likely to influence their engagement in, or withdrawal from, their company’s digital transformation initiatives.”

Table 13: Digital Maturity Model Comparison Chart – People, Structure, and Organization

Table 13: Digital Maturity Model Comparison Chart – People, Structure, and Organization												
	Digital Maturity Model Comparison											
	Developed by Academicians (Academic Journal and or Conference)										Developed by Practitioners (Consulting)	
	Academic Journal										Conference	Consulting
	DMAT Model (Aagaard et al., 2021)	Maturity Model (Amaral and Peças, 2021)	Industry 4.0 maturity model (Santos & Martinho, 2020)	Digital maturity of an organization (von Leipzig et al., 2017)	Multi-Attribute Assessment of Digital Maturity (Borštnar & Pucihar, 2021)	Strategy archetypes for digital transformation – BPM Model (Fischer et al., 2020)	Digital Transformation Maturity (Teichert, 2019)	Digital Transformation Capability Maturity Model (DX CMM) (Gokalp & Martines, 2021)	A Digital Readiness Check for Industry 4.0 (Lassnig et al., 2021)	Digital Maturity Model for Telecommunications Service Providers (Valdez-de-Leon, 2016)	Digital Leadership Extended Dimension Model (Gudergan et al., 2021)	Deloitte Digital Maturity Model (DMM) (2018)
Dimensions	Six dimensions: Strategy, Culture, Organization, Processes, Technology and, Customers and Partners	Technology, Production Process, People, Smart Product, Organization, Change	5 dimensions: Organizational strategy, structure and culture, Workforce, Smart factories, Smart processes, Smart products and services	8 dimensions : Strategy, Leadership, Products, Operations, Culture, People, Governance, Technology	7 dimensions: Digital technology, Management, Human resources, Strategy, Digital business model, Role of informatics organization culture	Six Core Elements of BPM Framework: Strategic alignment, Governances, Method, Information Technology, People, Culture	15 common elements: Digital culture, Technology, Operations & Processes, Digital Strategy, Organization, Digital skills Innovation, Customer Insight & Experience, Governance, Vision, Digital Ecosystem, Leadership, Compliance & Security, Products & Services, Business Models	Processes defined under 4 process groups of - strategic governance, - information and technology, - digital process transformation, and - workforce management	Dimensions: Strategy, Employees, Initiation of business transactions. Supply Chain	The seven dimensions of the final model are as follows: Strategy, Organization, Customer, Technology, Operations, Ecosystems, Innovation	Nine dimensions are: Leadership identification, Strategic Alignment, Competency Network, Trusting Relationships, Complexity Management, Boundary Spanners, Cloud First, Expectation Management, People Focus	5 dimensions: Customer, Strategy, Technology, Operations, Organization & Culture
Dimension Nr	6	6	5	8	7	6	15	4	4	7	9	5
Model Name	DMAT Model	A Framework for Assessing Manufacturing SMEs Industry 4.0 Maturity	Industry 4.0 maturity model	Digital maturity of an organization	Multi-Attribute Assessment of Digital Maturity	Strategy archetypes for digital transformation – BPM Model	Digital Transformation Maturity	Digital Transformation Capability Maturity Model (DX CMM)	A Digital Readiness Check for Industry 4.0	Digital Maturity Model for Telecommunications Service Providers	Digital Leadership Extended Dimension Model	Deloitte Digital Maturity Model (DMM)
Author	(Aagaard et al., 2021)	(Amaral and Peças 2021)	(Santos & Martinho, 2020)	(von Leipzig et al., 2017)	(Borštnar & Pucihar, 2021)	(Fischer et al., 2020)	(Teichert, 2019)	(Gokalp, Martines, 2021)	(Lassnig et al., 2021)	(Valdez-de-Leon, 2016)	(Gudergan et al., 2021)	(Deloitte 2018)

Public ation	Electroni cs Journal	Applied Sciences Journal	Journal of Manufacturing Technology Management	Sciencedire ct, Procedia Manufactur ing Journal	Electronics Journal	Information & Management	Acta Universitatis Agriculae et Silviculturae Mendelianae Brunensis	Computers in Industry Journal	Journal of Manufacturing Technology Management Emerald Publishing Limited	Technology Innovation Management Review	2022 IEEE Internationa l Conference on Engineering , Technology and Innovation	-
Dimension definitions – People, Structure and Organization	Organiz aiton: Digital organizat ion and refers to how an organizat ion organizat ions and applies their competen ces to adopt to the digital transfor mation and how to integrate digital business develop ment more effectivel y througho ut the organisat ion	People: This assessment needs to focus essentially on their skillset, what the company is actively doing in order to develop their capabilities, and most of all, the employee's willingness to change. Without the worker contribution, the implementation of I4.0 measures is not possible.	Organizational strategy, structure and culture: Analysis of impacts of the Industry 4.0 to the company's competitiveness Strategic management to the Industry 4.0 implementation Investments in the technologies of Industry 4.0 Innovation management and use of technologies Resources availability to implement the transformation actions Focus on benefits to the clients Collaboration with other companies of the value chain Existence of a central coordination for the Industry 4.0	Culture: Customer centricity, hierarchy vs., network, openness	Human resources: covers employee culture (engagement, accepting 76hanges) and HRM (digital competences, talent management, education & training)	People: all the companies in the study again confirmed the importance of adequate educational offerings, to raise process awareness for successful BPM as a common baseline for digital transformation	Organization: Management structure/practices supporting digital business, cross- functional collaboration, digital skills embedded throughout the organization, roles/tasks related to digitalization defined, adequate resource allocation, cross-functional teams to implement digital business priorities, flexible communities, agile management, ...	Workforce management: Cultural change should be implemented before the process transformation begins. Human resources (HR) skills development,or organizational structure management, sustainable learning man- agement, and organizational change management are all essential for the DX journey of organizations. WM1. HR skills development WM2. Organizational structure management WM3. Sustainable learning management WM4. Organizational change management	Employees: about the involvement of employees and the communicatio n from managerial staff towards employees regarding the digitalization process Employee questions: 1) Employees are aware of the chances and risks of digitalization. 2) Employees are well prepared for the upcoming challenges regarding digitalization. 3) Executive personnel perceptibly sets examples regarding digitalization and the development of new competences	Organization: Characterizing the changes in communicatio ns, culture, structure, training, and knowledge management within the organization that will enable it to become a digital player.	Leadership identificati on: Many positions can and must provide digital leadership in order to successfully manage digital transformati on. 1) Culture 2) Leadership & Governance 3) Workforce Enablement 4) Organizatio nal Design & Talent Management	Organizatio n & Culture: Defining and developing an organizational culture with governance and talent processes to support progress along the digital maturity curve, and the flexibly to achieve growth and innovation objectives

		Organization: This dimension covers how the company is organized throughout this journey—the leadership style or who is empowered to take decisions—along with an understanding of which type of collaboration exists in the enterprise's value chain	Workforce: Existent and required skills Skills acquisition Equips flexibility and autonomy Creativity and labor enrichment Innovation openness and change responsivity	People: Roles, expertise, capabilities			Digital Skills: Digital skills, expertise, experience and interest; personnel dedicated to I4.0, ICT competencies of employees, data empowered decision making, openness to new technologies, employees have access to digital skills/expertise as needed, ...				People Focus: The competencies and qualities of company's employees are crucial for the success of digital transformation.	

Note: Literal Text from [58], [7], [2], [59], [60], [61], [62], ([4]; [27]), [63], [23], [70], [69] papers

When the ontology and the literature review findings of 11 (digital) maturity models “*People, Workforce, Human Resources, Employees, People Focus, Digital People and Capabilities, People and Culture*” dimensions are consolidated, main points emerged for this aspect to be covered are (1) *Focus essentially on the skillset*, (2) *What the company is actively doing in order to develop their capabilities*, (3) *The employee’s willingness to change*, (4) *Worker contribution*, (5) *Educational offerings, to raise process awareness for successful BPM as a common baseline for digital transformation*, (6) *Roles*, (7) *Expertise*, (8) *Capabilities*, (9) *The competencies of the employees*, (10) *The qualities of company’s employees*, (11) *Employee culture (engagement, accepting changes)*, (12) *HRM (digital competences, talent management, education & training)*, (13) *Involvement of employees*, (14) *The communication from managerial staff towards employees*, (15) *HR skills development*, (16) *Organizational structure management*, (17) *Sustainable learning management*, and (18) *Organizational change management*.

Furthermore, the ontology and the literature review findings of “*Organization and Culture*” dimensions findings are emerged as (1) *Autonomy*, (2) *Communication*, and (3) *Collaboration*.

Moreover, the ontology and the literature review findings of “*Digital Skills*” dimensions are found as (1) *Digital skills*, (2) *Digital expertise*, (3) *Digital experience and interest*, (4) *ICT competencies of employees*, (5) *Data empowered decision making*, (6) *Openness to new technologies*, and (7) *Employees access to digital skills/expertise needed*. Therefore, these points are covered in the scope of this research under *People*, *Structure*, and *Organization*.

3.4.4 Processes and Systems

The fourth organizational aspect of successful digital transformation is the processes and systems aspect. It is described in different maturity models by different terminologies and organizational aspects such as *Process*, *Digital Process*, *Digitize the core processes*, *Production Process*, *Customers*, *Partners*, *Customer Insight & Experience*, *Digital customers & channels*, *Operation*, *Operations and Processes*, *Ecosystem*, *Digital Ecosystem*, *Integrating ecosystems*, *Smart Factories*, *Method*, *Supply Chain*, *Initiation of business transactions*, and *Process Digitization*.

For instance, “*Processes and Systems*” DMAT Model Aagaard et al. [58], Maturity Model Amaral & Peças [7], Industry 4.0 maturity model Santos & Martinho [2], highlighted *Process*, *Production Process*, and *Smart Processes* directly as a dimension. While these models directly mentioned as Processes, Digital maturity of an organization von Leipzig et al. [59], Digital Transformation Maturity Teichert [62], Digital Maturity Model for Telecommunications Service Providers Valdez-De-Leon [23], Exploratory Digital Transformation Maturity Model Gollhardt et al. [65], and Deloitte Digital Maturity Model (DMM) [69] highlighted the operational side of the processes; therefore in these models *Operations and Processes* are mentioned together. Furthermore, Digital Transformation Capability Maturity Model (DX CMM) Gökalp & Martinez ([4]; [27]), Digital Maturity Model (DMM) Berghaus & Back [22], and BCG Digital Acceleration Index (DAI) [66] maturity models highlighted the digitalization perspective of the processes by *Digital process transformation*, *Process Digitization* and *Digitize the core*. Additionally, Industry 4.0 maturity model Santos & Martinho [2] and A Digital Readiness Check for Industry 4.0 Lassnig et al.[63] highlighted the Smart factories and Supply chain, Production, Planning and Procurement perspective.

Moreover, Dobrovic [77: 1329] states that the “starting point for development of subsequent functional, information, process and application architectures which contribute to an adequate ICT-governance and orchestrate the resources for critical business activities for e-business efficiently”. Furthermore, Dobrovic [77: 1334] claims that “digital transformation is a multilayer and multidimensional process encompassing organizational culture, role of C-level management, organization, processes, and modern technologies like mobile or cloud solutions. Business processes are to be prepared and optimized if digital transformation is to be successful. Although digital transformation is a widely accepted paradigm nowadays, redesigning business processes and creating new business models rely upon methods that have already been in use for some time. Value chain analysis, business processes redesign, BCG matrices, affinity analysis and virtual organization concept, if properly applied, are useful tools for organization and processes dimension of digital transformation. Using these methods, higher levels of digital transformation maturity could be achieved.”

Lastly, on the organization level, digital technology influence on digital transformation varies based on different organizational aspects. Berghaus & Back [22] state that “digital innovation involves transformational changes in *strategy, processes, and products*, and thus requires the company to *rethink* its organizing logic [78]”.

Table 14: Digital Maturity Model Comparison Chart – Processes and Systems

Table 14: Digital Maturity model Comparison Chart – Processes and Systems												
Digital Maturity Model Comparison												
Developed by Academicians (Academic Journal and or Conference)											Developed by Practitioners (Consulting)	
Academic Journal										Conference	Consulting	
	DMAT Model (Aagaard et al., 2021)	Maturity Model (Amaral and Peças, 2021)	Industry 4.0 maturity model (Santos & Martinho, 2020)	Digital maturity of an organization (von Leipzig et al., 2017)	Digital Transformation Maturity (Teichert, 2019)	Digital Transformation Capability Maturity Model (DX CMM) (Gokalp & Martines, 2021)	A Digital Readiness Check for Industry 4.0 (Lassnig et al., 2021)	Digital Maturity Model for Telecommunications Service Providers (Valdez-de-Leon, 2016)	Berghaus (Digital Maturity Model (DMM) 2016)	Exploratory Digital Transformation Maturity Model (Gollhardt, 2020)	BCG Digital Acceleration Index (DAI)	Deloitte Digital Maturity Model (DMM) (2018)
Dimensions	Six dimensions: Strategy, Culture, Organization, Processes, Technology and, Customers and Partners	Technology, Production Process, People, Smart Product, Organization, Change	5 dimensions: Organizational strategy, structure and culture, Workforce, Smart factories, Smart processes, Smart products and services	8 dimensions: Strategy, Leadership, Products, Operations, Culture, People, Governance, Technology	15 common elements: Digital culture, Technology, Operations & Processes, Digital Strategy, Organization, Digital Skills, Innovation, Customer Insight & Experience, Governance, Vision, Digital Ecosystem, Leadership, Compliance & Security, Products & Services, Business Models	Processes defined under 4 process groups of - strategic governance, - information and technology, - digital process transformation, and - workforce management	Dimensions: Strategy, Employees, Initiation of business transactions. Supply Chain	The seven dimensions of the final model are as follows: Strategy, Organization, Customer, Technology, Operations, Ecosystems, Innovation	The final nine dimensions of the DMM are (1) customer experience, (2) product innovation, (3) strategy, (4) organization, (5) process digitization, (6) collaboration, (7) information technology, (8) culture & expertise, and (9) transformation management.	Five revised focus areas: culture, ecosystem, operations, governance, and strategy are characterizing the digital transformation maturity of a company.	6 dimensions: 1) Business strategy is driven by digital 2) Digitize the core 3) New digital growth 4) Changing ways of working 5) Data & technology 6) Integrating ecosystems	5 dimensions: Customer, Strategy, Technology, Operations, Organization & Culture
Dimension Nr	6	6	5	8	15	4	4	7	9	5	6	5
Model Name	DMAT Model	Framework for Assessing Manufacturing SMEs Industry 4.0 Maturity	Industry 4.0 maturity model	Digital maturity of an organization	Digital Transformation Maturity	Digital Transformation Capability Maturity Model (DX CMM)	A Digital Readiness Check for Industry 4.0	Digital Maturity Model for Telecommunications Service Providers	Digital Maturity Model (DMM)	Exploratory Digital Transformation Maturity Model	BCG Digital Acceleration Index (DAI)	Deloitte Digital Maturity Model (DMM)
Author	(Aagaard et al., 2021)	(Amaral and Peças, 2021)	(Santos & Martinho, 2020)	(von Leipzig et al., 2017)	(Teichert, 2019)	(Gokalp & Martines, 2021)	(Lassnig et al. 2021)	(Valdez-de-Leon, 2016)	Digital Maturity Model (DMM) (2016)	(Gollhardt, 2020)	(BCG 2018)	(Deloitte 2018)

Publication	Electronics Journal	Applied Sciences Journal	Journal of Manufacturing Technology Management	Sciencedirect, Procedia Manufacturing Journal	Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis	Computers in Industry Journal	Journal of Manufacturing Technology Management Emerald Publishing Limited	Technology Innovation Management Review	MCIS 2016 Proceedings Mediterranean Conference on Information Systems (MCIS)	2020 IEEE 22 nd Conference on Business Informatics (CBI)	-	-
Dimension definitions – Processes and Systems	Processes: Digital processes, which include the existing and new routines and processes developed by the company to gather, analyze and apply data throughout the business and its processes more effectively. big data analytics capabilities and fundamentally transform their decision-making processes. To adopt and assimilate big data analytics requires transformations regarding structure, capability, culture and procedures across the entire organization	Production Process: This dimension assesses how production is affected with the implementation of different technologies, and how the company collaborates within itself. This dimension is related to the assessment of how the company uses the data provided by the implemented technology, and which knowledge it encapsulates. It also embraces how production manages its processes, disregarding the use of technology in the first place.	Smart factories: Digital modeling of installations and equipment supported by 82cture with embedded systems Integrated information, communication and operation systems Data acquisition through sensors and actuators Autonomous equipment and artificial intelligence Reconfigurable layout	Operations: Channels & business practices, processes, agility	Operations & Processes: Process digitization and automation, flexibility/agility of processes, bringing processes to an 82supported standard, operations excellence, ...	Digital process transformation: This includes digitalization of business processes through technology to cut costs and increase productivity; integration of processes at different intra-company, and inter-company, levels, as well as across the entire value chain; establishing and maintaining a quantitative management of processes; improvement of the process performance; and data-driven decision-making, enabling machines to autonomously adapt to the predicted status. These are all essential dimensions in the DX journey of organizations. DPT1. Business process digitalization DPT2. Business process vertical integration DPT3. Business process horizontal integration DPT4. Data-driven decision management DPT5. Quantitative	Initiation of business transactions: Digitalization in the initiation of business transactions seems to be most advanced. Business transaction questions: 1) Digital services complement traditional ways of customer acquisition and product advertising. 2) The development of new products is accompanied by automated steps (e.g. product configurator). 3) Maintaining contacts with (prospective) customers is supported by digital services	Customer: Focusing on customer participation and empowerment, as well as new benefits created in customer experience through digital transformation of customer journeys.	Customer Experience: Experience design • Analytics	Ecosystem: Ecosystem refers to the collaboration within and outside the company. Ecosystem contains seamless interactions with associates, usage of their data, business and IT synergy, customer centricity, and cooperation with academia and industry.	Digitize the core: The degree of digital maturity along the core value chain from customer offer and go-to-market, to operations, and support functions.	Operations: Executing and evolving processes and tasks by utilizing digital technologies to drive strategic management and enhance business efficiency and effectiveness 1) Agile Change Management 2) Automated Resource Management 3) Real-time Insights & Analytics 4) Integrated Service Management 5) Smart and Adaptive Process Management 6)

						performance management DPT6. Self-optimized decision management DPT7. Business process integration toward life cycle DPT8. Quantitative process improvement						Standards & Governance Automation
Customers and Partners: the ways and activities planned and carried out to involve and engage customers and other partners and stakeholders in the digital business development across the company's value chain and ecosystem			Smart processes: Utilization of mobile devices Utilization of cloud computing Security of assets and data protection Autonomous processes Digital modeling and simulation of processes Agile information share across organization Visual computing and contextualized tasks interfaces Data analytical capability and artificial intelligence		Customer Insight & Experience: Customer benefit from digitization; personalization of products/services; utilizing digital services to engage customers; focus on customer value; digitization of customer touchpoints; creating value out of data, customer participation and empowerment, ... Digital Ecosystem: The organization works as a part of a digital ecosystem; digitization/integration of vertical/horizontal value chains, digital connection with the business network (e.g.		Supply chain: The study identifies the lowest degree of digitalization in the SC – compared to other business areas. In general, many companies share data and information already via digital platforms; however, automated processes and interconnected databased systems are rather rare. Supply chain questions: Planning 1) The planning of the production program is automated within one system. 2) The production program can be adapted automatically with real-time data. 3) There is an automated exchange of information between all divisions. Procurement: 1) Data is shared via a web based platform with suppliers. 2) Planned orders and forecast data are automatically shared	Operations: Focusing on the capabilities that support the service provision. Increased maturity within this dimension demonstrates a more digitized, automated, and flexible operation. Ecosystem: Signifying partner ecosystem development and sustenance as a key element for a digital business.	Process Digitization: Digital marketing communication • Automation • Data-driven business	Operations: refers to internal processes and is specified by the presence and degree of process standardization and automatization, the checking for process improvements, service launches based on digital technologies, and the absence of operational silos.	Integrating ecosystems: Orchestration of digital-related partnerships and how joint value is created from it, e.g., by complementing digital offerings Broadly, through the DAI, companies can better understand their DAI maturity stages	

					through API), interoperable technology platforms enable new/highly customizable solutions configured by end-users, ...		with suppliers. 3) Inventories are equipped with sensors which communicate with the warehouse software Production: 1) Core processes are digitalized to a great extent. 2) The majority of production plants are digitally connected. 3) Production processes can react to changing conditions autonomously and in real time. Delivery: 1) New orders are inserted into IT-systems automatically and in real time. 2) Billing and dunning are fully automated. 3) Data is shared via a web based platform with customers. Returns, Services and Maintenances: 1) New orders are inserted into IT-systems automatically and in real time. 2) Billing and dunning are fully automated. 3) Data is shared via a web based platform with customers.					

Note: Literal Text from [58], [7], [2], [59], [60], [61], [62], ([4]; [27]), [63], [23], [70], [69], ([66]; [67]) papers

When the ontology and the literature review findings of 11 (digital) maturity models “*Process, Digital Process, Digitize the core processes, Production Process*” dimensions are consolidated, the main points for this aspect are (1) *Digital marketing communication*, 2) *Automation*, 3) *Data-driven business*, 4) *Digitalization of business processes through technology to cut costs and increase productivity*, 5) *Integration of processes at different intra-company, inter-company, levels, and across the entire value chain*, 6) *Establishing and maintaining a quantitative management of processes*, 7) *Improvement of the process performance*, 8) *Data-driven decision-making*, 9) *Enabling machines to autonomously adapt to the predicted status*, 10) *Business process digitalization*, 11) *Business process vertical integration*, 12) *Business process horizontal integration*, 13) *Data-driven decision management*, 14) *Quantitative performance management*, 15) *Self-optimized decision management*, 16) *Business process integration toward life cycle*, 17) *Quantitative process improvement*.

Furthermore, the ontology and the literature review findings of “*Customers, Partners, Customer Insight & Experience, Digital customers & channels*” dimensions findings are emerged as 1) *Involvement and engagement of customers, partners, and stakeholders*, 2) *Customer benefit from digitization*, 3) *Personalization of products/services*, 4) *Utilizing digital services to engage customers*, 5) *Customer value*, 6) *Digitization of customer touchpoints*, 7) *Creating value out of data*, 8) *Customer participation and empowerment*.

Moreover, the ontology and the literature review findings of “*Operation, Operations and Processes*” dimensions are found as 1) *Process digitization*, 2) *Process automation*, 3) *Flexibility/agility of processes*, 4) *Bringing processes to an industrialized standard*, and 5) *Operations excellence*.

Additionally, the ontology and the literature review findings of “*Ecosystem, Digital Ecosystem, integrating ecosystems*” dimensions are emerged as 1) *Partner ecosystem development*, 2) *The organization works as a part of a digital ecosystem*, 3) *Digitization/integration of vertical/horizontal value chains*, 4) *Digital connection with the business network, API*, 5) *Interoperable technology platforms*, 6) *New/highly customizable solutions configured by end-users*.

Furthermore, the ontology and the literature review findings of “*Smart Factories*” dimensions emerge as 1) *Digital modeling of installations and equipment*, 2) *Equipment infrastructure with embedded systems*, 3) *Integrated information, communication, and operation systems*, 4) *Data acquisition through sensors*, and 5) *Autonomous equipment and artificial intelligence*.

Additionally, the ontology and the literature review findings of “*Method*” dimensions are emerged as 1) *Methods and IT to enable and support company-wide BPM activities*, while “*Initiation of business transactions*” is found as 1) *Digitalization in the initiation of business transactions are the most advanced*; “*Supply Chain*” is emerged as 1) *The lowest degree of digitalization in the SC*, 2) *Companies share data and information already via digital platforms*, 3) *Automated processes and interconnected databased systems are rather rare*; “*Process digitization*” is found as 1) *Digital marketing communication*, 2) *Automation*, 3) *Data-driven business*. Therefore, these points are covered in the scope of this research under Processes and Systems.

3.4.5 Strategy

The fifth organizational aspect of successful digital transformation is the “*Strategy*” aspect. It is described in different maturity models by different terminologies and organizational aspects such as *Strategy, Digital Strategy, Vision, Business strategy*.

They are driven by digital, Collaboration, Strategic Alignment, Governance, Strategic Governance, Transformation Management, Digital governance, Innovation, Business Models, Digital Business Model, and New digital growth.

For instance, “*Strategy*”, DMAT Model by Aagaard et al. [58], Digital maturity of an organization by von Leipzig et al. [59], Multi-Attribute Assessment of Digital Maturity by Borštnar & Pucihar [60], A Digital Readiness Check for Industry 4.0 by Lassnig et al. [63], Digital Maturity Model for Telecommunications Service Providers by Valdez-De-Leon [23], Digital Maturity Model (DMM) by Berghaus & Back [22], Exploratory Digital Transformation Maturity Model by Gollhardt et al. [65], Deloitte Digital Maturity Model (DMM) [69] highlighted *Strategy* directly as a dimension. Industry 4.0 maturity model by Santos & Martinho [2] mentions *Organizational strategy, structure and culture*, Multi-Attribute Assessment of Digital Maturity by Borštnar & Pucihar [60] mentions *Digital business model*, Strategy archetypes for digital transformation - BPM Model by Fischer et al. [61] mentions *Strategic alignment* and *Governances*, Digital Transformation Maturity by Teichert [62] mentions *Innovation, Governance, Vision* and *Digital Ecosystem*, Digital Transformation Capability Maturity Model (DX CMM) by Gökalp & Martinez ([4]; [27]) mentions *Strategic governance*, Digital Maturity Model for Telecommunications Service Providers by Valdez-De-Leon [23] mentions *Innovation* and *Ecosystem*, Digital Maturity Model (DMM) by Berghaus & Back [22] mentions *Product Innovation, Collaboration* and *Transformation Management, Digital Leadership*, Extended Dimension Model by Gudergan et al. [70] mentions *Strategic alignment*, Exploratory Digital Transformation Maturity Model by Gollhardt et al. [65] mentions *Ecosystem, Governance* and *Strategy*, BCG Digital Acceleration Index (DAI) [66] mentions, *Business strategy is driven by digital, New digital growth* and *Integrating ecosystems*.

Moreover, according to Osmundsen, Iden, and Bygstad [72: 8], “To accomplish a digital transformation, the organization must align the changes with its strategies. Several organizations have acknowledged the need for a fusion of the IS strategy and the business strategy into what is referred to as a digital business strategy.” In addition to Osmundsen et. al [72], it was also proposed by Bharadwaj et al. [12: 472], a digital business strategy is an “organizational strategy formulated and executed by leveraging digital resources to create differential value”.

Table 15: Digital Maturity Model Comparison Chart –Strategy



Table 15: Digital Maturity Model Comparison Chart –Strategy														
	Developed by Academicians (Academic Journal and or Conference)												Developed by Practitioners (Consulting)	
	Academic Journal									Conference			Consulting	
	DMAT Model (Aagaard et al., 2021)	Industry 4.0 maturity model (Santos & Martinho, 2020)	Digital maturity of an organization (von Leipzig et al., 2017)	Multi-Attribute Assessment of Digital Maturity (Borštnar & Pucihar, 2021)	Strategy archetypes for digital transformation – BPM Model (Fischer et al., 2020)	Digital Transformation Maturity (Teichert, 2019)	Digital Transformation Capability Maturity Model (DX CMM) (Gokalp & Martines, 2021)	A digital Readiness Check for Industry 4.0 (Lassnig et al., 2021)	Digital Maturity Model for Telecommunications Service Providers (Valdez-de-Leon, 2016)	Berghaus (Digital Maturity Model (DMM) 2016)	Digital Leadership Extended Dimension Model (Gudergan et al., 2021)	Exploratory Digital Transformation Maturity Model (Gollhardt, 2020)	BCG Digital Acceleration Index (DAI)	Deloitte Digital Maturity Model (DMM) (2018)
Dimensions	Six dimensions: Strategy, Culture, Organization, Processes, Technology and, Customers and Partners	5 dimensions: Organizational strategy, structure and culture, Workforce, Smart factories, Smart processes, Smart products and services	8 dimensions: Strategy, Leadership, Products, Operations, Culture, People, Governance, Technology	7 dimensions: Digital technology, Management, Human resources, Strategy, Digital business model, Role of Information organization on culture	Six Core Elements of BPM Framework: Strategic alignment, Governances, Method, Information Technology, People, Culture	15 common elements: Digital culture, Technology, Operations & Processes, Digital Strategy, Organization, Digital Skills Innovation, Customer Insight & Experience, Governance, Vision, Digital Ecosystem, Leadership, Compliance & Security, Products & Services, Business Models	Processes defined under 4 process groups of - strategic governance, - information and technology, - digital process transformation, and - workforce management	Dimensions: Strategy, Employees, Initiation of business transactions. Supply Chain	The seven dimensions of the final model are as follows: Strategy, Organization, Customer, Technology, Operations, Ecosystems, Innovation	The final nine dimensions of the DMM are (1) customer experience, (2) product innovation, (3) organization, (4) process digitization, (6) collaboration, (7) information technology, (8) culture & expertise, and (9) transformation management.	Nine dimensions are: Leadership identification, Strategic Alignment, Competency Network, Trusting Relationships, Complexity Management, Boundary Spanners, Cloud First, Expectation Management, People Focus	Five revised focus areas: culture, ecosystem, operations, governance, and strategy are characterizing the digital transformation maturity of a company.	6 dimensions: 1) Business strategy is driven by digital 2) Digitize the core 3) New digital growth 4) Changing ways of working 5) Data & technology 6) Integrating ecosystems	5 dimensions: Customer, Strategy, Technology, Operations, Organization & Culture
Dimension Nr	6	5	8	7	6	15	4	4	7	9	9	5	6	5
Model Name	DMAT Model	Industry 4.0 maturity model	Digital maturity of an organization	Multi-Attribute Assessment of Digital Maturity	Strategy archetypes for digital transformation – BPM Model	Digital Transformation Maturity	Digital Transformation Capability Maturity Model (DX CMM)	A Digital Readiness Check for Industry 4.0	Digital Maturity Model for Telecommunications Service Providers	Digital Maturity Model (DMM)	Digital Leadership Extended Dimension Model	Exploratory Digital Transformation Maturity Model	BCG Digital Acceleration Index (DAI)	Deloitte Digital Maturity Model (DMM)
Author	(Aagaard et al., 2021)	(Santos & Martinho, 2020)	(von Leipzig et al., 2017)	(Borštnar & Pucihar, 2021)	(Fischer et al., 2020)	(Teichert, 2019)	(Gokalp & Martines, 2021)	(Lassnig et al., 2021)	(Valdez-de-Leon, 2016)	(Berghaus & Back, 2016)	(Gudergan et al., 2021)	(Gollhardt, 2020)	(BCG 2018)	(Deloitte 2018)
Publication	Electronics Journal	Journal of Manufacturing Technology Management	Science direct, Procedia Manufacturing Journal	Electronics Journal	Information & Management	Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis	Computers in Industry Journal	Journal of Manufacturing Technology Management Emerald Publishing Limited	Technology Innovation Management Review	MCIS 2016 Proceedings Mediterranean Conference on Information Systems (MCIS)	2022 IEEE International Conference on Engineering, Technology and Innovation	2020 IEEE 22 nd Conference on Business Informatics (CBI)	-	-

Dimension definitions – Strategy	Strategy: the company's digital business strategy, which constitutes a pattern of deliberate competitive actions undertaken by a firm as it competes to offer digitally enabled businesses, processes, products, and services	Organizational strategy, structure and culture: Analysis of impacts of the industry 4.0 to the company's competitiveness Strategic management to the industry 4.0 implementation Investments in the technologies of Industry 4.0 Innovation management and use of technologies Resources availability to implement the transformation actions Focus on benefits to the clients Collaboration with other companies of the value chain Existence of a central coordination for the Industry 4.0	Strategy: Strategic vision, transformation roadmap Governance: Communication & collaboration rules, KPIs, alignment	Strategy: covers data, cybersecurity, digital Digital business model covers value proposition, customers (CRM, digital channels), customer segment (new markets), and activities (key processes, suppliers & partners relationship, revenue-costs)	Strategic alignment: The importance of strategic alignment and governance, to establish a digital strategy and to ensure agility, collaboration, and digital expertise was cited consistently across all companies in our study. Governances: Actions taken to align BPM to the demands of digital transformation ranged from determining clear project goals to ensuring top management support. To establish training programs, the companies further highlight the importance of	Innovation: Capabilities enabling a more flexible/agile way of working, development of disruptive business models, using agile methods, involving customer into innovation process, funding innovation, innovation conducted regularly Governance: Ensuring comprehensive/reliable execution of digital strategy; everyone has a mandate to think creatively and innovate, systematic approaches are taken to innovation/change management, engagement on different hierarchical levels, standards and regulations, adequate resource allocation Vision: Organization has defined an initial digital vision; digital technology realizes the vision of the organization; all staff work in sync with the digital vision	Strategic governance: The DX strategy needs to be led from the top, with a strong, clear, and inspiring vision of how emerging technologies can create a new future with shared value. Organizations should create their DX roadmap, which is generated based on their vision. The portfolio should be designed based on strategic objectives, enterprise worth, and risk. The projects should be managed by identifying, establishing, and controlling DX activities. Finding the most appropriate supplier and maintaining the relationship is also essential in the DX journey. SG1. DX strategy development SG2. Portfolio management SG3. Project management SG4. Financial resources and	Strategy: about the involvement of employees and the communication from managerial staff towards employees regarding the digitalization process Strategy questions: 1) There is a digitalization strategy with concrete targets and target values. 2) There is a well established process how to develop and implement digital innovations exist. 3) There is a dedicated person or department responsible for the topic digitalization	Strategy: Representing the vision, governance, planning, and management processes that will support the implementation of the digital strategy. Ecosystem: Signifying partner ecosystem development and sustenance as a key element for a digital business. Innovation: Focusing on the capabilities that enable more flexible and agile ways of working that will form the basis for an effective digital business.	Product Innovation: Business segment extension • Innovation capability • Customer integration Strategy: Strategic innovation • Digital commitment Collaboration: Teamwork • Knowledge management • Flexible working Transformation Management: Governance • Performance measurement • Management support	Strategic Alignment: Digital strategy and the business strategy are inseparable; they are intertwined.	Ecosystem: Ecosystem refers to the collaboration within and outside the company. Ecosystem contains seamless interactions with associates, usage of their data, business and IT synergy, customer centricity, and co operation with academia and industry. Governance: Governance also reflects an internal perspective and describes how digital transformation leadership reacts to the changing environment. Strategy: Strategy, as the fifth focus area, reflects the inclusion of the digital transformation into the business strategy.	Business strategy is driven by digital: The vision, ambition level, priorities & alignment, and digital roadmap of an90mbed90zation. New digital growth: Developing new digital products and services, pilots and venture capital, and incubator programs. Integrating ecosystems: Orchestration of digital-related partnerships and how joint value is created from it, e.g., by complementing digital offerings Broadly, through the DAI, companies can better understand their DAI maturity stages	Strategy: Focuses on how the business transforms or operates to increase its competitive advantage through digital initiatives; it is90mbed90zation within the overall business strategy 1) Brand Management 2) Ecosystem Management 3) Market & Customer 4) Finance & Investment 5) Portfolio, Ideation & Innovation 6) Stakeholder Management 7) Strategic Management

					harmonizing BPM with other organizational initiatives and provide process architectures to structure and coordinate corresponding activities.	Digital Ecosystem: The organization works as a part of a digital ecosystem; digitization/integration of vertical/horizontal value chains, digital connection with the business network (e.g. through API), interoperable technology platforms enable new/highly customizable solutions configured by end-users	supplier management								

Note: Literal Text from [58], [2], [59], [60], [61], [62], ([4]; [27]), [63], [23], [22], [70], [65], ([66]; [67]), [69] papers

When the ontology and the literature review findings of 11 (digital) maturity models “*Strategy, Digital Strategy, Vision, Business strategy is driven by digital*” dimensions are consolidated, the main points found for this aspect to be covered are (1) *Pattern of deliberate competitive actions to offer digitally enabled businesses, processes, products, and services*, (2) *Strategic vision*, (3) *Transformation roadmap*, (4) *The strategy needs to be led from the top, with a strong, clear, and inspiring vision of how emerging technologies can create a new future with shared value*, (5) *Organizations should create roadmap based on their vision*, (6) *The portfolio should be designed based on the strategic objectives, enterprise worth, and risk*, (7) *The projects should be managed by identifying, establishing, and controlling activities*, (8) *Finding the most appropriate supplier and maintaining the relationship essential in the journey*, (9) *Involvement of employees and the communication from managerial staff towards employees regarding the digitalization process*, (10) *Representing the vision, governance, planning, and management processes that support the implementation of the digital strategy*, (11) *The vision, ambition level, priorities & alignment, and digital roadmap of an organization*, (12) *Digital Transformation strategy development*, (13) *Portfolio management*, (14) *Project management*, and (15) *Financial resources and supplier management*.

Furthermore, the ontology and the literature review findings of “*Collaboration, Strategic Alignment*” dimensions findings are (1) *Teamwork*, (2) *Knowledge management*, (3) *Flexible working*, (4) *Strategic alignment and governance to establish a digital strategy*, and (5) *Strategic alignment to ensure agility, collaboration, and digital expertise*.

Moreover, the ontology and the literature review findings of “*Governance, Strategic Governance, Transformation Management, Digital governance*” dimensions

are emerged as (1) Governance, (2) Performance measurement, and (3) Management support.

Furthermore, the ontology and the literature review findings of *Products, Services, Product Innovation*” dimensions emerge as (1) Business model, (2) Innovation capabilities, and (3) Digital value chain.

Furthermore, the ontology and the literature review findings of *"Innovation"* dimensions are (1) More flexible/agile way of working, (2) Development of disruptive business models, (3) Using agile methods, (4) Involving customer into innovation process, (5) Funding innovation, and (6) Innovation conducted regularly.

Additionally, the ontology and the literature review findings of *New digital growth*” dimensions emerge as (1) Developing new digital products and services, 2) Pilots and venture capital, and 3) Incubator programs. Therefore, these points are covered in the scope of this research under Strategy.

Lastly, Correani et. al. [79: 37] by offering a *digital strategy* implementation framework suggest “The rapid growth of digital technologies and the extraordinary amount of data that devices and applications collect each day are increasingly driving companies to radically transform the business architecture through which they create and appropriate value. However, companies may fail to extract value from digital transformation due to the disconnection between strategy formulation and strategy implementation.”.

3.4.6 Technology

The sixth organizational aspect of successful digital transformation is the technology aspect. It is described in different maturity models by different terminologies

and organizational aspects such as *Technology, Digital Technology, Information Technology, Compliance and Security, Cloud First, and Role of informatics*.

For instance, “*Technology*”, DMAT Model by Aagaard et al. [58], Maturity Model by Amaral & Peças [7], Digital maturity of an organization by von Leipzig et al. [59], Digital Transformation Maturity by Teichert [62], Digital Maturity Model for Telecommunications Service Providers and Deloitte Digital Maturity Model (DMM) [69] highlighted *Technology* directly as a dimension. On the other hand, Multi-Attribute Assessment of Digital Maturity by Borštnar & Pucihar [60] and Digital transformation of SMEs: a four levels approach by Garzoni et al. [25] models differentiated “*Digital Technology*”. Furthermore, Strategy archetypes for digital transformation - BPM Model by Fischer et al. [61], Digital Transformation Capability Maturity Model (DX CMM) ([4]; [27]), and Digital Maturity Model (DMM) by Berghaus & Back [22] differentiated technology as “*Information Technology*”, while Exploratory Digital Transformation Maturity Model by Gollhardt et al. [65] and BCG Digital Acceleration Index (DAI) ([66]; [67]) are approaching from the “*Ecosystem*” perspective.

Moreover, what is digital technology? According Tekic and Koroteev [49: 685], “*Digital technology is a business transformation enabler: a means for achieving strategic and powerful ends of digital transformation itself. Conversely, a business model is a digital transformation driver: a factor that causes transformation to succeed or not. A business model illustrates the logic of how to do business with new means. Digital technologies significantly accelerated experimentation with business models [80].*”

Digital technology can be regarded as a general-purpose technology (GPT) as defined by ([38]; [39]; [40]). Digital means that data are expressed in binary format: a series of 0’s and 1’s, that can be read by computers. The widespread use of common

standards enabled handling the same data by different computing devices. The simultaneous development of telecommunications technology combined with use of common data transmission protocols, has enabled connecting these various devices. The combination of binary, computers, communications, and connectivity creates the potential of a GPT ([11]; [12]; [40]). The implications of a GPT are potentially huge Brynjolfsson & McAfee [39], but will not always be immediately realized, as pointed out in the original paper of Bresnahan and Trajtenberg [38]. Over the last decades, most companies have been ‘digitizing’ at least part of their business data, information and have been using that digitized data and information to support business processes and functions, and increasingly also as an integral part of business processes. This transition, which Tilson et al. [11] refer to as ‘digitizing of the cow paths’, is not complete, and much gain is still to be realized.

The evolution of digital technologies has also changed how people and business interact. Digital technologies have changed and reshaped the industry dynamics and are changing business structures. To survive and succeed in this changing environment, business starts to offer new experiences to the customers, sets a new focus, derives new ways of working, and creates or participates in digital platforms. Many companies start to reinvent and digitally transform their enterprises. Successful digital reinvention or transformation involves a fundamental reimagining of how an organization operates and how it engages with its environment [55]. In some sectors we have observed much more fundamental changes in business structures. It is known that GPT’s have an impact on the social structure of business and society ([11]; [39]). Examples abound, the most visible ones in digital platforms and ecosystems, such as eBay, Amazon, Airbnb or UBER, where, based on digital technology and ubiquitous connectivity, whole industries are being transformed. But digital technology also enables what Benkler [42] referred to as

‘social production in the digitally networked environment’, with high-profile examples such as bitcoin, replacing conventional currency, or social networks and the blogosphere, replacing traditional news sources and publication outlets.

What kind of digital technologies are influencing business then? According to Schallmo et. al [48: 6], “Within Digital Transformation of business models, enablers, and technologies (e.g., big data) are used to generate new applications or services (e.g., on demand prediction). These enablers require skills that enable data collection and exchange as well as the ability to analyze, calculate and evaluate options.” ([48]; [59]). According to Borštnar & Pucihar [60], their combined literature reviews and case study analyses resulted in three major areas of technology: Communication and other enabling technologies, Technologies combining hardware and software in intelligent systems, and Data technologies. Tekic and Koroteev [49: 685] suggests that “At the end of the second decade of 21st century, technologies like artificial intelligence, machine learning, big data analytics, cloud computing, the Internet of Things, and social media are the main enablers of digital business. They dilute borders between the world of physical/tangible artifacts and cyber/intangible space.” By touching to the evolutionary perspective, Tekic and Koroteev [49: 685] state that “Digital technologies do not displace and replace existing components; rather, they enhance and digitize them, turning them into data sources and enabling novel connections and recombination [61]”.

Considering both the findings from the first round of interview and the literature review, digital technologies are grouped under five categories: Virtual Reality or Mobile Connectivity, Internet of Things (IoT), Autonomous Robots, Data and Analytics (Big Data, ML/AI practices), and Cloud.

Even though there is lots of research going on currently on digitalization and digital transformation topics, the area is still not a mature area, instead it is an evolving research area. There are several academics who conducted research in this area: Garzoni [25], [McKinsey Contributors: Brennen & Kreis [28], Gobble [29], Ross [31], Tilson [11], Irniger [36], Bughin [33], Savić [13], IBM [10], Pousttchi et al. [81], Teichert [62], and Lassnig [63].

According to the McKinsey Global Survey on digital transformation, adoption of technologies plays an important role across digital transformations. “The results from successful transformations show that these organizations deploy more technologies than others do. Organizations with successful transformations are likelier than others to use more sophisticated technologies, such as artificial intelligence, the Internet of Things, and advanced neural machine-learning techniques.” McKinsey [73].

Furthermore, according to BCG research, “the rise of new digital industrial technology, known as Industry 4.0, is a transformation that makes it possible to gather and analyze data across machines, enabling faster, more flexible, and more efficient processes to produce higher-quality goods at reduced costs. Nine Technologies are transforming industrial production” BCG [3].

From the Evolutionary Theory perspective, in this research it is proposed that through emerging and evolving digital technologies, organizations are considered as living beings and try to further evolve and improve to survive in the changing market and economic conditions. Therefore, in this research question, it is also investigated how digital technology influences the organization’s different internal digital transformation structure.

Lastly, other researchers are also mentioning the influence of digital technology on the organization's internal aspects. For instance, Sestino et. al. [82] select IoT and Big Data as digital technologies and mentions their impact on the organization stating that “the results show that IoT and Big Data are predominantly reengineering factors for *business processes, products and services*”. Williams et al [64]. Supporting that Gollhardt [65] suggests “The diffusion of digital technologies has enabled a notable transformation in the firms’ boundaries, *processes, structures, roles*, and interactions. It is now clear that digital transformation is not just a traditional IT back-end process; rather it affects the organization, *redefining strategies, entrepreneurial processes, innovation*, and *governance mechanisms*.” They also suggest, “Firms and organizations use digital transformation in different ways. Some use it to improve the *internal organizing process of innovation* and run it more efficiently and effectively (e.g., GE, IBM). Others use it to sharpen the way they connect to and collaborate with consumers, product suppliers, and other firms, including rivals (e.g., BMW, CFA, and Tesla). Others instead leverage digital transformation to build multi-sided platforms and remodel their role and impact within entire industries by changing the rules of competition (e.g., Airbnb, Uber, or Amazon).”

Moreover, several scholars are pointing out digital transformation is driven by digital technology which influences the organizational structure mainly. Kretschmer & Khashabi [83: 86] state: “The widespread implementation and adoption of digital technologies by organizations has given rise to a massive transformation with the potential to affect many organizations’ internal operations and processes. This transformation affects different levels and steps of output creation in companies, which eventually triggers changes in their organizational structures. The process of rapid and widespread adoption and application of digital technologies in commercial settings is commonly referred to as *digital transformation*—and our focus is specifically on the

recent and emerging digital technologies (i.e., artificial intelligence [AI], Internet of Things, cloud computing, and big data). This transformation is expected to *bring key changes to business operations, processes, and organizational structures* aiming to provide competitive products and services to the market.”

According to Osmundsen et al. [72: 2], “Digital technology, digital innovation, and digitalization are fundamentally altering business processes, products, services, and relationships, and organizations need to fundamentally change the way they do business and employees’ mindset, as well as restructure to survive. In other words, many organizations have undergone or are currently undergoing a digital transformation”.

Table 16: Digital Maturity Model Comparison Chart –Technology

Table 16: DMI Comparison Chart – Technology													
Digital Maturity Model Comparison													
Developed by Academicians (Academic Journal and or Conference)												Developed by Practitioners (Consulting)	
Academic Journal										Conference		Consulting	
	DMAT Model (Aagaard et al., 2021)	Maturity Model (Amaral and Peças, 2021)	Digital maturity of an organisation (von Leipzig et al., 2017)	Multi-Attribute Assessment of Digital Maturity (Borštnar & Pucihar, 2021)	Strategy archetypes for digital transformation – BPM Model (Fischer et al., 2020)	Digital Transformation Maturity (Teichert, 2019)	Digital Transformation Capability Maturity Model (DX CMM) (Gokalp & Martines, 2021)	Digital transformation of SMEs: a four levels approach (Garzoni et al., 2020)	Digital Maturity Model for Telecommunications Service Providers (Valdez-de-Leon, 2016)	Berghaus (Digital Maturity Model (DMM) 2016)	Exploratory Digital Transformation Maturity Model (Gollhardt, 2020)	BCG Digital Acceleration Index (DAI)	Deloitte Digital Maturity Model (DMM) (2018)
Dimensions	Six dimensions: Strategy, Culture, Organisation, Processes, Technology and, Customers and Partners	Technology, Production Process, People, Smart Product, Organization, Change	8 dimensions: Strategy, Leadership, Products, Operations, Culture, People, Governance, Technology	7 dimensions: Digital technology, Management, Human resources, Strategy, Digital business model, Role of informatics organization culture	Six Core Elements of BPM Framework: Strategic alignment, Governances, Method, Information Technology, People, Culture	15 common elements: Digital culture, Technology, Operations & Processes, Digital Strategy, Organization, Digital Skills, Innovation, Customer Insight & Experience, Governance, Vision, Digital Ecosystem, Leadership, Compliance & Security, Products & Services, Business Models	Processes defined under 4 process groups of - strategic governance, - information and technology, - digital process transformation, and - workforce management	3 groupings: - Digital technologies adopted - Cultural value - Digital technologies impact (for strategy, processes and organization	The seven dimensions of the final model are as follows: Strategy, Organization, Customer, Technology, Operations, Ecosystems, Innovation	The final nine dimensions of the DMM are (1) customer experience, (2) product innovation, (3) strategy, (4) organization, (5) process digitization, (6) collaboration, (7) information technology, (8) culture & expertise, and (9) transformation management.	Five revised focus areas: culture, ecosystem, operations, governance, and strategy are characterizing the digital transformation maturity of a company.	6 dimensions: 1) Business strategy is driven by digital 2) Digitize the core 3) New digital growth 4) Changing ways of working 5) Data & technology 6) Integrating ecosystems	5 dimensions: Customer, Strategy, Technology, Organization & Culture
Dimension Nr	6	6	8	7	6	15	4	3	7	9	5	6	5
Model Name	DMAT Model	A Framework for Assessing Manufacturing SMEs Industry 4.0 Maturity	Digital maturity of an organisation	Multi-Attribute Assessment of Digital Maturity	Strategy archetypes for digital transformation – BPM Model	Digital Transformation Maturity	Digital Transformation Capability Maturity Model (DX CMM)	Digital transformation of SMEs: a four levels approach	Digital Maturity Model for Telecommunications Service Providers	Digital Maturity Model (DMM)	Exploratory Digital Transformation Maturity Model	BCG Digital Acceleration Index (DAI)	Deloitte Digital Maturity Model (DMM)

Author	(Aagaard et al., 2021)	(Amaral and Peças, 2021)	(von Leipzig et al., 2017)	(Borštnar & Pucihar, 2021)	(Fischer et al., 2020)	(Teichert, 2019)	(Gokalp & Martines, 2021)	(Garzoni et al., 2020)	(Valdez-de-Leon, 2016)	(Digital Maturity Model (DMM) 2016)	(Gollhardt, 2020)	(BCG 2018)	(Deloitte 2018)
Publication	Electronics Journal	Applied Sciences Journal	Sciedirect, Procedia Manufacturing Journal	Electronics Journal	Information & Management	Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis	Computers in Industry Journal	Emerald Insight Management Decision Journal	Technology Innovation Management Review	MCIS 2016 Proceedings Mediterranean Conference on Information Systems	2020 IEEE 22 nd Conference on Business Informatics (CBI)	-	-
Dimension definitions – Technology	Technology: dimension refers to the various combinations of digital technologies (e.g., IoT, machine learning, AI, VR/AR) that companies include in their business, processes, products, services and digital business development Customers and Partners: the ways and activities planned and carried out to involve and engage customers and other partners and stakeholders in the digital business development across the company's value chain and ecosystem	Technology: The aim of this dimension is thus not to list technologies nor to assess if the company has them or not since their infrastructure is different from company to company. The real aim of this dimension is to allow the understanding of which kind of infrastructure each company has in order to support the implementation of technologies.	Technology: Software tools, cloud architecture, ICT infrastructure, Industry 4.0	Digital technology: covers advanced technologies (blockchain, industry 4.0 and data analytics), SMACIT (social media, cloud), and basic business technologies (business software solutions, and digital workplace)	Information Technology: On the basis of a common business understanding and means for communication, all companies use BPM methods and IT to prepare for digital transformation by using IT innovation to foster not only organizational agility, but also digital expertise on the basis of IT innovation	Compliance and Security: IT security, digital security, IT compliance within organization and towards stakeholders, assessing risk factors, risk management, IP, optimizing value-chain network for compliance; avoid unauthorized access, ... Technology: ICT, IT architecture/systems and new digitalization-based IT systems, agility of supporting systems, digital data processing, ...	Information and technology: An IT strategy should be developed that is aligned with the organization's DX strategy for migration to the desired future environment. The IT requirements for each DX project should be defined: the development, integration, and maintenance of a standardized enterprise architecture (EA), including hardware, software, data, and business process layers; management of infrastructure such as IoT devices, servers, and so on; collecting, storing, analyzing, and distributing data; management of data analytics; development of applications based on agile software development principles; and IT	Digital technologies adopted: 1) Supply Chain Traceability (IoT, RPA, Blockchain) Precision Farming (Machine Learning, BI & Analytics; DSS, 2) Product-Process Maintenance Services (Machine Learning, Predictive, BI & Analytics; DSS), 3) Smart PPE (Wearable, Advanced Service Platform) Digital technologies impact: for strategy, processes and organization	Technology: Representing the capabilities that enable effective technology planning, deployment, and integration to support the digital business.	Information Technology: Agile project management • Integrated architecture • IT-expertise	Ecosystem: Ecosystem refers to the collaboration within and outside the company. Ecosystem contains seamless interactions with associates, usage of their data, business and IT synergy, customer centricity, and cooperation with academia and industry.	Data & technology: The management of data – from strategy to governance, from digital platforms to artificial intelligence, and the future-readiness of the world-class technology function, plus Development, Operations, cyber security, and internet of things. Integrating ecosystem: Orchestration of digital-related partnerships and how joint value is created from it, e.g., by compleme	Technology: Underpins the success of digital strategy by helping to create, process, store, secure and exchange data to meet the needs of customers at low cost and low overheads 1) Applications 2) Connected Things 3) Delivery Governance 4) Data & Analytics 5) Network 6) Security 7) Technology Architecture

							security management. These processes are all fundamental to the DX journeys of organizations. IT1. IT strategy management IT2. Requirement definition IT3. Enterprise architecture development IT4. Infrastructure management IT5. Data governance IT6. Agile software development IT7. Security management IT8. Enterprise architecture integration IT9. Data analytics IT10. enterprise architecture maintenance					ning digital offerings Broadly, through the DAI, companies can better understand their DAI maturity stages	

Note: Literal Text from [58], [7], [59], [60], [61], [62], ([4]; [27]), [25], [23], [22], [65], ([66]; [67]), [69] papers

When the ontology and the literature review findings of 11 (digital) maturity models “*Technology, Digital Technology, Information Technology*” and dimensions consolidated, the main points emerged for this aspect to be covered are (1) *Agile project management*, (2) *Integrated architecture*, (3) *IT-expertise*, (4) *IT strategy management*, (5) *Requirement definition*, (6) *Enterprise architecture development*, (7) *Infrastructure management*, (8) *Data governance*, (9) *Agile software development*, (10) *Security management*, (11) *Enterprise architecture integration*, (12) *Data analytics*, (13) *Enterprise architecture maintenance*.

Moreover, when “*Compliance and Security*” dimensions are consolidated, the main points emerged for this aspect to be covered are (1) *IT security*, (2) *Digital security*, (3) *IT compliance within organization and towards stakeholders*, (4) *Assessing risk factors*, (5) *Risk management*, (6) *Intellectual Property*, (7) *Optimizing value-chain network for compliance*, (8) *Avoid unauthorized access*.

Furthermore, when “*Cloud First*” dimensions are consolidated, the main points found in this aspect to be covered are (1) *Cloud first is the predominant digital strategy*, while “*Role of informatics*” covered as (1) *% of investments in IT*, (2) *Planned investments*, (3) *IT department*. Therefore, these points are covered in the scope of this research under Technology.

3.5 Conclusions

This work focuses on answering the following research question: 1. *What internal organizational aspects should be considered when measuring the digital transformation of the company?*

While answering this research question, it was found that there are internal factors that should be considered measuring the digital transformation of the company. However, like the difference between digital transformation related terminologies, it was found that these internal factors are also named differently from paper to paper. The most prominent examples of these findings were Culture, Strategy, and Processes. On the other hand, Data, Technology, People, and Organization description of the concepts were more consistent. For instances, while several papers highlight “Culture” directly ([58]; [61]; [65]; [59]), several papers grouped “People and Culture” or “Structure and Culture” together ([2]; [64]; [69]); others highlighted the digital side of the culture ([62]; [68]). Therefore, it was found that “Culture, Culture and Expertise, Digital culture” can be grouped under the umbrella of “Culture” aspect of the organizations. It emerged that in all of these papers, culture is defined by agility, emerging set of values, practices, digital awareness, and development of digital and organizational culture to support progress along digital transformation journey.

Furthermore, “Strategy” mentioned directly as a dimension of several digital maturity models ([58]; [59]; [60]; [61]; [23]; [22]; [64]; [69]). However, BCG DAI ([66]; [67]) defined “Strategy” as “Business strategy is driven by digital, and New digital growth”, and KPMG [68] defined as “digital strategy”, and Fischer et al. [61] defined as “strategic alignment”. Additionally, “strategy” dimension is also associated with collaboration, strategic governance, digital innovation, product / service innovation, digital business models, and strategic alignment.

Lastly, “processes” mentioned directly by ([58]; [22]; [4]; [27]; [62]) as process digitization or digital process and product process by Amaral & Peças [7]. Furthermore, in contrast to the other dimensions, process dimension’s scope is widened by operations, systems, digital ecosystems, smart factories, supply chain and process digitization.

During this research, it was also found that there is a research gap between how the internal organizational aspects derived. Therefore, in order to fill this gap, this research focused on merging the strengths of the qualitative expert interviews with the literature review. First the initial literature review was conducted in order to identify the organizational aspects. The most mentioned aspects grouped and ranked together. Then the first round of expert interviews conducted to get insights into digital transformation and organizational aspects, enabler topics. These findings were synthesized to derive the internal organizational aspects.

When all the dimensions of 18 digital maturity models are listed, the mostly mentioned dimensions are sorted by descending order as strategy, technology, people, culture, organization, processes, systems, and data. Therefore, it was emerged that based on the literature review the most encountered internal organizational aspects and as well as the most mentioned aspects during the interviews are investigated, namely *Strategy, Systems and Processes, Data and Analytics, Culture, People, Structure and Organization, Technology*.

CHAPTER IV

DIGITAL MATURITY INDEX DEVELOPMENT

To accelerate the digital business transformation and increase digital literacy and digital awareness, companies are taking initiatives towards (1) *Culture*, (2) *Data and Analytics*, (3) *People, Structures and Organization*, (4) *Processes and Systems*, (5) *Strategy*, and (6) *Technology*. However, one of the problems they are encountering is the measurement of where they are standing. In the “*Digital Technology and The Stages of Digital Business Transformation*” chapter and the “*Organizational Aspects of Digital Maturity*” chapters, the rational background of columns and rows as dimensions of the Digital Maturity Index are explained. Based on the expert interview and literature review (i) *digital passive*, (ii) *digitization*, (iii) *digitalization*, (iv) *digital transition*, and (v) *digital transformation* have been proposed as stages in this business transformation process. Researchers have also proposed a variety of digital maturity models to assess this transformation as summarized in *Chapter 3 Organizational Aspects of Digital Maturity*. Using these findings about constructs from the articles, the Digital Maturity Index, its rubrics, content and the number of initial questions were reduced from 280 questions to 35 questions based on the feedback sessions with academics and business are explained.

The findings of “*Chapter 2 – The Stages of Digital Business Transformation*” and “*Chapter 3 – Organizational Aspects of Digital Maturity*” suggested *Culture, Data and Analytics, People, Structure and Organization, Processes and Systems, Strategy*, and *Technology* as 6 main organization aspect in the digital transformation journeys. The outputs of Chapter 2 and Chapter 3 form the solid basis for the content and the design and

development of Digital Maturity Index. Chapter 4 combines both Chapter 2 and Chapter 3 findings.

The target of this chapter is to target is to purify the measure to develop a measurement instrument. The fourth chapter aims to explain the design and development phases of Digital Maturity Index including literature feedback sessions and methodology. The chapter covers the feedback sessions from the academic side as well as the business side, aspect and dimension development, rubric content development, and reduction from initial questions of 280 question to final 35 questions.

Keywords: *Digital Maturity Index, Digital Maturity Measurement, Digital Acceleration, Digital Business Transformation, Business Transformation.*

4.1 Introduction

This chapter basically complements Chapter 2, the “*The Stages of Digital Business Transformation*” and Chapter 3, the “*Organizational Aspects of Digital Maturity*”. Building on the initial constructs and the digital business transformation phases, this chapter aims to support the organizations by providing a tool to measure the organization’s maturity level which is developed based on 8 step approach of Churchill. The main motivation for this chapter is described by the following research questions:

RQ3: How can the digital maturity level of an organization be measured?

The reason and motivation behind looking for an answer for this research question is the necessity of digital maturity measurement. As discussed in Chapter 2, digital business transformation progresses in stages. However, it is not so clear for the companies to clearly define in which stage they are in the transformation. There are already developed digital maturity assessment and measurement models in the literature. Among

these models, several of them were developed by academicians and several of them were developed by the practitioners. This research differentiates itself by developing the measurement instrument based on both literature review and expert interviews, and afterwards by testing and validating both statistically, and empirically.

The method to build a measure starts initially with literature-based definition of digital maturity. Then it is followed by the development of the measurement tool based on Churchill's paradigm for better measures.

4.2 Literature Review

4.2.1 Digital Maturity Definition and Measurement

Digital maturity is a measure of organizational ability to utilize technology and to integrate their processes to create value. Therefore, digital maturity assessment model is a tool which assesses the readiness and / or maturity of the organization and provides a roadmap and guides the organizations to digital transformation. During the literature review, it found that there are 2 research streams in the digital readiness, assessment, and maturity measurement models: *academic research*, and *empirical research*. In the initial one, academic, the researchers are developing maturity models as an outcome of the literature findings. Therefore, academia is proposing methods, tools, and instruments for digital maturity assessment. The second stream is on the practitioner side, the consulting companies are proposing maturity models and providing organizations a clear path to follow how to excel in the digital transformation journey. The definition of digital maturity varies in the literature both for the literature and for the practitioners.

From the academic side, according to Amaral and Peças [7], a maturity model is a tool for organization from digital perspective and depicts a structured path ahead to

achieve the way of doing business. Furthermore, Aagard et al. [58] define the digital maturity assessment tool as a methodology to identify digital development areas and to assess organizational effect and digital intervention.

From the practitioner side, BCG ([66]; [67]) defines DAI as measure for an organization's potential and ability to generate value using digital initiative and as an indicator to measure success of the digital transformation through maturity levels. Furthermore, Deloitte [69] highlights that many industries lack a clear industry-based roadmap and defines digital maturity model as tool to provide guidelines for a clear path at the transformation journey. Moreover, KPMG sees Digital Maturity Model (DMM) as a tool to identify the areas where actions need and deriving measures during the digital maturity journey [68].

According to Berghaus and Back [22], “a maturity model provides some guidance since it gives an overview of the different areas and maps out typical paths of how organizations go about their transformation”. For Berghaus and Back [22], Digital transformation encompasses both process digitization with a focus on efficiency, and digital innovation with a focus on enhancing existing physical products with digital capabilities ([84]; [22]). They claim that “the current debate on digital transformation Berman [85] reveals that the changes induced by the simultaneous and dynamic influences of digitization on user behavior, organizations, and industries, constitute a new kind of transformation that provides new challenges [86].” Furthermore, according to Dobrovic [77: 1329], “Digital transformation is a contemporary term, it covers the usage of existing methods from different areas like business processes, management by measurement, organizational culture etc. The way we see business processes is usually through process models. Regardless of the notification we use, these models help in understanding the way an organization does its business and are the basis for the work

optimization/redesign, activity-based costing analysis, or the development of information system's architecture".

All in all, to summarize maturity models proposed both from the academia and practice are mainly covering the research of the maturity model literature in the following focusses: *proving a descriptive as-is status, offering a prescriptive steps to progress in the journey, including and excluding aspects* which are considered in the digital maturity measurement, *considering mutually exclusive and collectively exhaustive aspects, identifying several maturity measurement levels, and specializing industry specific implementation and measurement models.*

4.2.2 Digital Maturity Measurement Stages

Based on the literature review, it was found that there is no standard maturity measurement method or scaling systems. Instead, each research defines their own approach, stages definitions, and scaling mechanism. Among the selected 18 articles mentioned in Chapter 3, it was observed that scale ranges changes between 0 to 6. The comparison table is summarized in the following tables. (Table 17 and 18)

Based on the literature review, there are three different maturity stage scaling approaches that were observed; *based on numbers, based on stage naming, and based on a statement regarding agree disagree.*

The first one is based on *numbers*. Maturity models of DMAT Model by Aagaard et al. [58], Maturity Model by Amaral & Peças [7], Industry 4.0 maturity model by Santos & Martinho [2], Digital maturity of an organization by von Leipzig et al. [59] identify the maturity stages as a scale. However, their proposed scale ranges vary from level 0-6, or level 1-5, or level 1-5.

The second one is based on *stage naming*. For instance, Digital Transformation Capability Maturity Model (DX CMM) by Gökalp & Martinez ([4]; [27]) proposes Level 0 as incomplete, Level 1 as performed, Level 2 as managed, Level 3 as established, Level 4 as predictable, and Level 5 as innovating. Furthermore, Digital transformation of SMEs: a four levels approach by Garzoni et al. [25] propose 4 levels of engagement towards digital transformation Level 1 digital awareness, Level 2 digital enquirement, Level 3 digital collaboration, and Level 4 digital transformation. Moreover, Digital Maturity Model for Telecommunications Service Providers by Valdez-De-Leon [23] propose scale from 0-5 and maturity in each dimension is assessed across five levels which are Level 0-not started, Level 1-Initiating, Level 2-Enabling, Level 3-Integrating, Level 4-Optimizing, Level 5-Pioneering. Among the other models, Digital Leadership Extended Dimension Model by Gudergan et al. [70] and Patterns of Digitization by Mugge et al. [46] defines the levels as Level 1-Initial, Level 2-Managed, Level 3-Defined, Level 4-Quantitatively Managed, Level 5- Optimizing. Furthermore, among consulting models, BCG's Digital Acceleration Index ([54]; [66]; [67]) proposes 4 scales based on maturity stages: Digital starter, digital literate, digital performer, digital leader. KPMG Digital Readiness Assessment (DRA) [68] model proposes 4 levels based on transformation intensity and operational effectiveness: Ambitious transformer, Smart digitalist, Reactive participant, Digital operator.

The third one is *based on a statement regarding agree disagree*. A Digital Readiness Check for Industry 4.0 by Lassnig et al. [63] defines Six-point Likert scale; “strongly agree” (6) or “agree” (5); “strongly disagree” (1) or “disagree”. Moreover, Berghaus's Digital Maturity Model DMM propose 5-step Likert-scale, to what degree

they agree with the statements, from “0–do not agree” to “4–fully agree” and “I don’t know”.



Table 17: Digital Maturity Measurement Stages inc. Academic Journal											
DIGITAL MATURITY MODEL COMPARISON											
Developed by Academicians (Academic Journal and or Conference)											
Academic Journal											
	DMAT Model (Aagaard, 2021)	Maturity Model (Amaral & Peças, 2021)	Industry 4.0 maturity model (Santos & Martinh O, 2020)	Digital maturity of an organisation (von Leipzig et al., 2017)	Multi-Attribute Assessment of Digital Maturity (Borštnar & Pucihar, 2021)	Strategy archetypes for digital transformation – BPM Model (Fischer et al., 2020)	Digital Transformation Maturity (Teichert, 2019)	Digital Transformation Capability Maturity Model (DX CMM) (Gokalp & Martines, 2021)	Digital transformation of SMEs: a four levels approach (Garzoni et al., 2020)	A Digital Readiness Check for Industry 4.0 (Lassnig et al., 2021)	Digital Maturity Model for Telecommunications Service Providers (Valdez-de-Leon, 2016)
Scale / Stage	Scale from 1-5	Scale from 0-5	Scale from 0 to 5	Scale from 1-5	Scale from 1-5 Many business maturity models are based on CMM and they adopted a five-level approach, describing the evolutionary path from initial to the optimized level of maturity	No scale exists. Instead, morphological analysis is provided based on 3 meta objectives.	-	Six levels, from Level0: Incomplete, to Level 5: Innovating.	Scale from 1-4. The levels of engagement towards digital transformation Level 1 digital awareness Level 2 digital enquirement Level 3 digital collaboration Level 4 digital transformation	Scale from 1-6. On the Six-point Likert scale, companies are assumed to agree with a statement if they chose either “strongly agree” (6) or “agree” (5). Similarly, they are assumed to disagree with a statement if they chose “strongly disagree” (1) or “disagree” (2)	Scale from 0-5 Maturity in each dimension is assessed across five levels. In order of decreasing maturity, these levels include:
Stage 0			Level 0 low or none degree of implementation.			For Governance and Compliance: - Bottom-up - Hybrid - Top-down		Level 0: Incomplete – The DX initiative has not yet started.			0. Not started: The organization has not taken any steps to transform.
Stage 1			Level 1 pilot actions being planned or being developed.	1. The first level, “unaware”, describes companies in which there is no strategy for digital transformation, nor are there any digital competencies available.		Management Support: - Observing - Supporting - Involved		Level 1: Performed – The DX initiative has been started. The vision of DX exists, and the roadmap for the transition strategy has been developed, but it has not been entirely implemented. The portfolio consisting of the DX projects that have been identified, evaluated, prioritized, and authorized is created. Additionally, a department or group is assigned to carry out DX. Workforce skill necessities are determined, and	Level 1 – digital awareness: This level is grounded on the awareness about the potentiality of DT on SMEs. This level sees the participation of a larger and differentiated community of stakeholders (companies belonging to all the three industries) participation		1. Initiating: The organization has decided to move toward a digital business and is taking initial steps in that direction.

								corresponding training starts to be acquired in the company.	through phone calls and live meetings aimed at informing about the project and collecting subscriptions.		
Stage 2			Level 2 implementation of actions initiated, with some benefits being observed.	2. The conceptual" level, are those which offer a few digital products, but are still without a digital strategy.		Interaction Model: - Bottom-up - Hybrid - Top-down		Level 2: Managed – DX is managed at this level, at which the digital shadow of physical items begins to be created. Existing business processes are digitized through technology; the IT department publishes an IT strategy to migrate to the demanded future environment stated in the organization's DX strategy; DX-related projects are started; feasibility analysis of the projects is performed, pilot studies are conducted, and requirements are defined for each project; the acquisition of IoT devices, hardware, and software has begun, and the vendor relationship is managed; the requirements and needs of the enterprise architecture (EA), consisting of the business process, information, data, application, and technology architecture layers are identified, and standards, guidelines, procedures are defined; and, finally, infrastructure, data governance, software development, and the security of the information systems are managed. Existing business processes are digitized through technology; the IT department publishes an IT strategy to migrate to the demanded future environment stated in the organization's DX strategy; DX-related projects are started; feasibility analysis	(2) Level 2-- digital enquirement: At this level, the technological solutions at the basis of the Smart District 4.0 are presented in terms of functionalities and potentialities to sensitize SMEs and all the other stakeholders, etc. The modalities of SMEs engagement regard a more powerful interest of SMEs in the project of DT and are involved through working sessions, seminars, focus group, etc.		2. Enabling: The organization is implementing initiatives within the dimension that will form the foundation of its digital business.

								of the projects Is performed, pilot studies are conducted, and require ments are defined for each project; the acquisition of IoT devices, hardware, and software has begun, and the vendor relationship is managed; the requirements and needs of the enterprise architecture (EA), consisting of the business process, information, data, application, and technology architecture layers are identified, and standards, guidelines, procedures are defined; and, finally, -infrastructure, data governance, software development, and the security of the information systems are managed.			
Stage 3			Level 3 partial implementation of actions, that enhance the competitiveness of the company.	3. “defined” level of digitization, are the companies who are able to consolidate experiences gained from pilot implementations into partial strategies.		Education: - Open - Selective - Targeted		Level 3: Established – DX is established robustly at this level. Key processes are well defined and consistent with corresponding standardization. Vertical integration, including intra-company integration of IoT devices, up to enterprise resource planning or customer requirement management systems, has been achieved.	(3) Level 3-- digital collaboration: On the basis of their interests, companies are accompanied into an activity of exploration of the potential benefits of digitalization in their own business processes and strategies. At this level, a number of limited companies are engaged; they are allowed to use the G Suite to sustain their administrative and communication processes.		3. Integrating: The organizatio's initiatives are being integrated across the organization to support end-to end capabilities.
Stage 4			Level 4 advanced implementation of actions, with clear economic returns.	4.“integrated” level: profitability of these partial strategies and the effects of the pilot implementations are assessed and used to develop an		Tool Support: - Collaborative - Individual		Level 4: Predictable – The quantitative techniques begin to be applied to the collected real-time data for products, services, or processes. Horizontal integration, which is the integration across networks at the business level, is established	(4) Level 4-- digital transformation: This is the level of highest engagement that sees a limited number of SMEs interested in. SMEs in this level show a major interest		4. Optimizing: The organizatio's digital initiatives with in the dimension are being fine-tuned and used to further increase overall performance.

				overall digital strategy. At this point, where a clear digital strategy is developed, the company falls into the “integrated”					towards the digitization process and that can represent pivotal set for the project’s goals. In this stage, the technologies made available are mainly digital solutions for production, distribution and with a more relevant impact on the company’s in terms of strategic and organizational issue for the business strategy and organizational settings.		
Stage 5			Level 5 reference in applying the concepts and implementing the technologies of Industry 4.0	5. “Transforme”: Only once this strategy has been implemented across all products and business processes, can the “transformed”. The company be classified as now-defined digital strategy will have transformed the business and operations models of the company		Conventions and Guidelines: - Guiding - Restrictive - Rigid		Level 5: Innovating – The organization uses the collected data for continuous improvement, innovative culture is established, and dynamic cooperation and increasing transparency, by extending operational visibility with automated and seamless information exchange among the network, are enabled.			5. Pioneering: The organization is breaking new ground and advancing the state of the practice within the dimension.
Stage 6						Meta Objective: - Communication/ Learning - Unification/ Optimization - Automation/ Certification					

Note: Literal Text from [58], [7], [2], [59], [60], [61], [62], ([4]; [27]), [25], [63], [23] paper

Table 18: Digital Maturity Measurement Stages inc. Conference Papers and Consulting Articles

Digital Maturity Model Comparison							
Developed by Academicians (Academic Journal and or Conference)				Developed by Practitioners (Consulting)			
Conference				Consulting			
	Digital Maturity Model (DMM) (Berghaus & Back, 2016)	Digital Maturity Models for Small and Medium-sized Enterprises (Williams et al., 2019)	Digital Leadership Extended Dimension Model (Gudergan et al. 2021) & Patterns of Digitization (Mugge et al., 2022)	Exploratory Digital Transformation Maturity Model (Gollhardt, 2020)	BCG Digital Acceleration Index (DAI)	KPMG Digital Readiness Assessment (DRA)	Deloitte Digital Maturity Model (DMM) (2018)
Scale / Stage	5-step Likert-scale, to what degree they agree with the statements, from “0 – do not agree” to “4 – fully agree” and “I don’t know”	-	Scale from 1-5 This model’s definition of digital maturity is based on Carnegie Maturity Model Integration (CMMI) process	Scale from 1-5	4 maturity stages: Digital starter, digital literate, digital performer, digital leader	4 scales based on Transformation Intensity and Operational Effectiveness: Ambitious transformer, Smart digitalist, Reactive participant, Digital operator	
Stage 1			Level 1 – Initial: Processes unpredictable, poorly controlled and reactive. (Gudergan 2021) “Level 1 is the initial state, with no concerted efforts on digitization. (Mugge 2022)		1) Digital Starter: The organization has no clear plan for digital transformation, although IT and business functions may collaborate from time to time in an ad hoc manner. The company outperforms its peers in key digital metrics and sees digital as an essential driver of business. (DAI score 0-25) Aware that digital might impact the industry, but doesn't yet have a well-defined digital strategy		
Stage 2			Level 2 – Managed: Process characterized for projects and is managed. (Gudergan 2021) Level 2 is where organizations make digitization a strategic imperative, and a transformation strategy is developed. (Mugge 2022)		2) Digital Literate: Leaders recognize the need and value of digital technologies and are ready to invest in digital transformation. A roadmap exists, and projects are in the early stages. However, business units, functions, and regions are still operating in functional silos rather than being part of a coordinated organization-wide effort. (DAI score >25-50) Several functions or business units have their own digital strategies and separately analyze digital trends and the impact; the company has not defined a digital ambition		
Stage 3			Level 3 – Defined: Process characterized for the organization and is proactive.		3) Digital Performer: A robust digital mindset exists, and a clear transformation path is defined. The talent and		

			(Gudergan 2021) Level 3 is where managers' actions reflect the new, desired behaviors; their goal is to institutionalize the new model. (Mugge 2022)		data platforms required for digitization were set up. Several digital initiatives were successful, and new digital services and businesses were also launched. (DAI score >50-75) The digital target state for the organization is developed and the vision is articulated; digital ambition is defined and understood across the organization; metrics are defined and deployed to measure progress toward the ambition	
Stage 4			Level 4 – Quantitatively Managed: Process quantitatively measured and controlled. (Gudergan 2021) Level 4 is the level where synergies occur; the company involves competencies and people from outside the organization. (Mugge 2022)		4) Digital Leader: Digital is embedded throughout the entire organization and is driving innovation, R&D, value delivery, digital technologies adoption, strategy development, and day-to-day (DAI score >75-100) Digital is one of the key priorities and an integral part of the CEO agenda; a clear process to update the vision has been defined, and a digital strategy across business units and functions is in place	
Stage 5			Level 5 – Optimizing: Focus on continuous process improvement. (Gudergan 2021) Level 5 is the optimized state. Companies operating at Level 5 have achieved digital maturity and are primarily concerned with the continuous improvement of the new business model and business processes.” (Mugge 2022)			

Note: Literal Text from [22], [64], [46], [54], [65], [66], [68], [69] papers

For instance, the maturity model is proposed by Gudergan et al. [70]. Their model is based on the Carnegie Maturity Model Integration (CMMI) process. According to Gudergan et. al [70: 3], “The CMMI model breaks organizational maturity into five levels. For businesses that embrace CMMI, the goal is to raise the organization to Level 5, the "optimizing" maturity level.

Considering the CMMI model, with inclusion of literature on digital transformation and direct feedback from leaders, we have developed an approach that includes 5 digital maturity levels. Level 5 is the optimized state. Companies operating at Level 5 have achieved digital maturity and are primarily concerned with the continuous improvement of the new business model and business processes. Level 4 is the level where synergies occur; the company involves competencies and people from outside the organization. Level 3 is where leaders' actions reflect the new, desired behaviors; their goal is to institutionalize the new model. Level 2 is where organizations make digital transformation a strategic imperative, and a transformation strategy is developed. Level 1 is the initial state, with no concerted efforts on digital transformation.”

Therefore, it can be concluded that definition of the digital maturity levels varies from research to research, with a scale between 0 to 6.

4.3 Method and Data

There are several maturity assessment and digital maturity measurement models available in the literature, which were discussed in more detail in Chapter 3. These models include the ones developed by the academicians which are published in the academic journals and conferences, and the other ones developed by the practitioners which are published as consulting studies. In comparison to the other models, this research aims to differentiate itself by developing a digital maturity measurement instrument combining the strengths of both academic and practice and testing and validating the developed model by both statistically and empirically.

In comparison to the other models available in the literature, this model development is based on empirical data. This research is organized as mixed research combining the strengths of qualitative and quantitative research. The fundamental aim of

qualitative research is to gather in depth information from the industry experts and experts from the company where the research takes place. To support the findings of the qualitative interview, the quantitative analysis is conducted.

4.3.1 Digital Maturity Index Development

In this research, the Digital Maturity Index is developed as a questionnaire. The logic behind this development is explained by selection of semi-structured interview for the design instrument and qualitative research classification and rubrics as well as the purpose of the digital maturity measurement.

Background of Contributors who supported Digital Maturity Index Development

The contributors who supported the Digital Maturity Index can be grouped into three expertise areas. The first group consists of academicians with minimum 15 years of academic experience and whose research focus areas related with innovation management, digital transformation, and digital innovation. The second group consists of Information Technology experts whose specialization areas are ERP systems, web and mobile application development, data analytics and cyber security. The third group consists of business experts who are taking an active role in the digital project development process.

Both from the business and the IT side, the eligible experts who voluntarily contributed to the questionnaire implementation have more than 10 years of professional experience. Furthermore they have been working for the company for more than 10 years and in leadership positions more than 2 years long. Therefore, it can be concluded that they have a good overview of the initiative in the company's digital transformation journey.

Rationale of Using Semi-Structured Interview for The Questionnaire Design

The main reason behind this selection method is gathering more detailed information as well as the scoring information from the participant. When the participant is directly answering the question through the Digital Maturity Index, it made possible the collection of quantitative data. In addition, discussions during the workshops enabled the receival of more detailed insights.

Instrument, Qualitative Research Classification, Rubrics

As the instrument, Digital Maturity Index, an assessment tool is developed. The rubric content comes from the interview and literature review findings and the blend of analysis. On the other hand, the DMI dimensions are coming from the digital transformation phases and the organizational aspects based on the literature review and initial analysis.

Digital Maturity Index and DMI Purpose

It is a reference model that describes the digital effectiveness of an organization and how well digitization contributes to the performance of the organization. Outlines the company's digital maturity levels and provides a roadmap for successful digital change and transformation.

The purpose of DMI measurement can be grouped into three main drivers. First, it provides clarity and common *understanding of the digitalization strategy* across the organization. Secondly, the need to pursue a *common goal* with the participation of all units and departments of the company. Finally, it provides a *measurement mechanism for the digital maturity* of all units over the same criteria and scale through the same measurement tool.

4.3.2 Digital Maturity Index Development Process Steps

As discussed in the research abstract and the Chapter 1 introduction, Digital Maturity Index (DMI) development process took several steps. Mainly they are categorized under eight steps. However, the Digital Maturity Index Development and Implementation Steps developed and used in this research are categorized in parallel to Procedure for Developing Better Measures proposed by Churchill [1].

The research is designed in eight steps which are depicted in the following figure as Digital Maturity Index Development and Implementation Steps (Figure 10). However, the scope of this chapter is limited to an initial 5 steps. The first step is “*Literature Review and 1st Round of Interview Findings*” which are designed as an unstructured interview format to collect general understanding data on digital transformation and technology and doing literature research to generate measurement questions and rubrics. The second step is “*DMI Development and Individual Feedback Sessions*” which was designed as an assessment tool development for the measurement of the company’s digital maturity level through individual feedback session. The third step is the “*initial test phase*” with the industry experts. After updating the index based on the initial test phase, the fourth step is the “*second test phase*” with the industry experts. After reviewing the questions and gathering feedback from the industry experts and academics, some adaptations and amendments in the questionnaire are done. The fifth step is “*DMI Implementation*” designed for the actual digital maturity measurement of the company.

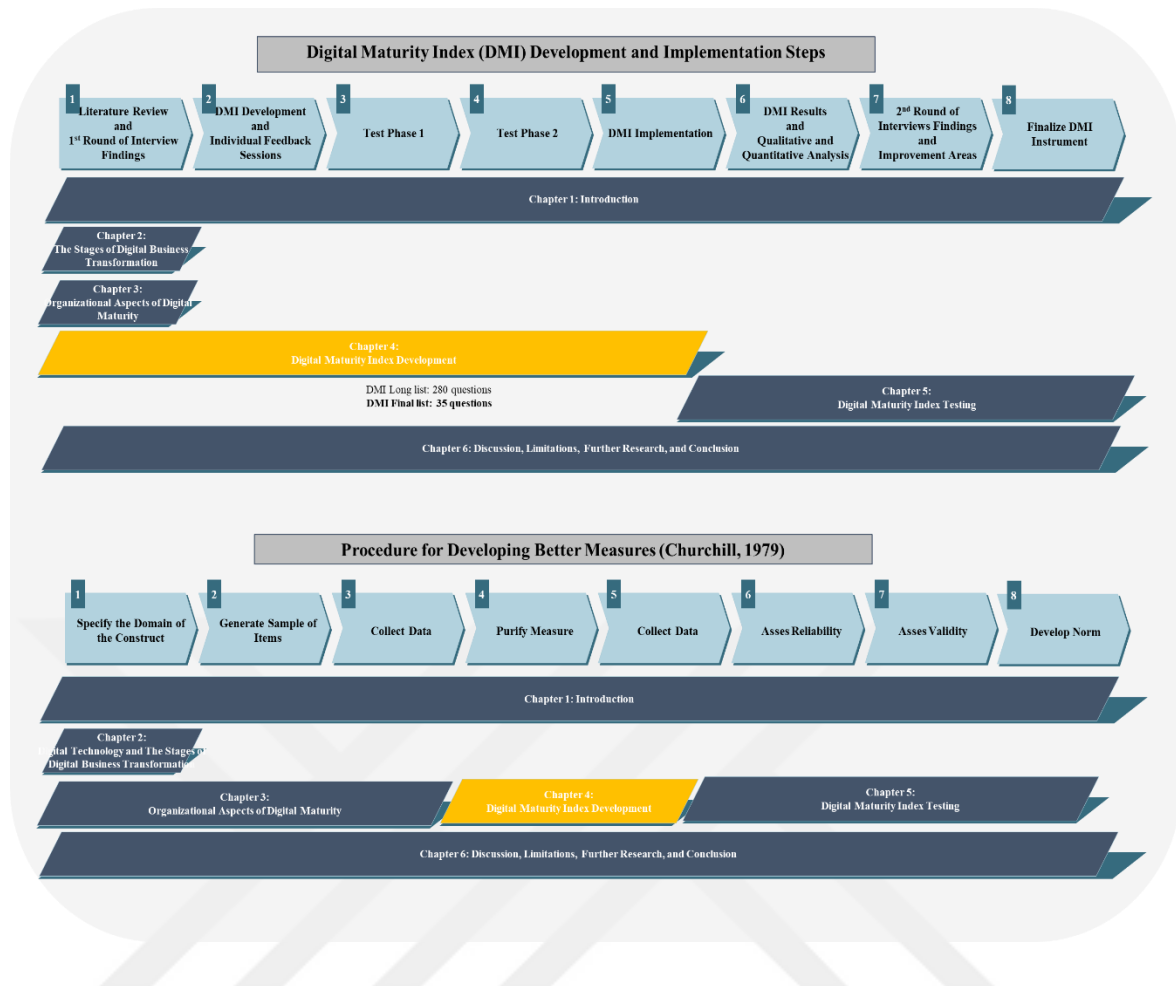


Figure 10: Phases of Digital Maturity Index Development Process

Step 1- Literature Review and Interview Findings

The first step is the initial analysis based on the literature review and the findings from the interviews. The findings from the literature review and the interviews are merged with the studies of consulting firms such as Deloitte ([69]; [89]; [90]; [91]; [92]), BGC ([3]; [66]; [93]; [94]; [95]), TDWI [87], KPMG ([68]; [96]; [97]; [98]; [99]; [100]), OrgCMF [88], and McKinsey ([8]; [32]; [33]; [71]; [73]; [101]; [102]; [103]) documents and consulting research. In total, the process began with a questionnaire list of 280 questions.

Following Delphi Method approach, from the academic side the list of 280 questions with relevant organizational aspect dimension sent to the PhD Research

Committee to enable members to click and select the respective category or organizational dimension for each question based on their view. The aim of this approach was to have a consensus on the question and organizational dimension match. After 3 members of the PhD Committee and an external Committee member selected the relevant organizational aspects for each question, a final list was compared with the researcher's initial selection of the question vs. organizational dimension match. Furthermore, in addition to the question vs. organizational dimension match, the feedback of the PhD Committee members regarding 280 questions were collected. Duplicating, or redundant questions were eliminated, and the content of several questions were united or revised. The total number of questions was reduced to 75 questions.

Step 2 – Individual Feedback Sessions

Based on Delphi Method, later, at step 2, via gathering individual feedback from the Business and IT experts, as well as academia, the number of questions were reduced to 50. Redundant questions and / or replicating questions were eliminated. The content of several questions which were meaningless or misunderstood were rephrased. At the end of this round, the index ended up with 50 questions.

At this stage, the questions did not have the corresponding rubrics for each digital business transformation stage, instead the questions had *disagree*, *partially disagree*, *indifferent*, *partially agree*, *agree* options to check mark the respective digital business transformation stage.

Step 3 – Test 1 Pilot Feedback Session

Following Delphi Method approach from the practice side, experts were asked if they would like to voluntarily contribute to the research. In total, 9 experts agreed to contribute to the research.

Later, with the voluntary participant to test these 50 questions, pilot sessions were organized. The first pilot session took place with the support of IT Experts and Business Experts who voluntarily contributed to the research. In the 1st pilot session, 9 experts participated, and they gave their feedback while answering the questionnaire on an online survey app called, Mentimeter. In this pilot session, based on the votes of the participants, the company's digital maturity score for each organizational aspects were measured, from culture to strategy, data, process and systems, people, organization, and structures. (See Appendix A)

However, at this stage still the questions did not have the corresponding rubrics, instead the questions had *disagree*, *partially disagree*, *indifferent*, *partially agree*, *agree* options to check mark the respective digital business transformation stage.

At this stage, experts responded to the questionnaire, their feedback received and discussed during the pilot meeting in order to collect insights. As a researcher and as a facilitator at the same time, I collected the expert responses and noted the feedback, improvement areas, non-clear questions, and outliers. Afterwards, 50 questions were revisited. Unclear questions were eliminated, a duplicate deleted, and several questions were rephrased. Based on the need additional cycles of quick feedback collected from the participants at one-to-one meetings. At the end, the number of questions was reduced to 35.

Step 4 - Test 2 Pilot Feedback Session

Following the Delphi Method, after gathering feedback during Pilot 1, the questionnaire was reviewed, and literature was revisited. The number of questions was reduced to 35. Based on feedback, several questions were replaced with more valid questions and some of the questions' rubric content was renewed.

When the questionnaire was ready, the second pilot workshop took place 2 months after the first pilot with voluntarily participating 9 experts. In this workshop, there were voluntary participants from Business Experts, Managers, and IT Experts roles. Based on their feedback, the questionnaire was tested again. This time as a tool Google Forms was used and again the scores of each organizational aspect were measured. The main difference between Pilot 1 and Pilot 2 is the content of the rubrics. At Pilot 1 phase only, the questions were tested and at Pilot 2 phase both questions and the rubrics were tested. Again the content of several questions that were meaningless or misunderstood were rephrased. (See Appendix A)

During the Pilot 2 session, responses and feedback collected from the participants and even based on the need content of rubrics were discussed. Based on this feedback, detailed rubric content discussions took place. These small group of rubric discussion meetings took place with 4 participants covering management, IT expert, business expert, and digital leader roles. The 35 questions were split among these 4 participants based on 6 organizational aspects and a deadline set for arranging the rubric content. After the deadline, the small group of participants came together to explain and discuss the rubric contents corresponding to each question. After this step, DMI with 35 questions was ready to be implemented at the practice for a real digital maturity measurement.

Step 5 – DMI Implementation

After having confidence both from the business and the academic side to roll out the Digital Maturity Index, the DMI implementation phase was started.

Main Constructs / Aspects	Questions	Digital Passive	Digitization	Digitalization	Digital Transition	Digital Transformation
		Score 1: Passive	Score 2: Digital Literacy	Score 3: Digital Player	Score 4: Competitive	Score 5: Digital Leader
Culture	How do you apply the principles of agile product and service delivery across a broad spectrum of the organization, including business units and IT units?	We use waterfall projects models and methods.	We experiment with agile processes. We defined agile roles such as scrum master and agility coach.	We use an agile working model, that continues to evolve. We have a stable portfolio of agile teams that work with the rest of the organization.	We observe the principles of agile culture and agile in all development processes (across business units and information technologies) in most business units.	Agile working methods move beyond digital product and service delivery to other departments of the organization. All business decisions and processes are created with agile processes. Every individual in the company has an agile role.
Data and Analytics	What is the scope, use and implementation of your data platform?	There is no data platform.	A partial data platform is available or a data platform based on several modules.	A data platform is available covering all modules.	Data platform components are documented to avoid complexity.	The data platform implementation supports data strategy objectives and is actively used across the enterprise.
People, Structure and Organization	How is digital talent development done in your company?	A program is not implemented.	A limited number of interest-based programs are run in a decentralized manner.	A program is carried out to raise digital awareness of all employees. All units have digitally competent employees. Business units started to work agile. (High level trainings)	The company runs a large-scale program to develop the skills of its employees in specific digital technologies, products and services. (Systematic specialized trainings)	The company aims to develop digital skills both at an advanced level and in detail, by organizing trainings in which all of its employees are required to attend. (Mandatory)
Processes and Systems	How do you conduct digital marketing?	We have digital tools (websites, apps). But it has limited traffic.	Our digital tools are used effectively by the customer. We have no significant influence on these practices.	Our digital application investments are made by focusing on key customer touchpoints. However, return on investment (ROI) cannot be tracked. Our digital marketing experts use "traditional" marketing techniques.	There is a two-way interaction with consumers by segment. Return on investment (ROI) is tracked and used as a decision supporter. We have digital experts who can query effectively in digital campaign applications.	We can clearly measure the return on investment (ROI) of digital marketing. We have a direct relationship with a significant portion of our consumers. Digital is one of the core skills of all marketers in the organization. There is effective collaboration between marketing, media, sales and
Strategy	How does your organization digitalize?	No particular priority is given	Overarching digital transformation goal is determined	Before starting working on the primary goal, we are selecting for low-hanging fruits (things can be done quickly, easily, and without much investment that will start paying off immediately). We defined smaller projects which will have the biggest impact on our primary goal are determined.	After we committed to one primary goal and selected the low hanging fruit projects, we engaged engage in mid-level projects that support our goal, and boost efficiency on the path to success. A high priority is given to these studies throughout the institution.	Digital initiatives are the most valuable and top priorities on the company's agenda. We engage in large scale digitalization program throughout the company which includes many mid-size and large-size projects that support our goal.
Technology	How do you use emerging technologies such as AI, RPA or IoT etc.?	The organization has limited or incidental knowledge of recently developed technologies	The organization has basic knowledge of newly developed technologies, but does not use them.	There is knowledge and awareness about the main usage areas of newly developed technologies in the organization. Pilot projects are being carried out.	The main use cases of new technologies have been identified and prioritized. Pilot practices were created and responsibilities were clarified. The focus is prioritized processes in the value chain.	Both AI and new technologies are successfully used in the products, services and processes offered and provide competitive advantage. There are continuous applications of artificial intelligence to cover all steps and processes in the value chain.

Figure 11: Digital Maturity Index – Fragment of Questionnaire

Overall – Business and PhD Committee Contributions

In between every step, both academic and business support was received. During the index development at each phase, they gave their contribution with regards to questions and rubrics and translation check. The committee also supported DMI by placing items in relevant categories which also increased the reliability of the research and the questionnaire.

In between each phase, the support from a couple of experts received in terms of Turkish and English back translation and control. Through this loss of meaning and semantic transfer were prevented.

4.3.3 Digital Maturity Index Model Construct

As a result of the Delphi Method, the Digital Maturity Index model construct with 35 questions and their rubrics corresponding to each digital business transformation stages were developed. The Digital Maturity Index model construct and the number of questions per organizational aspect vary from aspect to aspect. The Culture aspect has 5 questions, Data and Analytics aspect has 6 questions, People, Structure and Organization aspect has 5 questions, Processes and System aspect has 7 questions, and the Strategy aspect has 9 questions, and Technology aspect has 3 questions (Figure 12).

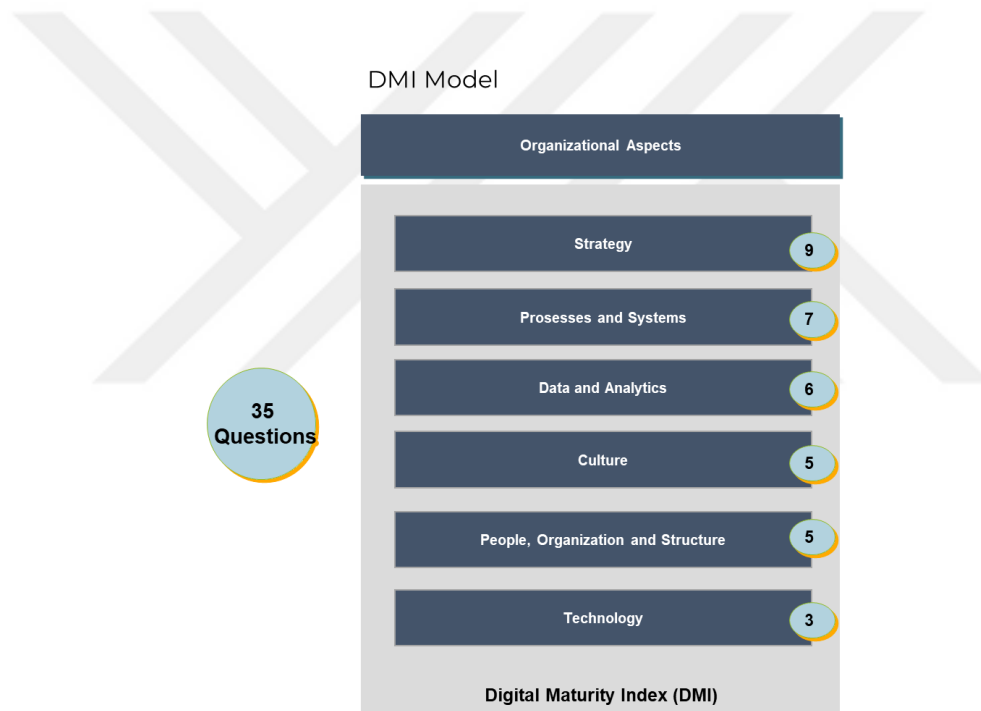


Figure 12: Digital Maturity Index – Genel Construct

4.3.4 Case Setting

Underlying reasons behind the selection of the company

Why did we choose this company for the research? There are five main reasons behind the company selection. The first and the most critical reason is the global automotive industry has been going through a drastic change which was initiated with the

introduction of Industry 4.0 and supporting technologies. These external forces are giving rise to four disruptive technology-driven trends (CASE) in the automotive sector: diverse *Mobility, Autonomous Driving, Electrification, and Connectivity*.

How do these trends affect the automotive sales and aftersales company then? These trends, which can be seen as a consequence of Industry 4.0 is reflected in the automotive sector as well. The automotive industry is basically in the transformation phase which is named Automotive 4.0. Globally the whole automotive industry is affected by these trends. These CASE and digital transformation trends and the increase in the use of digital technologies are shaping the product portfolio of the automotive companies e.g. Electric Vehicles, Connected Vehicles, Mobility Services, changing the way how they reach to their customers e.g. OEM's and automotive sales and aftersales company's direct sales to the end customer. These trends are leading to a shift among the revenue generation channels of the automotive companies from more conventional sales such as direct income generated from vehicle sales or after sales, to income more value-added services or mobility service provider product and services. To not remain indifferent, automotive companies worldwide are taking initiatives to digitalize their operations and innovate their products.

The second reason is the company's digital transformation journey. The company took the first steps towards digital transformation in 2017 by establishing a digital transformation unit which is aimed to take care of digitalization and technology related topics. Since then, the company is currently in the improvement process of digital transformation and digital technology implementation. The company started with a digital transformation roadmap when the department was first launched. However, the company was struggling to measure how the taken actions are moving the company forward.

Therefore, the digital maturity index is developed to provide a solution for the company's problem.

The third reason, the advantage of being a researcher and an employee of the company became a positive factor getting acceptance. Therefore, even though sometimes it might be difficult to switch between academic and business hats, conducting research as an employee and researcher at the same time provided good insights and access to DMI data, and company resources. However, to make a clear distinction between the two roles, notes were taken in a diary during all critical PhD research meetings.

The fourth reason, as stated above the company is one of the most frontier automotive sales and aftersales companies in Turkey with close relationship to the Original Equipment Manufacturer (OEM). Through OEM the company has access to digitalization know-how sharing.

Finally, one of the most critical reasons is the company's subsidiary. The company has a software subsidiary through which the automotive company has better access to all technological topics and trends.

Venue: Organization Description

The case study research is targeted to be conducted mainly based on an automotive sales and aftersales company in Turkey and including its technology subsidiary and as well as the automotive dealer subsidiary. As digital technology selection differs based on the companies' expertise areas, it should be noted that the company does not manufacture the vehicles. The company's business model is based on importing vehicles from the Original Equipment Manufacturer (OEM) in Germany, Sweden, and Spain and distributing the automotive products in the Turkish market through automotive sales and aftersales company and dealership network.

Automotive Sales and Aftersales Company

Automotive Company, where the case study research is mainly to be conducted, is a leading automotive importer and one of the largest automotive sales and aftersales companies in Turkey. Automotive Company determines its business plans according to its vision of offering “creative services beyond expectations,” and builds its corporate strategy with the aim of “working with a focus on customer satisfaction.” The Automotive Company has the biggest brand portfolio and the widest service network in the Turkish automotive industry. Representing international brands, each of which is the leader of its respective sector among passenger cars, light commercial vehicles, and heavy commercial vehicles. The Automotive Company provides its individual and corporate customers a wide array of products made up of more than 80 models. Unconditional customer satisfaction is the top priority of the Automotive Company in the services it provides, and the company has one of the largest authorized dealers and service networks in the nation. It has strong customer contact points throughout Turkey. With its size of employees, this Automotive Company is one of the most important players of the Turkish automotive industry [104].

The automotive company where the case study took place is a digital transformation journey since 2017. Based on the previously mentioned global CASE trend in the automotive industry, the company took the first steps towards digital transformation in 2017 by establishing a digital transformation unit. This digital unit's area of responsibility is positioned as leading all the digitalization and technology related topics for all group brands. However, to be successful at this journey, the company have got external support to define company's digital transformation journey. To be successful in this journey, the digital unit identified several areas for the company to address: employee competencies, culture, agile, and data. It started with establishing initiatives to

support cultural transformation, agile project portfolio management, digital competency development program, and defining technical roles and assigning responsibilities. In 2018, the company focused on the identification of the digital transformation roadmap and the focus areas. In 2019, the company started to use an agile approach in the software development projects which supported the agile cultural transformation. As of end of 2019, the number of project completion rates increased with the positive trend at the consecutive years. In 2019, the company defined several digital roles in the company and nominated the representatives from each department. Furthermore, in 2020 the company also initiated a digital competency development program to strengthen the digital skills and competencies of its employees in RPA, Data, UX/UI, ML/AI and general digital transformation areas. In 2021, while continuing the operations which were initiated in the previous years, the company started to focus more on data area. For this, it defined its data roadmap to support data transformation towards more data driven enterprises. In 2022, the company further strengthened its operations in these areas.

Technology Subsidiary

The Technology Company started its operations in 2012 to provide services to the Holding Group companies in the field of Information Technologies. The company focuses on customer satisfaction with its innovative, dynamic, solution-oriented, difference-creating, high value-added products, and services. In this respect, Technology Company, which prioritizes the quality approach and provides its services to its customers with optimum costs, realizes all the necessary infrastructure works in the field of Information Technology, and adaptation of systemic and software products. By applying modern technology in the information processing sector, it develops and supports technological projects. The Technology Company, which approaches its customers with a strategic understanding of cooperation, works in integration with the internal business

and information technology units of the organizations, determines the needs with proactive methods and develops products that provide a high level of solutions for current needs. Providing timely delivery and effective project management services by reflecting the strong technological and sectoral operation experience to the products, the company is reviewing and improving the methods that will keep customer satisfaction at the highest level [105].

Automotive Dealer Subsidiary

The company offers new vehicles, used vehicles, spare parts, accessory sales, and after-sales services, as well as insurance and financing services to its customers. It carries out authorized sales and services of major automotive brands and sells secondhand vehicles at authorized dealers. The company maintains its pioneering presence in the sector with its strength and stability, continuing its activities. Its mission is to provide the highest quality of sales and after-sales services for passenger and commercial vehicle brands it represents [106].

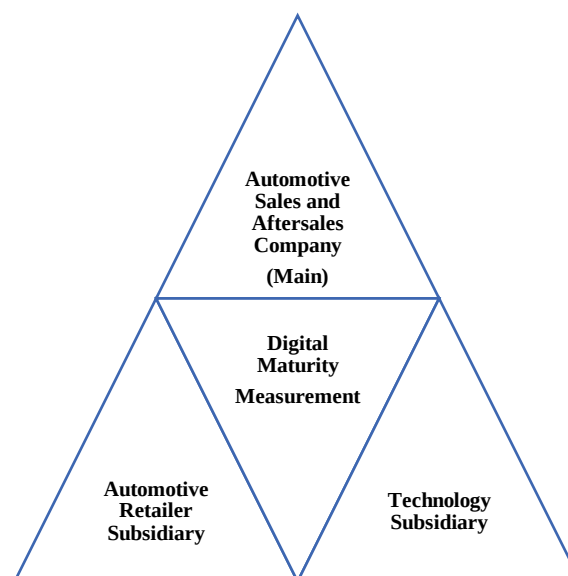


Figure 13: Venue Triangle

4.3.5 Role of Researcher

Action research aims to unite the strength of action and research towards discovering and managing transformational change. This research is not structured like action research. However, as the researcher is employed at a company at the same time, it brought it's the benefits and as well as the challenges during the implementation phase of the developed concept.

In this research, two different roles complemented each other. One of them is the researcher role and the other one is the organization employee. During the research, the main challenge became the differentiation between the employee and the researcher's hat.

The research questions in this research were not aimed to be found at the company of the implementation as in grounded research. Instead, the qualitative interviews conducted with the industry experts all over the companies, industries and countries and the literature review is done independently. However, it provided a chance to implement the outcome of the research at a company as the case study.

Having the two hats brought some benefits as well as some challenges. According to Garcia, Sabater, and Maheut, "research with a case study, action research, or grounded theory approach provides a way to study this complexity, and case report papers offer a way to report details that allow describing and standardizing future experiments" [107: 110]. Case study research provided evidence to the findings from the qualitative and the quantitative findings.

Information of the organization and the individuals and their relevant ideas, proposals and concerns were kept anonymized, but just kept blended with the research findings. One of the benefits it brought to the research is the diagnostic methods and

resources like observations, in depth interviews, index implementation, and feedback sessions. Another benefit was that people at the organization shared their interpretation of the findings more freely. Finally, it gave a chance to merge the experience, contribution and sources of the university and the industry.

Accompanying the benefits, it brought its own challenges such as time pressure, avoiding subjectivity, and having an outside look and remain an observer. The greatest challenge was to sustain objectivity during the research. To be able to maintain the objectivity during the whole research, I have tried to position myself at the more question raising side and tried to not comment on the feedback and avoid leading them towards answers. Rather than this, I tried to create a medium where they can freely express their opinion and comment.

Researcher Diary, Observations and Notes

As mentioned in the previous sections, in this research the researcher was wearing two hats: employee, and academic researcher. In the initial phases of the research from 2018-2020, the index improvement steps and qualitative run with external research, interviews, across country and industry input. In the second phase, index improvement sessions, index implementation, and after the implementation confirmatory qualitative interviews from the benefits of two hats provided a better understanding over the context, and conditions.

With the rise of the Covid 19 pandemic, the industry structure and business model were changed in 2020. More people had to convert their daily work and move to digital platforms. As digital transformation topic itself is a digital topic, in general the companies and the company where the case study takes place had to move more towards digital. These covid impacts which no one was able to interfere with accelerated the digitalization

in both companies and industry all over the world. Even the examples of the interviewees support this covid impact on the digitalization spread. From the employee's perspective, we felt uncertainty and had to learn how to deal with ambiguous situations as such pandemics.

The second thing based on the research diary and notes, as both researcher and an employee, we observed and experienced how to transform the business, daily work, and even physical meetings to online.

The third last point which can be highlighted is the trust provided as a researcher and an employee which provided a perfect environment where every idea can be freely discussed and further improved by keeping the identities anonymous.

The last point, as a researcher I believe that digital transformation is such a thing that can be definitely better explained by while you are going through it and experiencing it. So it was a great opportunity to map both theoretical information and business practices.

4.4 Results

The development of questions and the content of the rubrics was an outcome of a measure development procedure. In this research, digital maturity index development was built on Churchill's model [1].

According to Churchill [1: 72], "The following procedure is prepared to outline a purpose procedure which can be followed to develop better measures of variables. The framework represents an attempt to unify and bring together in one place that scattered bits of information on how one goes about developing improved measures that have been advanced." Based on the following model, there are 8 steps of developing a measure

which comes with recommended techniques. In Figure 14, in addition to the steps provided by Churchill, techniques which are implemented in this research are marked bold and additional techniques implemented are added in blue.

According to Churchill [1: 67], “The first step in the procedure for developing better measures involves specifying the domain of the construct. The researcher must be exacting in delineating what is included in the definition and what is excluded.”

This step is then followed by generating sample of items according to Churchill [1: 67]: “The second step in the procedure for developing better measures is to generate items which capture the domain as specified. Those techniques that are typically productive in exploratory research, including literature searches, experiences surveys, and insight stimulating examples [108]. The literature should indicate how the variable has been defined previously and how many dimensions or components it has”. Generating samples of items is followed by step three which is collecting data.

As the fourth step of Churchill [1: 68], they describe purifying the measure: “The calculations one performs in purifying a measure depend somewhat on the measurement model one embraces. The most logically defensible model is the domain sampling model which holds that the purpose of any particular measurement is to estimate the score what would be obtained if all the items in the domain were used [109]”.

After the measure is purified, data collection steps start again. After collecting the data, construct reliability and construct validity assessment starts with implementation of coefficient alpha and factor analysis. The results are checked after each iteration until scores reach digital maturity stage. At this stage, development of norms is completed.

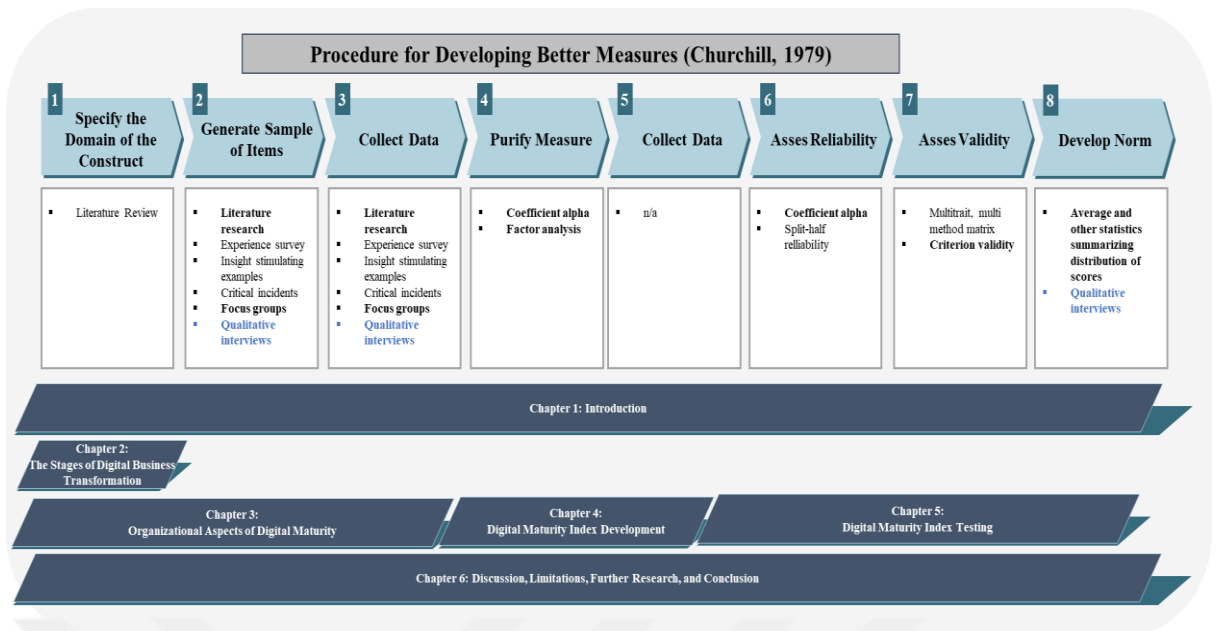


Figure 14: Procedure for Developing Better Measures by Churchill [1]

4.4.1 Results of Step 1 – Specify the Domain of the Construct (Stages of Digital Business Transformation as Digital Maturity Stages)

According to Churchill [1: 67], the process starts with specifying the domain of the construct: “The first step in the development procedure for developing better measures involves specifying the domain of the construct. The researcher must be exacting in delineating what is included in the definition and what is excluded.” Following this step, research was started with conducting literature review to identify the previous work in the digitization, digitalization, digital transformation areas. According to the findings of this step, digital business transformation stages were identified.

Based on the literature review of academic research, consulting studies, digital transformation is analyzed from the evolutionary perspective. According to the theory, digital transformation is handled based on five consecutive stages. One stage is the successor of the previous stage. Digital business transformation can be seen as a process of *consecutive* stages.

Next to the existing stages of *digitization*, *digitalization*, and *digital transformation*, two stages were added: *digital passive* and *digital transition*. Each stage is the successor of the previous stage. Therefore, the following five stages are proposed as the stages of digital business transformation.

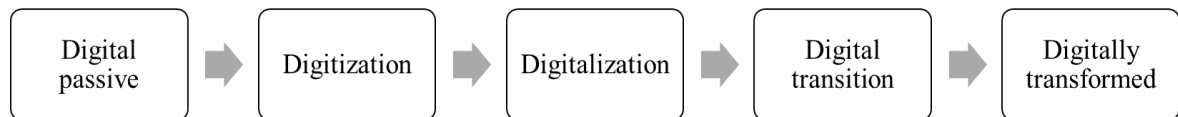


Figure 15: Digital Maturity Stages

Based on the outcome of Chapter 2, the following categories are considered as the stages of digital transformation.

- **Digital Passive:** Business and IT case by case work on digital issues just based on request and they are not coordinated. Target technologies and digital vision are not defined by organization.
- **Digitization:** Digitization can be defined as the conversion of analog information to digital format. Processes are digitized but digital initiatives are taken by business divisions or IT separately.
- **Digitalization:** Digitalization is defined as using digitized data and information to automate existing operations. Business divisions and IT developed competencies.
- **Digital Transition:** Transition stage from digitalization towards fully digital transformation. The culture of digital orientation exists. Digital technologies are used, and data and information are collected and analyzed for decision making.
- **Digital Transformation:** Digital transformation as the change of socio-economic structures (such as business models, supply chains, platforms, or ecosystems) as a consequence of the use of digital technology.

All in all, the synthesis of digital maturity stages and stage definitions underpins the rows of the index developed for the digital maturity measurement.

4.4.2 Results of Step 2, 3 – Generate Sample of Items and Collect Data (Organizational Aspects of Digital Maturity)

In addition to identification of digital business transformation stages based on *Step 1 Specifying the Domain of Construct* step of Churchill's model [1], in this part results of *Step 2 Generate Sample of Items* and *Step 3 Collect Data* are explained.

According to Churchill [1: 67]: “The second step in the procedure for developing better measures is to generate items which capture the domain as specified. Those techniques that are typically productive in exploratory research, including literature searches, experiences surveys, and insight stimulating examples [109]“. Generating samples of items is followed by step three which is collecting data.

In comparison to Churchill's recommended techniques, in this research at these steps it was utilized from literature review, focus groups, and qualitative interviews. Based on these techniques, digital business transformation stage or digital maturity stages form the rows of Digital Maturity Index and organizational aspects explained in Chapter 3 and form the columns of the DMI. This approach enables the organizations to measure maturity stage of the organizations per aspect: *culture, data and analytics, people, structure and organization, processes and systems, strategy*, and finally *technology*.

4.4.3 Results of Step 4, 5 – Purify Measure and Collect Data (Digital Maturity Index Questions, Rubrics, Scoring, and Construct Development)

In addition to the identification of digital business transformation stages and organizational aspects based on *Step 1 Specifying the Domain of Construct*, *Step 2*

Generate Sample of Items and *Step 3 Collect Data* steps of Churchill's model, in this part results of *Step 4 Purify Measure* and *Step 5 Collect Data* are explained.

Churchill [1: 68] describes purifying the measure as: "The calculations one performs in purifying a measure depend somewhat on the measurement model one embraces. The most logically defensible model is the domain sampling model which holds that the purpose of any particular measurement is to estimate the score what would be obtained if all the items in the domain were used [109]". After the measure is purified, data collection steps start again as *Step 5 Collect Data*.

Following the recommended techniques for *Step 4* and *Step 5* based on Churchill, in this research Coefficient Alpha and Factor Analysis were performed.

As mentioned in the previous chapters, columns and rows of the index were developed based on the literature review and the qualitative interview findings. On the other hand, Rubric Scaling and Scoring are determined based on digital maturity stages and scored from 1 to 5. In other words, the initial phase of digital maturity "digital passive" is scored as 1. The second phase, "digitization" is scored as 2. The following phase, "digitalization" is scored as 3. The fourth phase, "digital transition" is scored as 4. Finally, the last stage "digitally transformed" is marked as 5. In construct to the maturity stages, organizational aspects which are forming the rows are not represented with scores but instead with categories.

These findings formed the final Digital Maturity Index as a construct (Chapter 4) which was an outcome of Digital Maturity Index Development and Implementations' initial 5 steps; literature review and 1st round of interviews findings, DMI development and individual feedback sessions, Test phase 1, Test phase 2, and DMI implementation. These 5 steps correspond to Churchill's Procedure for Developing Better Measures 5

steps; *Step 1 Specify the Domain of the Construct*, *Step 2 Generate Sample of Items*, *Step 3 Collect Data*, *Step 4 Purify Measure*, and *Step 5 Collect Data*.

4.5 Discussion

This research aimed to answer the question of how to measure the digital maturity of an organization. To answer this research question, existing literature is investigated. Sixteen digital maturity assessment models identified in the literature as the prominent models including both academicians and practitioner models. Among these models several differences were observed which can be grouped into two categories: *digital maturity stages* and *digital maturity measurement model development method*.

The first category is “*digital maturity stages*”. There are three maturity stage scaling approaches observed: *based on numbers*, *based on stage naming*, and *based on a statement regarding agree disagree* ([58]; [7]; [2]; [59]) based their scaling on *numbering*. Their proposed scale ranges vary from level 0-6, or level 1-5, or level 1-5 ([25]; [4]; [27]; [46]; [23]) based their scaling on *stage naming* such as incomplete, performed, managed, established predictable, innovating, digital awareness, digital enquirement, digital collaboration, digital transformation, not started, initiating, enabling, integrating, optimizing pioneering, initial, defined, quantitatively managed, optimizing, digital starter, digital literate, digital performer, digital leader, ambitious transformer, smart digitalist, reactive participant, digital operator. Furthermore, ([22]; [63]) based their scaling on *a statement regarding agree disagree* such as a Likert scale; “strongly agree” (6) or “agree” (5); “strongly disagree” (1) or “disagree” or “0–do not agree” to “4–fully agree” and “I don’t know”.

In comparison to these scaling types, this research’s findings differentiate itself by focusing on the evolutionary perspective of digital business transformation. Based on

the findings of literature review, the ontology for most frequent words associated to these stages, and also their testing with the expert interviews, it is concluded that digital business transformation is progressing and evolutionary in stages, where one stage is the successor of the previous stage. In addition to, existing stages of digitization, digitalization, and digital transformation, two stages were added: digital passive and digital transition. Each stage and their definitions proposed as successive and progressing stages. Therefore, 5 stages proposed as (i) *digital passive* to (ii) *digitization*, over (iii) *digitalization*, and (iv) *digital transition* to (v) *digital transformation*.

The second category is “*digital maturity measurement model development method*”. Several methods were used for the digital maturity model development. Gökalp & Martinez ([4]; [27]) utilized from cross-case comparison. According to Gökalp & Martinez ([4]; [27]) the application and usability of the developed DX-CMM were verified by the multiple case study and the method for conducting DX maturity assessment were explained. They also gave the results of a multiple case study analysis based on two different organizations were given. Gökalp & Martinez ([4]; [27]) triangulated the questions sets and collected feedback from at least three people, and also collected data was also validated by the stakeholders. However, Teichert [62] performed systematic model comparison.

In comparison to existing model development approaches, in this research the model was developed for stage-wide digital business transformation. The model developed based on literature review, ontology, and expert interviews. However, model development was not limited by qualitative research. The detailed questionnaire was tested quantitatively, and the results triangulated again with the expert interviews with 9 individual experts, and 2 pilot sessions with a group of 9 experts for each pilot session.

Therefore, the main differentiation in comparison to the other models is the triangulation method which is strengthened by academic and practical contribution and feedback.

4.6 Conclusions

In this chapter, the research question aimed to answer, “*How do we measure the digital maturity level of the organization?*” To answer this question, the initial introduction explained the organization’s digital maturity and the stages of digital business transformation which are proposed to be the digital maturity stages of the organization. Following the definition of digital maturity, steps of the measure development procedure were explained and how they were implemented during the Digital Maturity Index development.

Based on the literature, it was found that there is a gap that can be strengthened in the academic vs practical implication of the maturity models. In this research, it was aimed to contribute to this area by uniting the strengths of both academia and business practice during the maturity model development process. In addition to the literature review findings, by involving both the academicians and the business and IT experts in the process of the index development and getting feedbacks through the iteration loops and pilots, the practical implications and the academic validity potential of the index were strengthened.

CHAPTER V

DIGITAL MATURITY INDEX TESTING

Companies are taking initiatives towards transforming their businesses through organizational aspects such as strategy, culture, systems, processes, structures, education, etc. However, one of the problems they are encountering is the measurement of what they have accomplished. In Chapter 2 “The Stages of Digital Business Transformation” and Chapter 3 “Organizational Aspects of Digital Maturity”, the rational background of development of digital business transformation stages and organizational aspects of the Digital Maturity Index are explained. In Chapter 4, these findings are used as the foundation to construct the Digital Maturity Index and its rubrics. As a complementary approach, this chapter covers the approach and results of implementation of the Digital Maturity Index at an automotive company and it also covers the follow-up interviews with the experts after the implementation.

The findings of “*Chapter 4 – Digital Maturity Index Development*” explained the steps of purifying measures. The output of Chapter 4 provides a maturity assessment instrument called Digital Maturity Index (DMI) to the companies. In Chapter 5, DMI is validated as a case study at an automotive sales and aftersales company.

The fifth chapter aims to analyze the findings from Digital Maturity Index implementation and the findings from the qualitative interviews afterwards. Therefore, the outcome of this chapter is having a purified measure.

Keywords: *Digital Maturity Index, Digital Maturity Measurement, Digital Acceleration, Digital Business Transformation, Business Transformation.*

5.1 Introduction

By building on the findings and the construct development of the initial chapters, the focus of this chapter is the implementation of the developed tool at an organization as a case study. Therefore, this chapter focuses on the following research questions:

*Q4: How can a Digital Maturity Index (DMI) as an instrument be validated?
(What is the digital maturity level of the automotive company where the research is taking place at t0?)*

In order to answer these research questions, a mix of qualitative and quantitative methods are used based on the data gathered from a case study at an automotive sales and aftersales company.

5.2 Method and Data

5.2.1 Digital Maturity Index Implementation

The research is designed in eight steps. As mentioned in Chapter 1, 2, 3, and 4, eight steps of *Digital Maturity Index (DMI) Development and Implementation* are synchronized with *Churchill's Procedure for Developing Better Measures* [1] steps. The fifth of them belongs to the development process and the following three processes are after the DMI implementation.

Digital Maturity Index Development Process (Steps 1-5)

The first step is “*Literature Review and 1st Round of Interview Findings*” and “*Specify the Domain of the Construct*” which was designed as an unstructured interview format to collect general understanding data on digital transformation and technology and doing literature research to generate measurement questions and rubrics. The second step

“Generate Sample of Items” or *“DMI Development and Individual Feedback Sessions”* is designed as an assessment tool development for the measurement of the company’s digital maturity stage through individual feedback session. The third step *“Collect Data”* or *“Test Phase 1”* is the initial test phase with the industry experts. After updating the index based on the initial test phase, the fourth step *“Purify Measure”* or *“Test Phase 2”* is the second test with the industry experts. After reviewing the questions and gathering feedback from the industry experts and academics, some adaptations and amendments in the questionnaire were done. The fifth step *“Collect Data”* or *“DMI Implementation”* is designed for the actual digital maturity measurement of the company.

Process After Digital Maturity Index Implementation (Steps 6-8)

After DMI is developed, the next step is the implementation. The developed index is implemented, and the data is analyzed. Therefore, the sixth step *“Assess Reliability”* or *“DMI Results and Qualitative and Quantitative Analysis”* is analyzing the data gathered from the Digital Maturity Index implementation at the company and qualitative and quantitative analysis including statistical validity and reliability analysis based on the maturity measurement results. The seventh step *“Assess Validity”* or *“2nd Round of Interviews Findings and Improvement Areas”* is the participant feedbacks after the DMI implementation and interviews with the experts. As the final and eighth step *“Develop Norm”* or *“Finalize DMI Instrument”*, based on the validity and reliability statistical analysis and the qualitative analysis, the replicating or unclear questions were eliminated to finalize the DMI as an instrument.

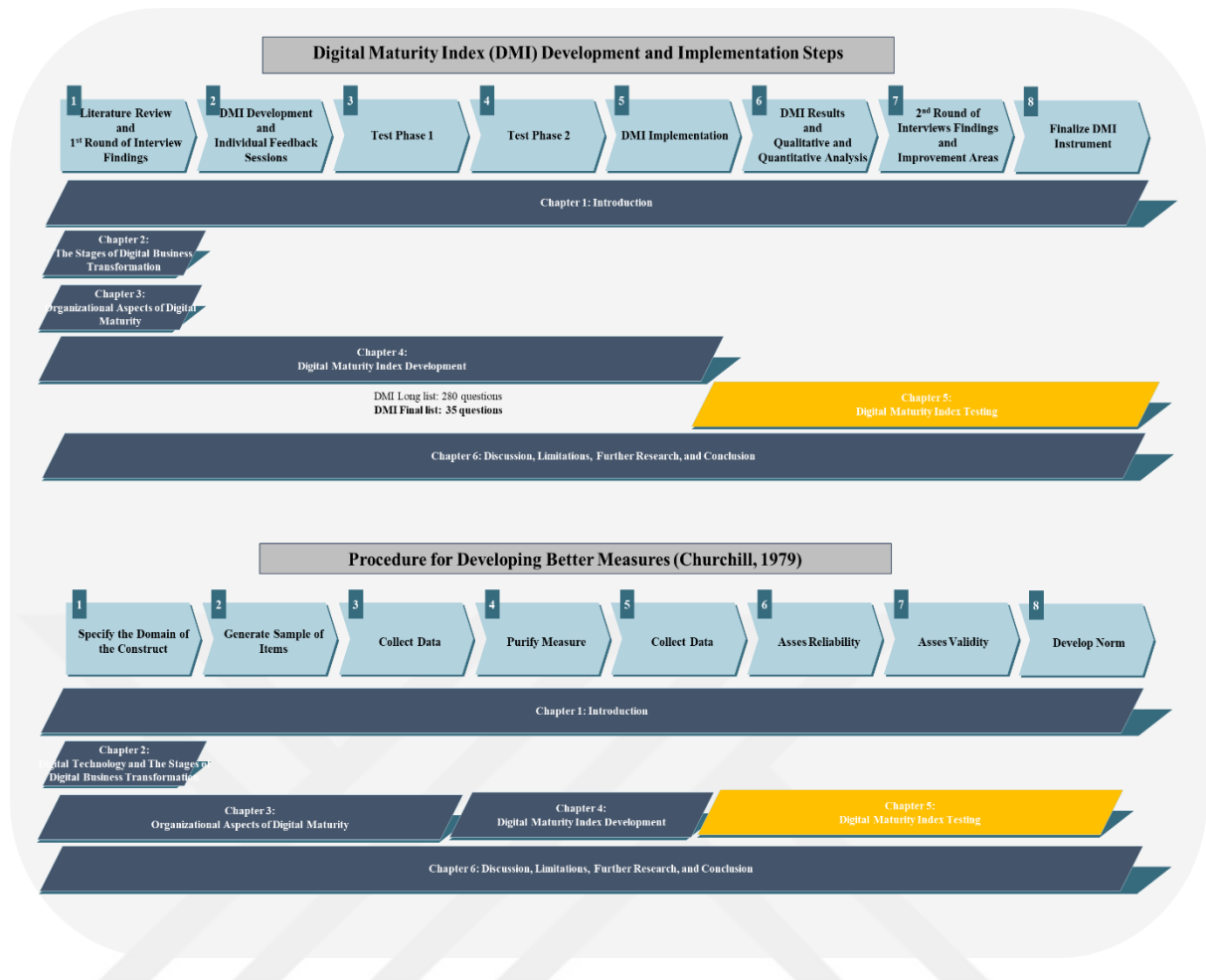


Figure 16: Digital Maturity Index Development Phases and Implementation

5.2.2 Digital Maturity Index to Measurement and Participants

Measurement Process

As *Step 5 DMI Implementation* of Digital Maturity Index Development and Implementation Steps, Digital Maturity measurement process is organized in a workshop format where the participants can select the most convenient option of the questionnaire. Based on their evaluation, they can also raise their opinions and ask questions regarding the questions on the DMI questionnaire.

There were 43 people split into two separate workshop groups where each group has around an equal number of representatives from different roles. Each session was

planned as 2.5 hours. The timing of the workshops was planned as a 2.5-hour workshop with the logic of making a 15-minute introduction on the research, content, and expectations and then allocating the rest of the time for answering 35 questions, about 3 minutes per question. The was sent as a link to the participants and questions were discussed one by one depending on the demand coming from the workshop participants. The collected data was kept anonymous. The names of the participants were kept anonymous, but positions were requested for the role-based analysis.

Participants

Participants represented groups of End users, IT professionals, Business professionals and Managers based equally on brands and support functions. It was aimed to carry out the study with the contributions and opinions of 43 participants from 4 different groups. The reason for the participatory support request from End-user, IT professionals, Business experts and Manager groups was to capture perspectives and areas of improvement from different groups in terms of digital maturity insights and contributions.

- **Business experts / Mid-Level Management:** Business Owners who actively support digitalization efforts.
- **IT experts / Implementers / ICT Experts:** Technological Product Owners who actively support digital project studies and contribute to technology perspective, implementation, and processes.
- **End users / Beneficiaries:** Employees who contribute to digitalization study on a product basis and from the end-user perspective of the systems.

- **Managers / High-Level Management:** The managers who lead teams and contribute to the study from general management, culture, strategy, and similar perspectives.

Participant's roles and their split is visualized in Figure 17.

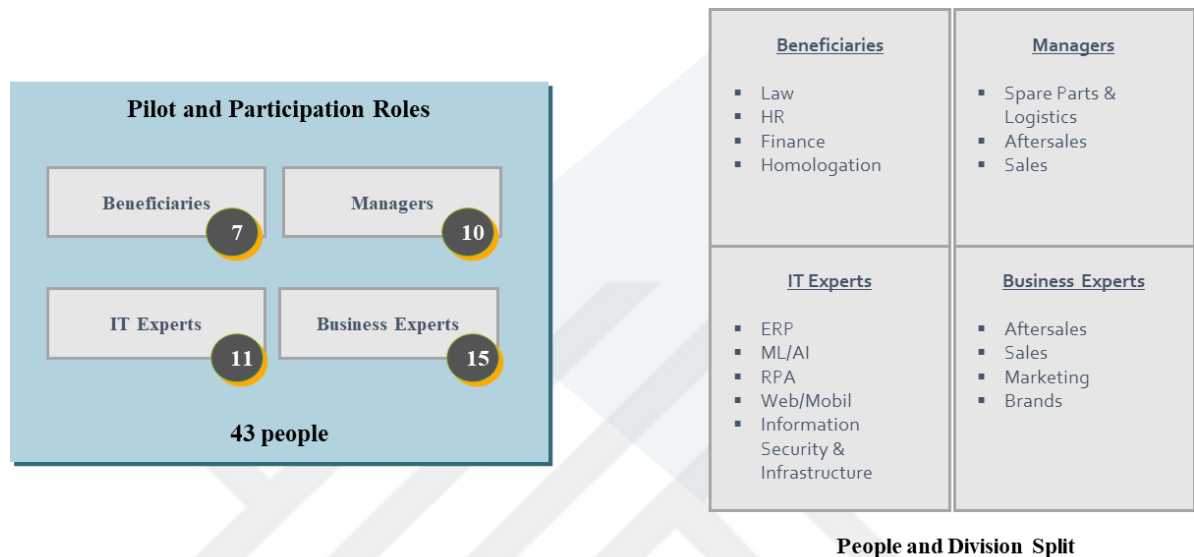


Figure 17: Digital Maturity Index Measurement Stage and Participant Groups

After the finalization of DMI and the completion of the pilot phases, the actual digital maturity measurement workshops were planned. As the research questions are “What is the organizations digital maturity stage at t0? How do we measure the digital maturity stage of the organization?”, the initial t0 measurement was planned to do analysis on the digital maturity score of the organization.

The aim of this measurement was to measure the initial digital maturity stage of the company, so that in the upcoming periods (from 6 months to 1 year) the research can be replicated, and the progress can be measured over time. Initial t0 measurements took place in the last 2 weeks of January 2022.

5.2.3 DMI Implementation Results, Findings and Improvement Areas

After the implementation of the DMI, as *Step 6 DMI Results and Qualitative and Quantitative Analysis* of Digital Maturity Index Development and Implementation Steps and *Step 6 Assess Reliability* of Procedure for Developing Better Measures by Churchill [1], data of DMI implementation was analyzed. As a part of *Step 7 Second Round of Interviews Findings and Improvement Areas* of Digital Maturity Index Development and Implementation Steps and *Step 7 Assess Validity* of Procedure for Developing Better Measures by Churchill [1], the results are shared with the participants. To discuss the DMI results, a workshop session was organized. During this workshop, an action plan and improvement areas were developed.

5.2.4 Second Round of Interviews after Digital Maturity Index Implementation

After DMI implementation, as *Step 7 Second Round of Interviews Findings and Improvement Areas* of Digital Maturity Index Development and Implementation Steps and *Step 7 Assess Validity* of Procedure for Developing Better Measures by Churchill [1], second interview rounds took place with 9 experts who also participated in DMI workshop. These interviews were conducted between July-September 2022.

After DMI t0 measurement, interviews with the selected experts were organized and they contributed to the research voluntarily. The experts were equally distributed over IT functions, support functions and brands. The expert interview list for the second round is as follows:

Table 19: Second Round of Interview Participant List

Area	Nr of Interviews
IT Experts (ERP, Data, Cybersecurity, Web/Mobil, Manager)	2 people
Managers	2 people
Business Experts	3 people
Beneficiaries	2 people

After conducting interviews with 9 experts, the digital maturity stage of the feedback and the questionnaire was saturated. In the second round of interviews, the target was to fill in gaps between the DMI data analysis and getting the expert views. The following questions were raised during the interviews:

Table 20: Second Round of Interview Question List

General Interview Questions (IR)	Cluster Based Interview Questions (IR)
1. How do you evaluate the culture score? 2. How do you evaluate the data and analytics score? 3. How do you evaluate the people, structure and organization score? 4. How do you evaluate the processes and systems score? 5. How do you evaluate the strategy score? 6. How do you evaluate the technology score? 7. Why do Managers score higher in Culture, Data and Analytics, People, Structure and Organization, and Processes and Systems aspects in comparison to Beneficiaries, Business Experts, and IT Experts? 8. Why do you think Data and Analytics scores are lower than other aspect scores? 9. Why do you think Culture and Strategy aspects scored higher on average?	1. What is technology? 2. What is digital technology? 3. Which technologies are you aware of? 4. Are you implementing those technologies? 5. Which technology has the highest impact in your industry? 6. How and why did you select those technologies? Age 1. Why do you think culture, strategy and technology score increases by the increase of age? Education 1. Why do you think social and positive science backgrounds scored higher on strategy and technology score? 2. Why are processes and system scores closer? 3. Why do business administration and fundamental sciences such as math, physics backgrounds score higher on people, strategy, and organization scores?

10. Why do you think IT Experts score highest in Strategy and Technology categories? 11. Why do you think IT Experts score higher in Processes and Systems categories? 12. Do you see any improvement area? Or any ideas for action development? (For the questionnaire & for the score improvement)	Experience 1. Why do you think people with 5-10 years and more than 20 years of work experience scored higher on culture score? 2. Why do you think people with 2-5 years of work experience scored higher on data analytics, people, structure and org and strategy, technology aspects? Digital Work Frequency 1. Why do you think people who declare that they work frequently on digital topics scored higher than all other scores? 2. Further questions “Why?” questions we generated based on per question from the DMI, based on the discussions.

5.3 Test Results of Digital Maturity Index

5.3.1 Results of Digital Maturity Index Implementation

DMI implementation workshops were organized in 2 sessions. Each of the sessions are represented by a similar number of people. The general score is calculated by utilizing the consolidated results of 43 participants.

Digital Maturity Index Participation

In total 43 experts contributed to the DMI implementation. Based on the role split, numbers and roles of the experts can be grouped as follows:

Table 21: DMI Participant Split Based on Roles

Participation Role	Number of Participants
Beneficiaries	7
Business Experts	15
IT Experts	11
Managers	10
Total	43

General Digital Maturity Index Score

The DMI score is calculated per organizational aspect including the responses of 43 experts. According to the data analysis, the total digital maturity score of the company was as 3.32; while culture score is 3.53; the data and analytics score is 2.89; the people, structure and organization score is 3.18; the processes and systems score is 3.36; the strategy score is 3.52; technology score is 3.46.

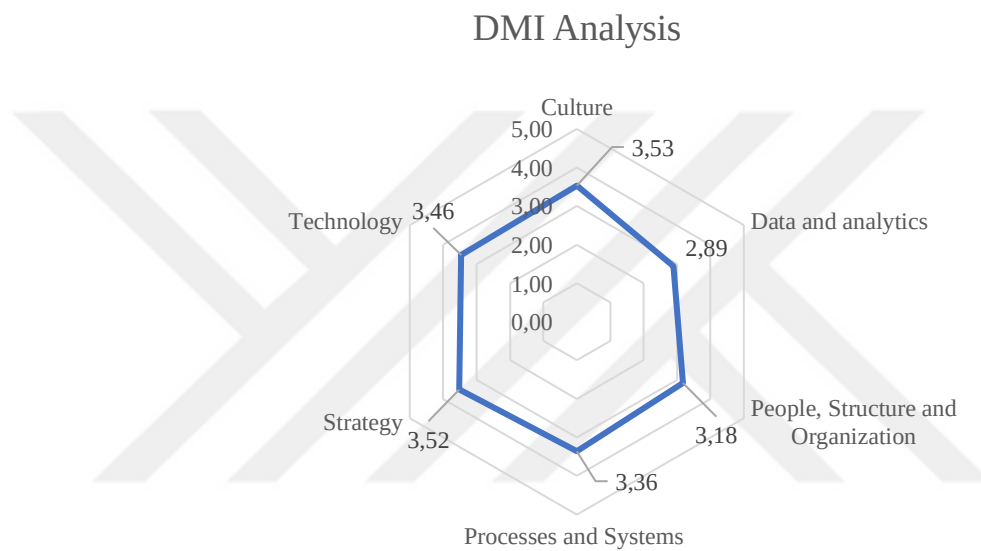


Figure 18: DMI Score

Culture scores (3.53) ranked highest among the other aspects. Culture (3.53) and strategy (3.52) scores are close to each other, and they are followed by the technology score (3.46). The Data and analytics aspect (2.89) is the lowest score among all aspects, a larger improvement area.

Table 22: DMI Score per Organizational Aspect

Organizational Aspect	Score
Culture	3.53
Data and Analytics	2.89
People, Structure and Organization	3.18

Processes and Systems	3.36
Strategy	3.52
Technology	3.46
Total	3.32

Demographic Info

Based on the statistical analysis of the questionnaire results, more than 60% of the participants declared that digitalization or digital related topics are part of their daily work. Moreover, more than 60% of the survey participants have 10-20 years of work experience and more than 50% have been working in their current job for 2-5 years long.

Participants split among the departments equally. More than 30% of the participants are working on the mid-manager level. More than 40% of the participants are around 30-40 years old. Finally, according to the results more than 38% of the participants are around 40-50 years old.

Position/Role Based Digital Maturity Index Scoring

There are several differences observed among the groups. Differences and their interpretation during the feedback and brainstorming sessions can be highlighted as follows:

Managers score higher in *Culture, Data and Analytics, People, Structure and Organization*, and *Processes and Systems* aspects in comparison to Beneficiaries, Business Experts, and IT Experts. It could be either because they have a bigger picture of the topics, or it could be because they are not operationally working on the topic. Secondly, IT Experts score highest in the Strategy and Technology categories. Finally, IT Experts score higher in Processes and Systems categories. (Table 23 & Figure 19)

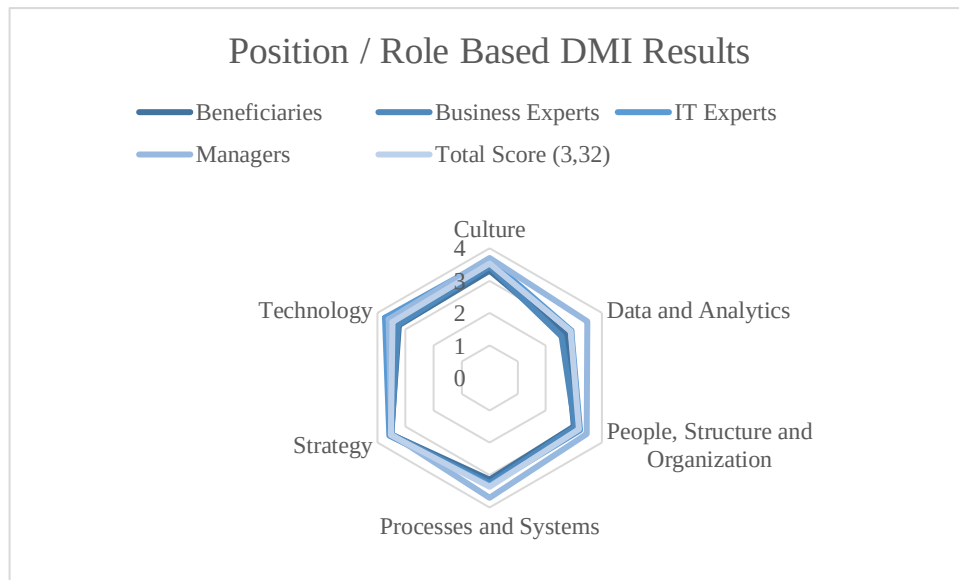


Figure 19: Role Based DMI Results

Table 23: Role vs Organizational Aspect Results

Score vs. Role	Culture	Data and Analytics	People, Structure and Organization	Processes and Systems	Strategy	Technology
Beneficiaries	3.31	2.69	3.00	3.14	3.51	3.24
Business Experts	3.43	2.57	3.04	3.25	3.50	3.27
IT Experts	3.65	2.91	3.22	3.32	3.57	3.73
Managers	3.70	3.48	3.46	3.70	3.50	3.60
Total Score (3.32)	3.53	2.89	3.18	3.36	3.52	3.46

Age Based Scoring

In addition to position-based results, age-based analysis was done. Based on the findings, it was observed that culture, strategy, and technology scores are increasing as the age increases. (Figure 20 & Table 24)

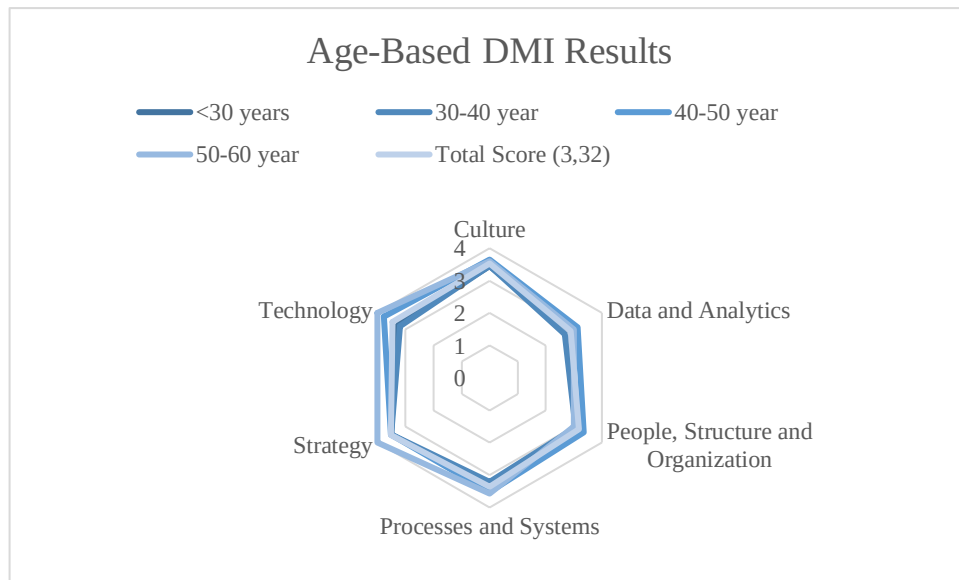


Figure 20: Age Based DMI Results

Table 24: Age vs Organizational Aspect Results

Score vs. Age	Culture	Data and Analytics	People, Structure and Organization	Processes and Systems	Strategy	Technology
<30 years	3.45	2.88	3.13	3.34	3.51	3.33
30-40 year	3.46	2.68	3.06	3.21	3.51	3.20
40-50 year	3.65	3.13	3.35	3.52	3.51	3.77
50-60 year	3.60	3.00	3.00	3.57	4.00	4.00
Total Score (3.32)	3.53	2.89	3.18	3.36	3.52	3.46

Education Based Scoring

Age based data analysis was followed by education-based analysis. The participants who graduated from Social Sciences (Psychology, Sociology, etc.) or Positive Sciences (Mathematics, Physics, etc.) scored higher in strategy and technology. It was also found that processes and systems are closer to each other and are parallel. The participants who hold degrees in Business Administration, Marketing, Finance and

Positive Sciences (Mathematics, Physics, etc.) score higher at people, structure, and organization. (Table 25 & Figure 21)

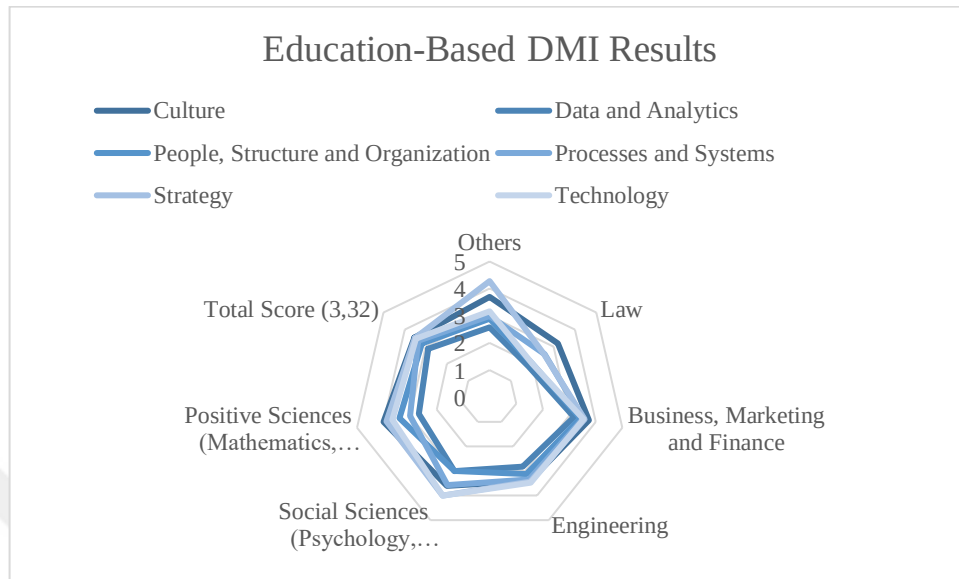


Figure 21: Education Based DMI Results

Table 25: Education vs Organizational Aspect Results

Score vs. Education	Culture	Data and Analytics	People, Structure and Organization	Processes and Systems	Strategy	Technology
Others	3.70	2.58	2.90	3.00	4.28	3.17
Law	3.20	1.83	2.00	2.57	2.56	2.00
Business, Marketing and Finance	3.74	3.18	3.42	3.52	3.58	3.54
Engineering	3.40	2.81	3.12	3.34	3.43	3.47
Social Sciences (Psychology, Sociology, etc.)	3.60	3.00	3.00	3.57	4.00	4.00
Positive Sciences (Mathematics, Physics, etc.)	4.00	2.67	3.40	3.00	3.89	3.67
Total Score (3.32)	3.53	2.89	3.18	3.36	3.52	3.46

Experience Based

Furthermore, education-based analysis was followed by experience-based analysis. Participants who have 5-10 years of work experience and more than 20 years of work experience have higher culture scores. Participants with 2-5 years of work experience have higher data analytics, people, structure and organization, strategy, and technology scores. (Table 26 & Figure 22)

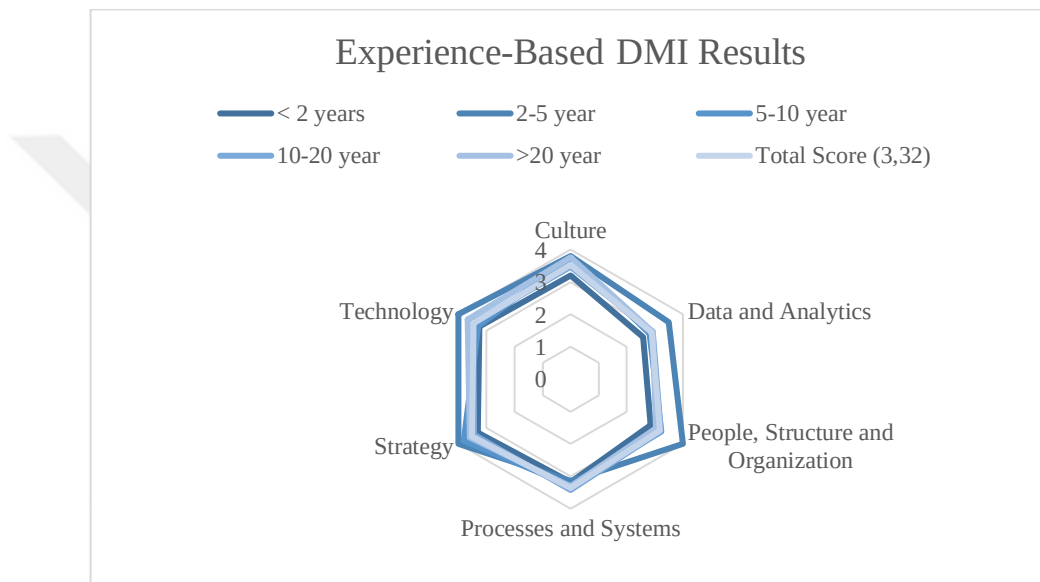


Figure 22: Experience Based DMI Results

Table 26: Experience vs Organizational Aspect Results

Score vs. Experience	Culture	Data and Analytics	People, Structure and Organization	Processes and Systems	Strategy	Technology
< 2 years	3.20	2.58	2.85	3.18	3.31	3.25
2-5 year	3.80	3.50	4.00	3.14	4.00	4.00
5-10 year	3.74	2.81	3.23	3.29	3.81	3.29
10-20 year	3.47	2.92	3.21	3.42	3.44	3.47
>20 year	3.76	2.93	3.04	3.31	3.60	3.67
Total Score (3.32)	3.53	2.89	3.18	3.36	3.52	3.46

Frequency Based

Around 60% of the participants declared that they are working frequently on and with digital topics in their daily work. Among the participants who declared that they are working frequently on digital topics have higher scoring almost on all organizational aspects. (Table 27 & Figure 23)

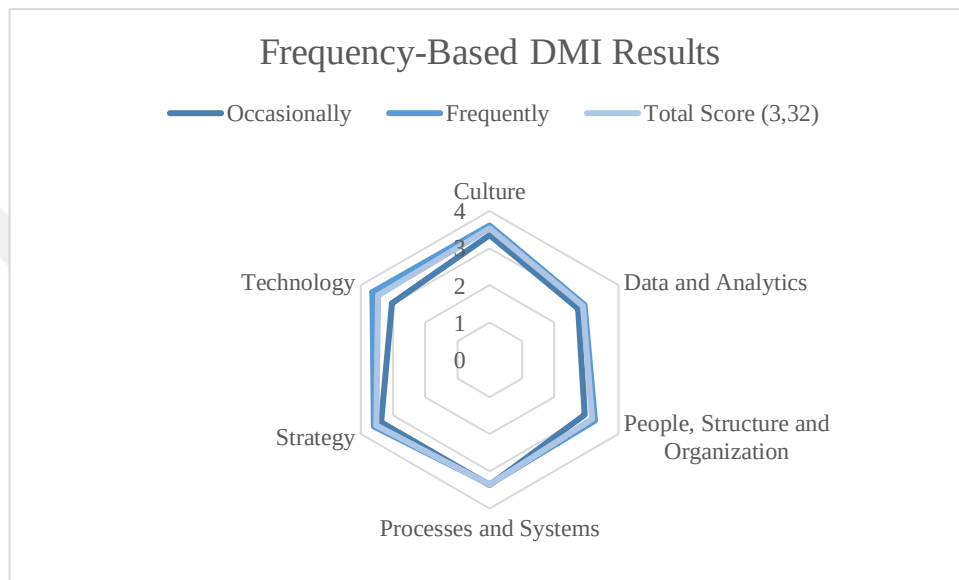


Figure 23: Frequency Based DMI Results

Table 27: Frequency vs Organizational Aspect Results

Score vs. Frequency of Working with Digitalization	Culture	Data and Analytics	People, Structure and Organization	Processes and Systems	Strategy	Technology
Occasionally	3.35	2.74	2.95	3.37	3.37	3.03
Frequently	3.61	2.95	3.27	3.35	3.59	3.64
Total Score (3,32)	3.53	2.89	3.18	3.36	3.52	3.46

The results were collected in Google Forms format as depicted in the following figure.

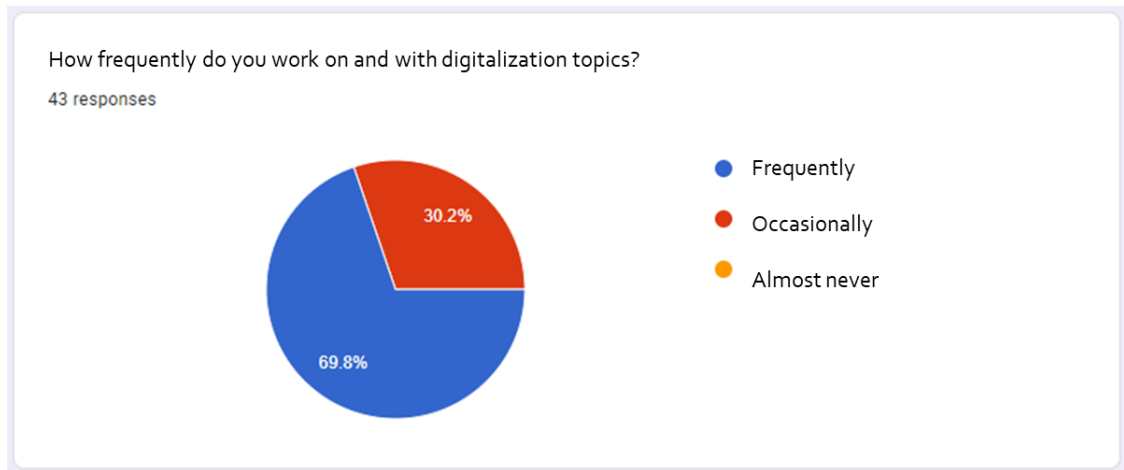


Figure 24: Pie Chart Example for Questionnaire Implementation

5.3.2 Statistical Results of Digital Maturity Index Implementation

After the implementation of DMI, results of the complete questionnaire gathered during the workshops were inserted into a SPSS program to perform descriptive analysis, independent t-test with 95% confidence interval, ANOVA, and boxplot based on age, education, role, experience, etc. per question. These analyses were performed for all the questionnaire results, as well as per construct. ANOVA was performed between role-based groups Business Expert, IT Expert, Manager, Beneficiaries with 95% Confidence Interval.

Based on the findings of these statistical tests, the variance of questions 5, 6, 7, 8, 9, 14, 22, 23, 25, 35 was identified as high. Among the culture questions, as p value is greater than 0.05, question 5 is found not statistically significant. Among the people, structure, and organization questions, as p value is greater than 0.05, question 4 is found to be not statistically significant. Among strategy questions, as p value is greater than 0.05, question 25 is found to be not statistically significant. Among technology questions, as p value is greater than 0.05, question 5 is found to be not statistically significant (Appendix A, Figure 25, and Table 28).

On the other hand, among the data and analytics questions, question 7 and 11's p values are smaller than 0.05. Therefore, these questions are statistically significant questions. When ANOVA was performed, it was found that questions 6, 7, 11 are statistically significant between business experts and manager (Appendix A, Figure 25, and Table 28).

Furthermore, among the processes and systems questions 18 and 19's p values are smaller than 0.05. Therefore, this question is statistically significant questions. When ANOVA was performed, it was found that question 19 is statistically significant between business experts and managers and question 18 and 19 are statistically significant between Managers and Beneficiaries. (Appendix A, Figure 25, and Table 28)

The importance of this statistical analysis comes from the validation of the model. Through this analysis, academically and practically developed maturity measurement instrument is statistically validated based on the empirical data of sample of 43 participants. Based on the variance, ANOVA, and p scores, the statistical results shade light on potential questions which can be discussed further in detail in the 2nd Round of Expert Interviews. A summary of these statistical analyses is reflected in Table 28.

Table 28: Descriptive, ANOVA, Indep t-Test Analysis Summary

Organizational Aspect	Variance	ANOVA* between groups	Independent t-Test
Culture	Question 5	P > 0,05 not statistically significant	Not significant
Data and Analytics	Question 6, 7, 8, 9	Question 7 & 11 P < 0.05 statistically significant	For Question 6,7,11 P < 0.05 statistically significant between <i>Business Experts</i> and <i>Managers</i>
People, Structure, and Organization	Question 14	P > 0.05 not statistically significant	Not significant

Processes and Systems	Question 22, 23	Question 18 & 19 P < 0.05 statistically significant	For Question 19 - P < 0.05 statistically significant between <i>Business Experts</i> and <i>Managers</i> For Question 18,19 - P < 0.05 statistically significant between <i>Managers</i> and <i>Beneficiaries</i>
Strategy	Question 25	P > 0.05 not statistically significant	Not significant
Technology	Question 35	P > 0.05 not statistically significant	Not significant

Descriptive Statistics												
	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Mean		Std. Deviation Statistic	Variance Statistic	Skewness		Kurtosis	
					Statistic	Std. Error			Statistic	Std. Error	Statistic	Std. Error
Question 1 Score	44	3,00	2,00	5,00	3,5349	,12738	,84493	,714	,370	,357	-,536	,702
Question 2 Score	44	3,00	2,00	5,00	3,4419	,13524	,89708	,805	,385	,357	-,552	,702
Question 3 Score	44	3,00	2,00	5,00	3,9070	,10185	,67562	,456	-,355	,357	,540	,702
Question 4 Score	44	3,00	2,00	5,00	3,5116	,09953	,66024	,436	,463	,357	-,067	,702
Question 5 Score	44	4,00	1,00	5,00	3,2558	,15624	1,03639	1,074	-,025	,357	-,257	,702
Question 6 Score	44	4,00	1,00	5,00	2,9302	,15726	1,04315	1,088	,790	,357	-,062	,702
Question 7 Score	44	4,00	1,00	5,00	2,9535	,16564	1,09870	1,207	-,234	,357	-,341	,702
Question 8 Score	44	4,00	1,00	5,00	2,6279	,18399	1,22043	1,489	,211	,357	-,156	,702
Question 9 Score	44	4,00	1,00	5,00	2,9767	,16089	1,06724	1,139	,409	,357	,051	,702
Question 10 Score	44	4,00	1,00	5,00	3,0233	,13597	,90189	,813	-,048	,357	1,104	,702
Question 11 Score	44	4,00	1,00	5,00	2,8140	,14633	,97063	,942	,397	,357	-,431	,702
Question 12 Score	44	4,00	1,00	5,00	3,1628	,12135	,80493	,648	,243	,357	1,183	,702
Question 13 Score	44	3,00	2,00	5,00	3,3256	,14438	,95773	,917	,277	,357	-,761	,702
Question 14 Score	44	4,00	1,00	5,00	2,5814	,17877	1,18582	1,406	,542	,357	-,392	,702
Question 15 Score	44	3,00	2,00	5,00	2,9535	,12573	,83397	,696	,848	,357	,613	,702
Question 16 Score	44	2,00	3,00	5,00	3,8605	,08341	,55327	,306	-,054	,357	,271	,702
Question 17 Score	44	4,00	1,00	5,00	3,5581	,14650	,97175	,944	-,889	,357	1,476	,702
Question 18 Score	44	3,00	2,00	5,00	3,0698	,12757	,84620	,716	,585	,357	,014	,702
Question 19 Score	44	4,00	1,00	5,00	2,9535	,14155	,93891	,882	,450	,357	-,181	,702
Question 20 Score	44	3,00	2,00	5,00	3,5116	,12747	,84557	,715	,445	,357	-,493	,702
Question 21 Score	44	3,00	2,00	5,00	4,6744	,09034	,59926	,359	-2,426	,357	7,930	,702
Question 22 Score	44	4,00	1,00	5,00	2,9070	,16196	1,07431	1,154	,194	,357	-,750	,702
Question 23 Score	44	4,00	1,00	5,00	2,8140	,16013	1,06216	1,128	,637	,357	-,885	,702
Question 24 Score	44	3,00	2,00	5,00	4,1163	,13090	,86829	,754	-,684	,357	-,262	,702
Question 25 Score	44	4,00	1,00	5,00	3,6512	,16541	1,09722	1,204	-,461	,357	-,201	,702
Question 26 Score	44	3,00	2,00	5,00	3,6279	,11274	,74781	,559	-,637	,357	,277	,702
Question 27 Score	44	3,00	2,00	5,00	3,8837	,10885	,72205	,521	-,201	,357	-,100	,702
Question 28 Score	44	3,00	2,00	5,00	3,4651	,11879	,78796	,621	,121	,357	-,250	,702
Question 29 Score	44	3,00	2,00	5,00	3,6279	,13803	,91558	,838	-,303	,357	-,595	,702
Question 30 Score	44	4,00	1,00	5,00	3,4186	,13497	,89527	,802	-,965	,357	,944	,702
Question 31 Score	44	4,00	1,00	5,00	2,4651	,13927	,92382	,853	1,127	,357	1,203	,702
Question 32 Score	44	3,00	2,00	5,00	3,3721	,10293	,68279	,466	,261	,357	,156	,702
Question 33 Score	44	4,00	1,00	5,00	3,5581	,12296	,81561	,665	-,331	,357	1,179	,702
Question 34 Score	44	3,00	2,00	5,00	3,5581	,13524	,89708	,805	-,385	,357	-,552	,702
Question 35 Score	44	4,00	1,00	5,00	3,2558	,18130	1,20258	1,446	-,188	,357	-,995	,702
Valid N (listwise)	44											

Figure 25: DMI Complete Questionnaire Descriptive Statistical Analysis

5.4 Testing the Conceptual Model and Confirmatory Factor Analysis

After the development of the index in chapter 4 through qualitative interviews and the literature review, this chapter provided a unique opportunity to implement a tool case study at an automotive industry company. For testing the conceptual model, 2 forms of test mechanisms were performed: first the discussion of the implementation results with the experts in a qualitative interview format and secondly performing statistical tests such as Cronbach Alpha analysis and confirmatory factor analysis.

The digital maturity measurement instrument was developed with rubrics for stage-wide transformation. That is the logic of the interval scale. However, since the scales are well-developed and tested, use statistical methods were with care. The “care” is in the triangulation with the qualitative interviews. Therefore, the measurement instrument was not developed for quantitative testing. Instead, the scales were developed. During the scale development, not only relied on qualitative data, but also quantitative data. Therefore, in this research an extra triangulation method was used.

5.4.1 Quantitative Metric for Reliability and Quality Indicators of Research (Reliability, Replicability, Validity)

The first analysis starts with questioning what types of relationship are being examined. In this research, the answer for this question is interdependence. The following analysis is the questioning of the structure among variables, cases, respondents, or objects. As in this research, the aim is to measure the relationship between constructs and variables. The next question that came to mind is whether to perform factor analysis or confirmatory factory analysis. In the initial chapters of this research, based on the literature review and the qualitative interviews, the construct, items within the constructs

and the rubrics defined. Therefore, rather than the principal factor analysis, confirmatory factor analysis is performed [110].

5.4.2 Reliability and Validity Analysis

The validity and reliability of the measure is a critical concern for the measure to be implemented or used for further research. Validity aims to explain to what extent a measure truly measures what it aims to measure. On the other hand, reliability is to what extent results can be reproduced when every condition is satisfied on the same level. Reliability is a condition for the validity measurement. Cronbach Alpha is one of the most used methods for measuring the reliability of the constructs.

The alpha coefficient is a weight standard change average found by dividing the sum of the variances of the k questions in the scale to the general variance. If there is a negative correlation between the questions, the alpha coefficient is also negative. This causes the reliability of the model to deteriorate. The Cronbach Alpha Coefficient investigates whether k questions in the scale form a whole to explain a homogeneous structure. The higher the alpha, it is understood that the items in the scale are consistent with each other and that examine the same feature [111].

K and n are two fundamental parameters in the reliability analysis. Ideally k should be greater than 20, n should be greater than 50. For the DMI case, k is 35 items within 6 constructs. However, the sample is only limited to 43 participants, just close to 50.

In order for a reliability measure to be considered sufficient, according to the Cronbach value, it should be around or more than 0.70. Based on the definition of Hair

[110: 91], “Cronbach’s Alpha is a measure of reliability that ranges from 0 to 1, with values of 0,60 to 0,70 deemed the lower limit of acceptability.”

Reliability Analysis – Summary Table of Cronbach Alpha

The Cronbach Alpha analysis started as the initial step in the multivariate factor analysis. Coefficient alpha by Churchill [1:69] is “The recommended measure of the internal consistency of a set of items is provided by coefficient alpha which results directly from the assumptions of the domain sampling model. Coefficient alpha absolutely should be the first measure one calculates to assess the quality of the instrument. A low coefficient alpha indicates the sample of items performs poorly in capturing the construct which motivated the measure”.

As mentioned in the previous chapters, DMI has 6 constructs and 35 questions in total: culture with 5 questions, data and analytics with 6 questions, people, structure and organization with 5 questions, processes and systems with 7 questions, strategy with 9 questions, and technology with 3 questions.

The 43 participants’ responses on these 35 questions were uploaded in SPSS program and a Cronbach Analysis run. The outcome of SPSS Cronbach Analysis can be found below (Table 29). In the second column, average Cronbach Alpha values can be found. From third column onwards, the values which are corresponding to the exclusion of the relevant question can be found to see the relevant questions impact on the value.

Table 29: Summary Table of Cronbach Alpha Reliability Analysis

Construct	Total Cronbach Alpha Value	Score without

		Q1	Q2	Q3	Q4	Q5					
Culture	0.751	0.741	0.736	0.770	0.637	0.614					
		Q6	Q7	Q8	Q9	Q10	Q11				
Data and Analytics	0.85	0.823	0.837	0.828	0.813	0.834	0.817				
		Q12	Q13	Q14	Q15	Q16					
People, Structure and Organization	0.82	0.742	0.797	0.786	0.782	0.809					
		Q17	Q18	Q19	Q20	Q21	Q22				
Processes and Systems	0.76	0.770	0.709	0.726	0.713	0.761	0.703				
		Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32
Strategy	0.836	0.812	0.811	0.812	0.812	0.818	0.830	0.803	0.826	0.833	0.828
		Q33	Q34	Q35							
Technology	0.682	0.470	0.630	0.689							

Bold marked questions are the questions whose exclusion from the index does not significantly affect the Cronbach alpha scores. So, this means that these questions might be candidates for deletion.

Validity Analysis – Confirmatory Factor Analysis (CFA) Factor Loadings for Digital Maturity Index Constructs

According to Hair [110: 20], “Structural equation modeling (SEM) is a technique that allows separate relationships for each set of dependent variables. It provides the appropriate and most efficient estimation technique for a series of separate multiple regression equations estimated simultaneously which is characterized by two basic components: the structural model and the measurement model. The measurement model enables the researcher to use several variables for single independent or dependent

variables. In a confirmatory factor analysis the researcher can assess the contribution of each scale item as well as incorporate how well the scale measures the concept (reliability). These scales are then integrated into the estimation of the relationships between dependent and independent variables in the structural model.”

According to Onwueghuzie et al. [112: 116], “Validity is the extent to which scores generated by an instrument measure the characteristic or variable they are intended to measure for a specific population, whereas validation refers to the process of systematically collecting evidence to provide justification for the set of inferences that are intended to be drawn from scores yielded by an instrument”. One of the most commonly used techniques to test the validity of measure is factor analysis.

According to Hair [110: 90], “factor analysis is a technique particularly suitable for analyzing the patterns of complex, multidimensional relationships encountered by researchers. It defines and explains in broad and conceptual terms the fundamental aspects of factor analytic techniques. Factor analysis can be utilized to examine the underlying patterns or relationships for many variables and to determine whether the information can be condensed or summarized in a smaller set of factors or components.” Based on the definition of Hair [110: 91], “factor loadings are the correlation between the original variables and the factors, and the key to understanding the nature of a particular factor”.

From the significant criteria of factor loadings, Hair [110: 116] assesses the loadings as follows: “Factors loadings in the range of 0.3 to 0.4 are considered to meet the minimal level for interpretation structure. Loadings 0.5 or greater are considered practically significant.”

Factor analysis can be grouped into 2 main categories: Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA). EFA basically explores the whole data and gives the researcher an insight into which ones best represent the model. On the other hand, CFA researchers specify the factors and set of variables in advance and this technique is used to confirm the researcher's factors. According to Hair [110: 663], "CFA is a way of testing how well measured variables represent a small number of constructs."

In the following table each questions factor loading estimates based on the SPSS analysis are depicted. (See Appendix A.8 for CFA Factor Loadings for DMI Constructs and Figure 27). Here the several questions which are marked as bold are below the significance level. Therefore, here it can be observed that Cronbach Alpha and CFA factor loading estimates go parallel to each other. Critical questions identified during the confirmatory factor analysis are Q3, 17, 21, and 31.

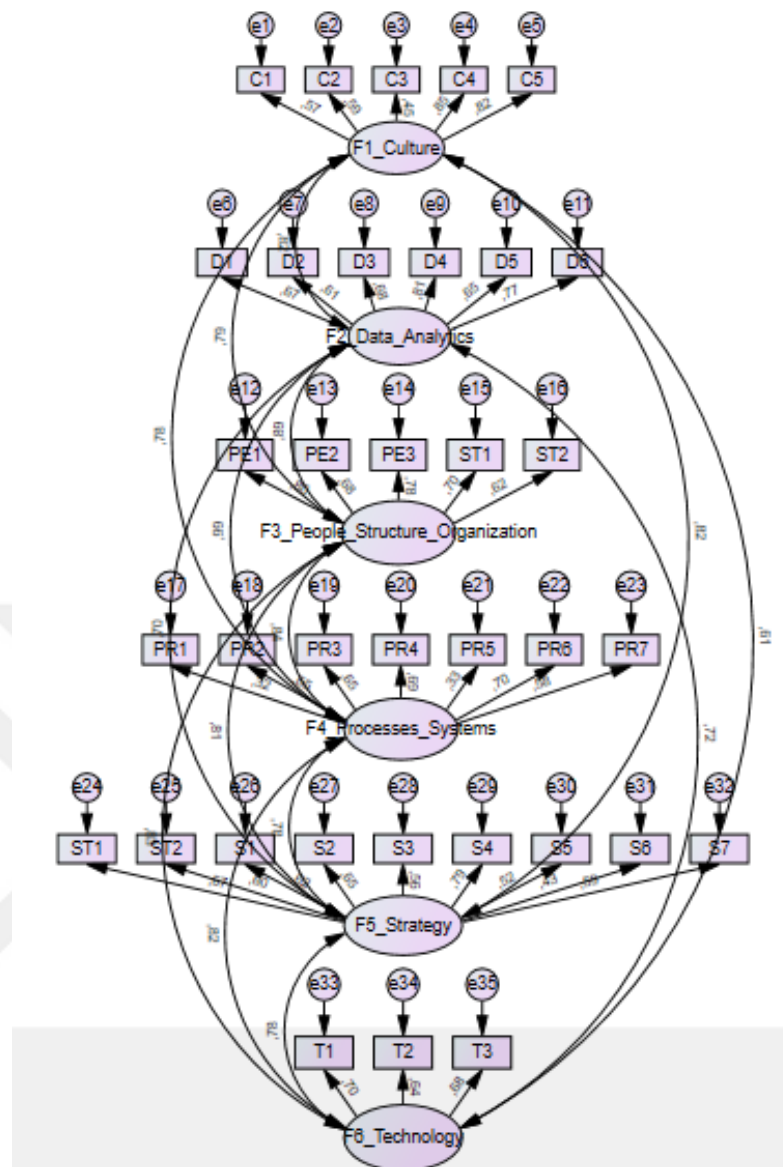


Figure 26: Confirmatory Factor Analysis

5.4.3 Summary Table for Scenarios including Model Fit Indices

Eight scenarios run after excluding the critical questions (Q3, 17, 21, 31) which were identified during the Confirmatory Factor Analysis (CFA) and Cronbach Alpha Analysis. Summary of the CFA results for each scenario with key measurement criteria (Chi-square, Degrees of freedom, Probability, TLI, CFI, RMSEA values) are listed below (Table 30):

Table 30: Summary Table for Scenarios including Model Fit Indices

Scenario (Standard ized)	Constructs	Ques tion Exclu sion	Chi-square (CMIN)	Degree s of freedo m (DF)	Probab ility Level (P)	TLI	CFI	RMSEA
Scenario 1	All constructs - F1-Culture - F2-Data and Analytics - F3-People, Structure and Organizati on - F4- Processes and Systems - F5- Strategy - F6- Technolog y	-	1038,744	545	.000	.492	.535	.145
Scenario 2	All constructs - F1-Culture - F2-Data and Analytics - F3-People, Structure and Organizati on - F4- Processes and Systems - F5- Strategy - F6- Technolog y	Q3 Q17 Q21 Q31	747,493	419	.000	.583	.625	.135
Scenario 3	- F1-Culture - F2-Data and Analytics	-	66,009	43	.014	.852	.884	.112
Scenario 4	- F1-Culture - F2-Data and Analytics	Q3	47,271	34	.065	.904	.927	.095
Scenario 5	- F3-People, Structure and Organizati on	-	68,105	53	.079	.890	.912	.081

	- F4-Processes and Systems							
Scenario 6	- F3-People, Structure and Organization - F4-Processes and Systems	Q17 Q21	43,283	34	.132	.923	.942	.080
Scenario 6a	- F3-People, Structure and Organization - F4-Processes and Systems	Q17	51,718	43	.170	.931	.946	.069
Scenario 6b	- F3-People, Structure and Organization - F4-Processes and Systems	Q21	59,574	43	.048	.875	.902	.095
Scenario 7	- F5-Strategy - F6-Technology	-	57,197	53	.322	.963	.970	.043
Scenario 8	- F5-Strategy - F6-Technology	Q31	41,141	43	.552	1.018	1.000	.000

5.4.4 Composite Reliability (CR) and Average Variance Extracted (AVE)

Analysis

According to Hair [110: 662], average variance extracted (AVE) definition is “a summary measure of convergence among a set of items representing a latent construct. It is the average percentage of variation explained among the items of a construct.” Furthermore, definition of composite reliability (CR) according to Hair [110: 662] is

“measure of reliability and internal consistency of the measured variables representing a latent construct.”

In the table below, based on CFA analysis factor loadings are listed (see Appendix A.9 Composite Reliability and Average Variance Extracted (AVE) Analysis) which is an input to calculate composite reliability (CR) and average variance extracted (AVE) calculation.

After inserting the CFA factor loadings as an input to the equation of CR and AVE in the tool, CR and AVE values are calculated for each construct. Please find below a summary of Composite Reliability and Average Variance Extracted. (Table 31)

Table 31: Summary of Composite Reliability and Average Variance Extracted (AVE) Analysis

Construct	Item / Question	CR	AVE
Culture	Q1	0.812	0.526
	Q2		
	Q4		
	Q5		
	Q6		
Data and Analytics	Q7	0.851	0.49
	Q8		
	Q9		
	Q10		
	Q11		
People, Structure and Organization	Q12	0.841	0.516
	Q13		
	Q14		
	Q15		
	Q16		
Processes and Systems	Q18	0.786	0.424
	Q19		
	Q20		
	Q22		
	Q23		
Processes and Systems Scenario 6a	Q18, 19, 20, 21, 22, 23	0.772	0.371
Processes and Systems Scenario 6b	Q17, 18, 19, 20, 22, 23	0.770	0.368

Strategy	Q24	0.845	0.433
	Q25		
	Q26		
	Q27		
	Q28		
	Q29		
	Q30		
	Q32		
Technology	Q33	0.715	0.456
	Q34		
	Q35		

According to Hair [110: 666], “With CFA, AVE is calculated as the mean variance extracted for the items loadings on a construct and is a summary indicator of convergence. It is the average squared completely standardized factor loading or average communality. An AVE of 0.5 and higher is a good rule of thumb suggesting adequate convergence. An AVE of less than 0.5 indicates that more error remains in the items than variance explained by the latent factor structure on the measure”.

Composite Reliability is also a validity indicator. As Hair [110: 679] highlighted, “The rule of thumb for either reliability estimate is that 0.7 or higher suggests good reliability. Reliability between 0.6 and 0.7 may be acceptable. High construct reliability indicates that internal consistency exists, meaning that the measures all consistently represent them same latent construct.”

If AVE value is > 0.5 then it can be concluded that the model is achieved convergent reliability. If Factor loading values are > 0.5 then it means the model has achieved convergent validity. Based on these results DMI has achieved composite reliability as $CR > 0.70$.

5.4.5 Deciding Between Competing Scenarios based on Degrees of Freedom and Chi-square Value

As in the previous chapters, critical questions are identified in this chapter scenario-based analysis is made in order to find the most optimum model. Based on the Cronbach Alpha results, question numbers 3, 17, 21, 31, and 35 were identified as the potential questions for deletion as they do not have a high impact on the Cronbach alpha results in the construct they belong to. Furthermore, in the CFA analysis, questions 3, 17, 21, and 31 were identified as critical with values below 0.5 significance level. On top of this, CFA factor loadings enabled the calculation of CR and AVE values. All the constructs' CR values are above 0.70. Composite reliability has been achieved for all constructs. However, AVE values vary between 0.368 and 0.526. Therefore, scenario-based analysis is performed to understand which question set is the optimum one and provides from the *quantitative* analysis perspective best results.

According to Werner and Schermelleh-Engel [113: 2], "To compute a χ^2 difference test, the difference of the χ^2 values of the two models in question is taken as well as the difference of the degrees of freedom.

$$\chi^2_{\text{diff}} = \chi^2_s - \chi^2_a \text{ and } df_{\text{diff}} = df_s - df_a$$

s denotes the "smaller" model with fewer parameters and therefore more degrees of freedom, whereas a denotes the "larger" model with more parameters and therefore fewer degrees of freedom. This χ^2_{diff} -value is distributed with df_{diff} degrees of freedom and can be checked manually for significance using a χ^2 table. If the χ^2_{diff} -value is *significant*, the "larger" model with more freely estimated parameters fits the data better than the "smaller" model in which the parameters in question are fixed. It "pays off" to estimate the additional parameters and to prefer the "larger" model. In case the χ^2_{diff} -

value is *insignificant*, both models fit equally well statistically, so the parameters in question can be eliminated from the model and the “smaller” model can be accepted.”

Here the summary of the analysis can be found:

Table 32: Deciding Between Competing Scenarios based on Degrees of Freedom and Chi-square Value

Scenario (Standardized)	Constructs	Question Exclusion	Chi-square (CMIN)	Degrees of freedom (DF)	Probability Level (P)
Scenario 3	- F1-Culture - F2-Data and Analytics	-	66,009	43	.014
Scenario 4	- F1-Culture - F2-Data and Analytics	Q3	47,271	34	.065
Scenario 5	- F3-People, Structure and Organization - F4-Processes and Systems	-	68,105	53	.079
Scenario 6	- F3-People, Structure and Organization - F4-Processes and Systems	Q17 Q21	43,283	34	.132
Scenario 6a	- F3-People, Structure and Organization - F4-Processes and Systems	Q17	51,718	43	.170
Scenario 6b	- F3-People, Structure and Organization - F4-Processes and Systems	Q21	59,574	43	.048
Scenario 7	- F5-Strategy - F6- Technology	-	57,197	53	.322
Scenario 8	- F5-Strategy - F6- Technology	Q31	41,141	43	.552

Scenario 3 vs Scenario 4 Comparison

Table 33: Scenario 3 vs Scenario 4 Comparison

Scenario (Standardized)	Constructs	Question Exclusion	Chi-square (CMIN)	Degrees of freedom (DF)	Probability Level (P)

Scenario 3	- F1-Culture - F2-Data and Analytics	-	66,009	43	.014
Scenario 4	- F1-Culture - F2-Data and Analytics	Q3	47,271	34	.065
Difference	Difference between CMIN	66,009 – 47,271 = 18,738			
Difference	Difference between DF	43 – 34 = 9			

For CI 90%, degrees of freedom 9 should be at least 14,684 based on the Chi-square table. As 18,738 is greater than 14,684, then it can be concluded that Scenario 4 is significantly better than Scenario 3. (p=0.05)

Scenario 5 vs Scenario 6 Comparison

Table 34: Scenario 5 vs Scenario 6 Comparison

Scenario (Standardized)	Constructs	Question Exclusion	Chi-square (CMIN)	Degrees of freedom (DF)	Probability Level (P)
Scenario 5	- F3-People, Structure and Organization - F4-Processes and Systems	-	68,105	53	.079
Scenario 6	- F3-People, Structure and Organization - F4-Processes and Systems	Q17 Q21	43,283	34	.132
Difference	Difference between CMIN	68,105 – 43,283 = 24,822			
Difference	Difference between DF	53 – 34 = 19			

For CI 90%, degrees of freedom 19 should be at least 27,204 based on the Chi-square table. As 24,822 is smaller than 27,204, then it can be concluded that Scenario 6 is not significantly better than Scenario 5.

Scenario 5 vs Scenario 6a Comparison

Table 35: Scenario 5 vs Scenario 6a Comparison

Scenario (Standardized)	Constructs	Question Exclusion	Chi-square (CMIN)	Degrees of freedom (DF)	Probability Level (P)
Scenario 5	- F3-People, Structure and Organization - F4-Processes and Systems	-	68,105	53	.079
Scenario 6a	- F3-People, Structure and Organization - F4-Processes and Systems	Q17	51,718	43	.170
Difference	Difference between CMIN	68,105 – 51,718 = 16,378			
Difference	Difference between DF	53 – 43 = 10			

For CI 90%, degrees of freedom 10 should be at least 15,987 based on the Chi-square table. As 16,378 is greater than 15,987, then it can be concluded that Scenario 6a is significantly better than Scenario 5. ($p=0.1$)

Scenario 5 vs Scenario 6b Comparison

Table 36: Scenario 5 vs Scenario 6b Comparison

Scenario (Standardized)	Constructs	Question Exclusion	Chi-square (CMIN)	Degrees of freedom (DF)	Probability Level (P)
Scenario 5	- F3-People, Structure and Organization - F4-Processes and Systems	-	68,105	53	.079
Scenario 6b	- F3-People, Structure and Organization - F4-Processes and Systems	Q21	59,574	43	.048
Difference	Difference between CMIN	68,105 – 59,574 = 8,531			
Difference	Difference between DF	53 – 43 = 10			

For CI 90%, degrees of freedom 10 should be at least 15,987 based on the Chi-square table. As 8,531 is smaller than 15,987, then it can be concluded that Scenario 6b is not significantly better than Scenario 5.

Scenario 7 vs Scenario 8 Comparison

Table 37: Scenario 7 vs Scenario 8 Comparison

Scenario (Standardized)	Constructs	Question Exclusion	Chi-square (CMIN)	Degrees of freedom (DF)	Probability Level (P)
Scenario 7	- F5-Strategy - F6- Technology	-	57,197	53	.322
Scenario 8	- F5-Strategy - F6- Technology	Q31	41,141	43	.552
Difference	Difference between CMIN	57,197 – 41,141 = 16,056			
Difference	Difference between DF	53 – 43 = 9			

For CI 90%, degrees of freedom 9 should be at least 14,684 based on the Chi-square table. As 16,056 is greater than 14,684, then it can be concluded that Scenario 8 is significantly and reasonably better than Scenario 7.

5.5 Qualitative Results of Second Round of Interviews after Digital

Maturity Index Implementation

As described in Chapter 4, the Procedure for Developing Better Measures proposed by Churchill [1], qualitative interviews were used to support the findings of the descriptive analysis. Based on the findings of statistical analysis explained in session C, the problematic questions were marked and raised additionally during the second round of interviews to combine the strength of both qualitative and quantitative analysis. (Table 38)

Table 38: Questions with High Variance, Skewness and Discussed During 2nd

Round of Interviews

<i>Culture</i>	▪ Q5: What is the impact of digital technologies on the culture of the organization?
<i>Data and Analytics</i>	▪ Q6: What is the scope, use and implementation of your data platform? ▪ Q7: To what extent do you use advanced analytics and business intelligence (e.g., Power BI, etc.) applications and to what extent are they integrated into standard processes? ▪ Q8: How is Data Lifecycle Management implemented for all data of the organization? ▪ Q9: Data quality is a measure of the health of data based on factors such as accuracy, completeness, consistency, reliability, and up-to-datedness. How is data quality ensured in the institution and set to a standard level? ▪ Q11: What does your data strategy and data roadmap include?
<i>Processes and Systems</i>	▪ Q18: Do you apply customization to enhance the customer experience? Do you leverage data for customization? ▪ Q19: How do you use digital technologies and analytics to improve, change or innovate business channels to leverage competitive advantage? ▪ Q22: What does your data infrastructure cover and which features does it have? (Efficient, flexible, complex, competitive advantage, etc.) ▪ Q23: Do you use KPIs to measure digitalization?
<i>People, Structure and Organization</i>	▪ Q14: How do you attract and recruit digital talent?
<i>Strategy</i>	▪ Q25: To what extent are digital technologies and opportunities integrated into corporate core functions? Is the digitization and expansion of core operations part of the roadmap and strategy?

Technology	▪ Q35: Do you use Information and Communication Technologies (ICT) partnerships?

Based on the general outcomes and as well as the questions listed at Table 38, qualitative interview conducted.

5.5.1 General Findings

Culture score (3.53) has the highest score compared to other organizational aspects. It was observed that the culture of digitalization has spread to different levels of the company. Therefore, it was concluded that digital awareness has been achieved.

In comparison to culture aspect, data, and analytics aspect (2.89) is the lowest score of all aspects with a wider scope for improvement. Data has emerged as an area to focus on. Awareness about the studies done in the data field is more limited. Structure and organization follow the culture.

The Culture (3.53) and Strategy (3.52) scores are close to each other, followed by the Technology score (3.46). Digitization strategy is included in the company's vision. Employees are aware of the digitalization strategy and experience its applications. It has been observed that all company roles about digital strategy have a similar perception and high awareness.

The Culture and Strategy scores are close to each other, followed by the Technology score. Technology is *used effectively in different functions of the company*, and there is confidence that the *relevant technologies will be brought and accessed by employees*.

In general, there are several *differences observed between groups*. *Managers scored higher* on Data & Analytics, People, Structure & Organization, and Processes &

Systems. It has been observed that the *expectation of the end user is higher*. They have higher expectations as they are the first to welcome products, services, and applications. It has been observed that the *managers are more satisfied* with the implementations and have a better overview of the big picture. People who declare that they work *frequently with digital subjects score higher* in all categories. More than 60% of employees emphasized that digital instruments are part of their daily work.

Managers gave an average of 0.3 points higher in data analytics, structure, organization, processes and systems which might be considered as outliers. Based on the qualitative interviews, interpretation of this score came as “managers might not know all the details, so they may have given high score.” Another interpretation came during the interviews was the managers generally have comprehensive knowledge on the big picture, so they might be taking it from the general framework. On the other hand, it is normal for IT professionals and business experts to see the shortcomings and give low scores, as they encounter and confront the technical problems”.

In addition to the interpretation of the general scores, aspect-based evaluations, comments, and interpretation of different roles; beneficiaries, business experts, IT experts, and managers, grouped separately. The summary of the general findings are as follows:

Table 39: Summary of Findings of Second Round of Interviews

Organizational Aspect	Score	General
Culture	3.53	▪ Highest score compared to other organizational aspects. ▪ The culture of digitalization spread to different levels of the company. ▪ Digital awareness is achieved

Data and Analytics	2.89	▪ The data and analytics aspect has <i>the lowest score of all aspects</i> with a wider scope for improvement. ▪ Data has emerged as an <i>area to focus on</i>. ▪ <i>Awareness</i> about the studies done in the data field is <i>more limited</i>.
People, Structure and Organization	3.18	▪ <i>Structure and organization follow the culture</i>.
Processes and Systems	3.36	▪ n/a
Strategy	3.52	▪ Culture and Strategy scores are close, followed by Technology scores. ▪ Digitization strategy is <i>included in the company's vision</i>. ▪ Employees are aware of the <i>digitalization strategy</i> and <i>experience its applications</i>. ▪ All company roles have a similar perception of digital strategy and awareness is high.
Technology	3.46	▪ Culture and Strategy scores are close, followed by Technology scores. ▪ Technology is <i>used effectively in different functions of the company</i>, and there is confidence that the <i>relevant technologies will be brought and accessed</i> by automotive company employees.
General	3.32	▪ Several <i>differences observed between groups</i>. ▪ <i>Managers scored higher</i> on Data and Analytics and People, Structure, and Organization and Processes and Systems. ▪ <i>Expectations of the end user are higher</i>. Higher expectations as they are the first to work on the products, services, and applications. ▪ The <i>managers are more satisfied</i> with the implementations and have a better overview of the big picture. ▪ More than 60% of employees emphasized that digital instruments are part of their daily work. ▪ People who work <i>frequently with digital subjects score higher in general</i>. ▪ IT professionals and Business experts <i>see the shortcomings</i> and give lower scores.

5.5.2 Culture Interpretation

The Culture score is interpreted differently based on the roles. Please find below the summary and quotes from the qualitative interview rounds.

Beneficiaries:

During the qualitative interviews, beneficiaries or end users interpreted DMI culture scores from three different perspectives. One of the perspectives that emerged was it is normal that IT experts and managers score high on culture, whereas it is normal for end users to score low. The argument brought for this comment was that digitalization is not a primary job of the beneficiaries. Instead, they are just supporting or using digital work and initiatives.

Another point that surfaced was the closer you get to the manager level, the more positive the answers. The end user is very focused on operational tasks in digitalization or digital products and systems.

Another view, which might be the reason for high scoring was that managers may see the bigger picture because they lead the team, and they can see more comprehensively.

The third view was based on the statement of the interviewee that “*Culture was formed through communication for awareness. We can say that cultural communication is done well. Everyone is touched.*” High and close culture score distribution among the roles is an outcome of good communication.

Business Expert:

Furthermore, Business experts also interpreted DMI culture score from different perspectives. One comment highlight was the corona impact: “*There are at least 0.5 points due to the corona effect. It was difficult for everyone to keep their jobs, so they stick the employees’ jobs harder.*”

Another view was managers’ higher visions. According to the interviewee, managers can look from high up. The score decreases downwards towards the last use.

Furthermore, another comment was the close vision of IT experts and business experts which is indicated by closer scores.

IT Expert:

During the interviews, IT experts interpreted the scores as culture is spreading in the field. Furthermore, they mentioned that “we expected people, structure & organization to be close with culture. (3.52 and 3.18)”.

Managers:

Managers interpreted scores as IT experts and managers’ scores are very close. There’s not much of a problem with conveying digital culture to managers.

Another point highlighted was unexpected culture scores of business experts. One of the interviewees mentioned that “I expected the culture score to be higher with business experts. It is normal for the end user score to be like this. I would expect the business expert to have a higher score when compared to the end-user and the business expert.”

5.5.3 Data and Analytics Interpretation

Data and Analytics scores interpreted differently based on the roles. Please find below the summary and quotes from the qualitative interview rounds.

Beneficiaries:

In the qualitative interviews, beneficiaries highlighted five points in total. The first was data awareness. According to the interviewee, “*The awareness of people who develop and manage data may be high.* End-users are those who produce and provide data, others are those who manage it, so there may be awareness in those who manage.”

The second view was that the positions with a high level of data usage or developing data related processes have lower scoring. According to the interviewees, “The lowest rate of business professionals may be due to the difficulties they face and the difficulties they face the most. *They are the workers in the field and in the kitchen.*”

The third view was about the *management role and non-involvement in operation*. Interviewees highlight managers may also have scored high because “they were not involved in the operation. If we subtract the score of the managers, the overall score goes down. There is a big difference between team management and team management.”

When it was asked why the data score might be low compared to other organizational aspects, a differentiation was made between the concrete and the abstract was made and data is pointed out to be an abstract subject. Concrete subject examples given by the interviewee are process system and technology, whereas culture and strategy and data are abstract subjects.

Business Expert:

Several points by the business expert impacted the data score. The first point is the managers’ high score. Without the managers, this score would be much lower. The Interviewee contributed saying that “I think people at the *manager level pull this score up a lot*. According to business experts, managers are more outliers.”

The second point highlighted was the *end user seems more satisfied than the people who made this product*. According to the interviewee “*The doer, and the end user, shows that the data is not used. The manager part neutralizes the end user score*”.

The third comment received from the experts is the negativity of too much exposure to data. The Interviewee claimed that “Business professionals produce a lot of

stuff. In return, data is used very well. *Talking with a lot of data can also be perceived negatively.*”

As the final comment, experts made a general comment of the data question’s quality and the content. The following point is mentioned by one of the interviewees, “Data questions had questions that the uninitiated questions and topics couldn’t be answered. Data governance can be very incomprehensible. Since the other teams did not know, they made a general interpretation. There was *no problem with data questions, but the end user may be off this data topics.*”

IT Expert:

During the qualitative interviews, while IT experts were interpreting the data and analytics scores, the following points were highlighted: According to the interviewees and based on the statistical results of DMI implementation, data analytics studies are supported in automotive companies. What can be done with the data within the institution is provided. The IT teams and business domains have initial work to create value using data.

Based on the DMI results data and analytics scores are the lowest among all scores. Based on the interview outcomes, it was found that there is *not much awareness about data*. One of the interviewees pointed out that there are “More messy numbers in Data. Your measurements and system are correct. It didn’t seem inconsistent to me. *Awareness in general may be low.* Awareness about the work done can be increased to increase the operation or to increase the management.” Another interviewee mentioned that “The data analytics part is already an area that can be improved. It didn’t surprise me.”

According to the interview outcomes, managers scored 3.48, and beneficiaries scored 2.69. It might be the results of lack of awareness or that end-user requirements cannot be met in terms of data-to-work requirements.

Managers:

From the managers' perspectives, communication, awareness, and exposure to data related processes came into the picture. According to one of the comments, *managers are pulling dashboards/reports and seeing and using them*. They can say yes to the data usage question, thinking that we are using data. On the other hand, the end user seems to request more development or awareness may be low.

Another point highlighted was communication. According to one of the employees, *"The data strategy is not announced to the company. There is a lack of information. The people who work in it know the topic and in addition only management knows."*

5.5.4 People, Structure, and Organization Interpretation

People, Structure, and Organization scores are interpreted differently based on the roles. Please find below the summary and quotes from the qualitative interview rounds.

Beneficiaries:

From the beneficiary perspectives, Human, Structure and Organization and Strategy scores are interpreted as very close.

Business Expert:

From the business expert point of view, several points are highlighted. The first one is, *structure and organization follows the culture*. It was mentioned that

“Interestingly, culture score is 3.53, while the score for human structure and organization score is lower, 3.18. The culture from the company is leading, the organization is lagging. Maybe we need to place the organization first. In general, when companies start to spread the culture, they move to a horizontal hierarchy. But in this company, the culture lagged behind the organization. The culture passed by the organization. There is a more digital culture, but the organizational structure is not suitable for it.”

The second view which was highlighted was active participation. Interviewees claimed that “The most critical thing on the digital side: Active participation.”

The last comment was on the training position-based question. According to the interviewee, “Assigned training is not the right thing. That person must come out because I want to see something from this forehead. Direct training is assigned. The demand must come from them. There should be a *roadmap*. It should provide training and place it in the first position opened when the trainings are completed.”

IT Expert:

Furthermore, scores were evaluated by the IT experts. According to their point of view, “When we look at the digital side, there is a structure that supports digitalization in terms of organization. There is an operational structure.”

The figures are closer when viewed on a role-based basis in people, structure, and organization. According to the interviewees, a slight difference is explained by, “For some reason, the managers scored high. It may be because they did not go into the operation. Big picture and cultural awareness spreads from top to bottom. The manager may say that we have done it, we have built the field. But the end user may say that it does not give the desired result.”

Managers:

Finally, people, structure and organization score of manager role are scored closely.

5.5.5 Process and Systems Interpretation

Processes and Systems scores interpreted differently based on the roles: Please find below the summary and quotes from the qualitative interview rounds.

Beneficiaries:

According to the beneficiaries, process and systems scores are interpreted as follows: “It goes according to the rules and *systematically*. It is good that the incoming subjects, projects are sorted by *prioritization* and managed properly.”

Business Expert:

From a business expert’s point of view, it was mentioned that there is a need to prepare the workflow of core processes.

IT Expert:

From IT experts, feedback reviewed per question had high variance. Details can be found in the next chapter.

Managers:

Managers did not make any comment on this score.

5.5.6 Strategy Interpretation

Strategy scores were interpreted differently based on roles. Please find below the summary and quotes from the qualitative interview rounds.

Beneficiaries:

According to the beneficiaries, the digital transformation strategy is well known and well communicated in the company. It was exclaimed by the following point, “Automotive’s strategy is known even by the employee in the field. The strategy is well established and well conveyed.”

IT Experts scored higher in Strategy Technology scores. These experts know how they understand the market. The IT professionals research this as the ideal and bring it before them. It’s normal to give it a high score. The digitalization strategy is something that works for IT professionals.

Business Expert:

From the business expert perspective, *the strategy is strong and well communicated*. It is mentioned that “It is known that there is *digitalization in the company strategy*. That’s why it’s a high score. We have a digital-focused strategy. We know what to do about it.”

Another highlighted point, “The biggest *gain of the digital transformation office*. *Stakeholders are speaking*. We talk to each other and *evaluate projects together*.”

IT Expert:

From the IT expert perspective, maturity of the digital strategy was highlighted by “The *strategy is very mature*. *Business processes and strategy go hand in hand*. The parallel dimensions of the strategy show that there is a *digital transformation parallel to the strategy*.”

The second point mentioned that “Managers may be high because they want to show everything is running well or the awareness of the managers is high. Since it is close

to the top, there may be more information flowing down there. On the other hand, having more information should not require high voting.”

Managers:

From the manager perspective, digital strategy and strong communication were highlighted by “No one has a question mark about determining and spreading the strategy”.

5.5.7 Technology Interpretation

As the last organizational aspect, technology scores interpreted differently based on the roles. Please find below the summary and quotes from the qualitative interview rounds.

Beneficiaries:

From the beneficiary perspective, technology transfers from the technology office towards the business units is mentioned. Interviewees observed that “There can be high variance in technology as IT experts work with outside companies. *Business experts & end users are getting technologies through the technology company.* The score might be lower than IT experts because of that.”

On the other hand, they made a comparison with the end user experience by “Company uses of technologies in areas such as automotive solar panel / IoT. But it is normal for the *end user to have a lower awareness* score because it is based on the user’s experience.”

Business Expert:

From the business expert perspective, they mentioned the ecosystems focus by “We don’t *have much of an ecosystem focus*, as it should be.”

Furthermore, score differences between IT experts, end-users, and managers were interpreted as follows: “End user / business professionals score low. IT professionals score higher. Moving to technology, IT professionals get a better view of infrastructure. *Technologies are being transferred from* technology companies. Manager level is off topic.”

IT Expert:

IT experts highlighted that their partnerships are more proactive in comparison to automotive sales and aftersales company which might be because of business model and / or industry dynamics.

Managers:

Managers interpreted the scores as follows.: “Technology score is low on the end user side. They may have a high score because we still have a long way to go. Or they may not count a technology subsidiary as a partner. Those who work with the main agencies, those who work with different companies have probably marked accordingly.”

5.5.8 Summary of Organizational Aspect and Role Based Interpretation

Role based interpretation of each organizational aspect scores are summarized in the following table. (Table 40)

Table 40: Summary of Findings and Quotes of Second Round of Interviews Based on
The Roles

Aspect	Score	Beneficiaries	Business Experts	IT Experts	Managers	Implications
Culture	3.53	<i>IT and managers come out high.</i> Digital work is not beneficiaries' main job and they just support, so they scored lower. The closer you get To manager level, the more positive the answers are. Beneficiaries are very focused on operational tasks in digitalization. Managers may see a bigger and more comprehensive picture. Culture was formed through communication for awareness.	Higher scores due to the corona effect. Managers have higher visions. The score decreases downwards towards the end-use. The vision of IT experts and Business Owners are close.	Culture spreads in the field. People, Structure and Organization score expected to be close with Culture.	IT Experts and Managers' scores are very close. No problem with conveying digital culture to Managers. Culture score is expected to be higher at Business Experts. Beneficiary score is normal to be like this. Business Expert's score is expected to be higher score when compared to Beneficiaries and Business Expert.	Roles which are more involved in digital topics such as Business and IT experts are more accustomed to digital culture. On the other hand, managers are more optimistic.
Data and Analytics	2.89	Awareness of people who develop and manage data may be high. Beneficiaries face difficulties most, as the workers in the field and in the kitchen. Managers may have scored high because of not being involved in operation. Difference between team	No sustainable approach. Without managers, this score would be much lower. Manager level pull this score up a lot. Beneficiaries seem more satisfied than Business Experts who made this product. Doer and end-user, show data is not used. The	Not much awareness about data. Awareness of work done can be increased, in operation and management. The data analytics part is already an area that can be improved. It didn't surprise me. DMI measurement and system are	Managers are pulling dashboards/reports and using them. They can say yes, we are using data. On beneficiary level awareness may be low. Data strategy is not announced to the company. Lack of information. The people who work in it know and management knows.	Role which more involve in data topic or use data and related technologies in their daily work have higher awareness.

		management and non-team management. Concrete subject: Process system, technology concrete subjects. Abstract subject: Culture and strategy, data abstract subjects	manager part neutralizes the end user score. Professionals produce a lot using data. Talking with a lot of data can also be perceived negatively. No problem with data questions, but beneficiaries may be off to this data topic.	correct. Not seem inconsistent. Awareness in general may be low		
People, Structure and Organization	3.18	People, Structure and Organization and Strategy scores are also very close.	Structure and organization follow the culture. Interestingly, while Culture score is 3.53, People, Structure and Organization score is lower with 3.18. In general, when companies start to spread the culture, they move to a horizontal hierarchy. But in this case, Company culture is leading, organization is lagging. More digital culture, but organizational structure is not suitable for it. Maybe it is needed to place the organization first. Active participation is critical.	On the digital side, organization structure supports digitalization. Managers scored high, maybe because of not being involved in operational work and seeing the big picture. Cultural awareness spreads top to bottom. The manager may say that we have done it, we have built the field, but for the beneficiaries it may give the desired result. The figures are closer when looked at on a role-based basis.	Close scoring	For successful digital transformation of the organizations, organization needs to clearly define the roles, organizational structures, and allocate human resources for the implementation.

			Assigned training is not the right thing. Demand must come from the employees. A roadmap should provide training for the relevant position .			
Processes and Systems	3.36	Processes and systems work systematically . Incoming projects and demands are sorted by prioritization and managed properly.	The workflow of core processes needs to be prepared.	Scoring feedback reviewed for per question with high variance.	n/a	Physical processes conversion to digital processes and implementation as systems has a positive effect on the digital transformation of the organizations.
Strategy	3.52	Digital strategy is well established and well conveyed. IT Experts scored higher in Strategy Technology scores , who knows the market. The IT professional research the trends and brings it to business side. The digitalization strategy is something that works for IT professionals.	The strategy is well communicated . It is known that there is digitalization in the strategy . We know what to do about it . This is the biggest gain of the digital transformation office . Stakeholders are involved in the digital processes and communicating their demands . IT and business talk to each other and evaluate projects together .	The strategy is very mature . Business processes and strategy go hand in hand . The digital transformation is parallel to the strategy . Awareness of the managers is high. Since it is close to the top, there may be more information flowing down there.	No one has a question mark about determining and spreading the strategy.	To have a stronger culture and digital awareness, (digital) strategy should be well communicated in all layers of the company.

Technology	3.46	Maybe there is a high variance in technology as IT experts work with outside companies. Business Expert and Beneficiaries are getting technologies through Technology Company. Company uses technologies in areas such as automotive solar panel / IoT. But it is normal for the beneficiaries to have a lower awareness score, because it is based on the user's experience.	Not <i>much of an ecosystem focus</i>, it should be. IT professionals get a better view of infrastructure. Manager level is off topic. End user / business professionals score low. IT professionals score higher. Technologies are being transferred from Technology Company.	Technology Company's <i>partnerships are more proactive</i>.	Technology is low on beneficiaries. It may be because we still have a long way to go. Maybe participants <i>didn't count Technology Company as a partner</i>. <i>Those who work with the main agencies, those who work with different companies have probably marked accordingly.</i>	Level of technology exposure and digital technology adaptation positively impacts the digital transformation journey.

5.5.9 Brainstorming Workshop Results

When the findings of DMI implementation were analyzed, all employees who participated in the implementation workshop were invited for a follow-up meeting. In this meeting, the results were discussed, and analysis was shown, and brainstorming was conducted for further idea generation for future improvement both regarding the index and for score improvement.

Feedback Session Results

Several actions for the overall score improvement was highlighted. With more communication and sharing, awareness increases of the whole company. For the data and analytics score improvement three ideas came out: The first is sessions can be organized to inform employees about the data platform usage and data policy and studies. Second, workshops can be organized on data quality, accuracy, completeness, consistency,

reliability. Lastly, in order to increase awareness, data workshops can be done for advanced analytics and business intelligence (e.g., Power BI, etc.) applications. Tool usage can be expanded or investment in relevant tools can be increased.

For the improvement of People, Structure and Organization score, two proposals were made: The first is a study that can be conducted for the discovery of people with digital competence to determine their potential value. Second, technical training for the development of digital competencies (coding, etc.) can be coordinated with human resources and depending on the content with technology training team.

For the improvement of Processes and Systems scores, three proposals were made: The First is collecting good practice examples as benchmarks and making them accessible to those in need. Second is dissemination of high awareness among IT and Managers about systems towards all employees can be sustained. Third is the studies or activities aimed at making the existing works known can be organized such as participation of different people to raise awareness in the meetings, workshops, making the completed projects public, newsletters, different technologies information sessions, explanation on technology trends ([103]; [5]) and where the world is going, adding KPIs to the dashboards and making them public, lock screen studies on completed projects.

For Strategy score improvement, the following two actions were proposed: awareness can be created by obtaining sample applications and digital transformation applications from OEMs, announcing the long-term digitalization strategy to the company.

For the Technology score improvement, it was highlighted that the technology trend session can be organized and opened to all employees.

Improvement Areas Based on Index

In addition to the brainstorming session, the DMI implementation outcome was compared with the index rubrics. Here the gap between the index rubric content and company results is explained.

From the Culture perspective, a strategy can be prepared for digitalization to penetrate all units of the company development plans.

From the Data and Analytics perspectives, several actions can be recommended: data platform implementation, data strategy objectives, active use across the organization, data lake dissemination, increase in reporting, advanced analytical studies, integration of, advanced analytical processes in strategic decision-making processes, standards and documentation for the management of the data lifecycle, identifying dependencies between business processes and data sources, data lifecycle management KPIs, data quality strategy, goal, implementation and measurement, and roadmap creation, improvement, systematic follow-up can be highlighted.

From the People, Structure and Organization perspective, attempts by employees to improve their skills, dissemination of digital tools, and attracting digital talent can be highlighted for future actions.

From Processes and Systems perspective, use of marketing technology, customer experience improvement, a highly automated, multi-channel sales structure, personalized dynamic pricing, MDM solutions, IT cloud architecture solutions, announcement, visualization, use of real-time data of KPIs can be highlighted.

For the Strategy score improvement, inclusive agenda, innovation approach and roadmap can be recommended.

For the Technology score improvement, experimenting with complementary products and services, business partnerships (agency, start-up etc.) can be recommended.

Consolidated Findings from Feedback Sessions and Improvement Areas Based on Index

Based on the detailed explanation from Feedback Session Results and Improvement Areas Based on Index, here the findings are consolidated. (Table 41)

Table 41:Consolidated Findings from Feedback Sessions and Improvement Areas

Based on Index

Organizational Aspects	Feedback Session Results	Improvement Areas Based on Index	Recommendations for Score Improvement
Culture	Sharing information on digital technologies, projects, or tools which increase the awareness of the whole company	Digitalization strategy in line with development plans all units of the company	Organizing activities to increase digital awareness
Data and Analytics	To inform about the data platform Workshops on data quality, accuracy, completeness, consistency, reliability. Activities for awareness studies for advanced analytics and business intelligence applications. Information sharing about data policy and related work	Activities towards data platform implementation, data strategy objectives, active use across the organization Data lake dissemination Increasing business intelligence, reporting, and advanced analytical studies Integration in advanced analytical processes and	Data platform implementation and announcement of data strategy

		strategic decision-making processes Standards and documentation for the management of the data lifecycle Identifying dependencies between business processes and data sources Data related KPIs Data quality strategy, goal, implementation, and measurement Roadmap creation, improvement, systematic follow-up	
People, Structure and Organizational	A study can be conducted for the discovery of people with digital competence. Technical training for the development of digital competencies (coding, etc.) coordinated with Human Resources and Technology Company.	Efforts by employees to improve their digital skills. Dissemination of digital tools Attracting digital talent	Increasing digital capabilities

Processes and Systems	Collecting good practice examples as benchmarks and making them accessible to those in need Dissemination of high awareness among IT Experts and Managers about systems to employees Studies aimed at making the existing work, projects known. Information sharing by the IT Experts on different technologies and on technology trends (McKinsey, Gartner), where the world is going Setting and visualizing KPIs on dashboard and making them public	Use of marketing technology, customer experience improvement A highly automated, multi-channel sales structure, personalized dynamic pricing. Data management solutions, IT cloud architecture solutions Announcement, visualization, use of real-time data of KPIs	Spreading the high awareness of IT experts & Managers about the systems to the employees
Strategy	Awareness can be created by obtaining sample applications and digital transformation applications from OEMs	Inclusive agenda, innovation approach and roadmap	Collecting and sharing good practice examples as benchmarks
Technology	Technology webinars, discussions, forums, or chats can be shared.	Experiencing complementary products and services, business partnerships (agency, start-up etc.)	Dissemination of IT tools, advanced analytics, reporting/business intelligence applications and digital tools

5.6 Discussion

As mentioned in the previous chapters, based on the literature review 18 articles were identified where they also focus on digital maturity and maturity model developments. In these articles, several of them had only focus on the quantitative findings, on the other hand several of them also included the qualitative findings. In this section, research findings both from the quantitative and qualitative perspectives are summarized. Furthermore, these findings are compared with the literature review findings.

5.6.1 Discussion of Quantitative Findings

From the quantitative finding perspective, several methods were used in the literature. Gökalp & Martinez ([4]; [27]) utilized from cross-case comparison for the validity analysis. They observe a rating for each Digital Transformation Capability Level and Maturity Level of the organizations. They used qualitative data of the multiple case studies for the risk mitigation regarding validity concerns. For the internal validity check, Gökalp & Martinez ([4]; [27]) triangulated the detailed questions sets of different levels of Digital Transformation processes and collected feedback from at least three people. Collected data in detail was also validated by the stakeholders. To achieve the construct objectivity, data collected was performed over different sources and different people and rated using four-point scale called SPICE. For the external validity check, they selected cases from different sectors with different sizes and from different countries such as a machine company performs operations in the UK, a chemical company performs operations worldwide. Through this they aimed to test the applicability of DX-CMM in different sectors. To ensure the reliability, so that people can perform the same study with same methodology, they utilized from the structured research question, design, and data

collection. In these validity and reliability checks, they determined the consistency of the output.

Furthermore, Kırmızı and Kocaoğlu [114] utilized from Intra class correlation (ICC), Wilcoxon signed rank test and Pearson correlation for the quantitative analysis. According to Kırmızı and Kocaoğlu [114] design science theory proposes maturity model development approach and robust validation process. Therefore, they performed three consecutive discussion sessions with experts and iteratively evolved the maturity model and they validated the model with intra-class correlation (ICC) coefficient. They also utilized the Wilcoxon signed rank test to see the difference between consecutive sessions. Finally, they pilot the model as two studies in the manufacturing sector.

In comparison to the previous research, in this research the developed index was implemented at an automotive sales and aftersales company which was going through the digital transformation journey. After implementing DMI at this company, descriptive statistics, ANOVA and Independent t-tests were performed for 35 questions and 43 responses. It was found that several questions had high variance, and some questions had $P < 0.05$ values which indicates their statistical significance. Furthermore for reliability control, Cronbach Alpha was performed. Then it was followed by Confirmatory Factor Analysis (CFA) for the validity check. With these factor loadings, Composite Reliability and Average Variance Extracted (AVE) Analysis were performed to identify the potential questions for deletion.

In order to understand these questions' individual performance and to check whether they were formulated in an understandable way etc., the research was supported by qualitative interviews.

5.6.2 Discussion of Qualitative Findings

As mentioned in the previous chapters, based on the literature review 18 prominent digital maturity models were analyzed. Several of them have only quantitative approach, several of them have only qualitative approach and several of them have both approaches.

From the qualitative finding perspective, Valdez-de-Leon [23] developed “Digital Maturity Model for Telecommunications Service Providers” framework by implementing Delphi Method. Moreover, Teicher [62] performed systematic review to provide a better understanding of the digital maturity field and compared 22 digital maturity models in detail. He also highlighted the inconsistency of the digital maturity definition across models and found that models are mainly in the manufacturing domain. Furthermore, he also differentiated the academic and practitioner split.

Even though there are qualitative and mixed approaches, this research positions itself slightly different from the others via using the digital expert support. This practical implication perspective was received both during the index development and implementation through qualitative interviews.

During these interviews, it was found that several questions’ content was not clear and needed to be reviewed or several questions were too technical even though the question itself was good. Therefore, these questions were modified. At the end, it was found that 4 questions are subject to deletion.

5.6.3 Synthesis of Quantitative and Qualitative Findings

In addition to the general interpretation of the DMI results, based on the results of descriptive analytics, ANOVA and T-test explained in Chapter 5.3, identified questions

with high variation or deviation based on the statistical tests were also discussed with the interviewees to understand if there is a problem with the question's formulation, wording and so on and to get their comments on the results. In addition to these qualitative analyses, quantitative reliability and validity analysis of the index has been added. In this part, the findings of both quantitative analysis and qualitative analysis are merged and findings are depicted in the table below. (Table 42)

Table 42: Comparison Chart of Quantitative and Qualitative Findings

Construct	Quantitative Findings inc. Reliability and CFA Analysis	Qualitative Findings of Expert Interviews exc. Brainstorming Session Findings	Recommended Action
Culture	Among the culture questions, question Q3 might be subject to deletion.	Q5: "This question has high variance. Sales and operations might have stronger digital culture in comparison towards back-end functions such as audit, legal departments." Q5: "Corporate culture and its coverage might have been interpreted differently by the participant." Q5: "There was a question of how much the person was using in their daily job. If the person is good at using the digital tools in their daily job, then their awareness on digital topics would be high. If the people are scored low on this question, they would probably be thinking that it is not reaching to him / her."	Q3 can be deleted. Q5 can be kept.
Data and Analytics	Among the data analytics questions, Q7 might be subject to deletion.	Q6: "There might be a gap in the understanding of the data infrastructure." "The answer to this question might be varying	All the questions kept.

		based on the person's capability of data usage." "Questions were quite good. However, people who do not know about this topic cannot answer then." "They might not understand the systems modules and models. The person who uses ERP systems, would probably answer this question thinking ERP system. A person who uses web/mobile would be answering thinking web/mobile. The legal department might me answering by thinking ticket system. Maybe it is better to use 'application' wording instead of module, platform for the sake of the question's understandability." Q7: "This question is clear. That's why answers are different." "Criteria are variable. In this question, it is stated standard process, but there are no standard processes." "People who are using reporting function," Q8: "Data life cycle management is not well known." "Open end question." "Only limited number of employees are working on data life cycle E2E. Some of these are working on the generation, some of them are working on the usage, some of them are working on the system upload." Q9: "People know a little about the data quality. The knowledge is limited with the usage and technical details are not well known."	

		Q11: “Beneficiaries might not be well informed enough to answer this question. The projects might have started from the central office and might not be well spread towards the end user.” “Data strategy is not well known. I am using reporting functions only. On my daily work life, I am not thinking about the data quality improvement”. “There is lack of knowledge on data strategy. It is not well announced to the company. Therefore, there might be lack of awareness.”	
People, Structure and Organization	No question is coming forward towards deleting a question from the construct based on Cronbach Alpha value.	Q14: “Everyone would be answering based on their point of view.” “There might be department based or role-based awareness.”	
Processes and Systems	Among processes and systems questions, exclusion of Q21 is not affecting the results. This also confirms the feedback received during the qualitative interviews. The second question which is not affecting the total Cronbach alpha score is Q17.	Q18: “This question should be asked based on the positions. Marketing and customer focused functions would be utilizing more from data. On the other hand, it is not relevant to legal department.” “Employees who have customer touch would have higher expectations, therefore they would be voting lower scores. The employees who do not have customer contact would be scoring higher. Managers might be comparing with the market. The business experts’ expectations would probably be higher.” Q19: “This question should be asked based on the positions. IT functions	Q17 can be deleted. Q21 can be deleted. Q18, Q19, Q22 can be kept.

		would be used more as they are involving technology in the operation work as well. On the other legal department would be dealing less, 1-2 times per year with this topic.” “Question is good, but there might be confusing because of pricing. Is it customer based, segment based, customer-based pricing, etc?” Q22: “Question number 22 sounds complicated.” “This question can only be answered by the employees who are working on data and related topics. 80% of the people would probably be not heard about MDM.”	
Strategy	Exclusion of Q28, Q30 and Q32 separately is not affecting the end Cronbach alpha score. There these questions are candidate for deleting.	Q23: “This question might be answered based on the KPI maturity in the related department.” “Some of them might have tough about the cost benefits when they are voting for KPIs. Some of them might be thinking that they should be doing more.” Q25: “People who are working on the operation might be scoring lower, as they are working more hands on, and they have higher expectations.”	Q23 and Q25 can be kept.
Technology	No question is coming forward towards deleting a question from the construct based on Cronbach alpha value.	Q35: “There are departments who are only working with technology subsidiary, some of them are working with agencies, or other service providers. Therefore, the answer to this question varies.”	Q31 can be deleted. Q35 can be kept.

It can be noted that the only the questions with high variance based on ANOVA and Statistical Analysis are discussed during the qualitative expert interviews.

5.6.4 Final Digital Maturity Index Instrument

In order to sum up the findings of competing models based on the Chi-Square difference test, scenario 4 is better than 3, scenario 5 is better than 6, scenario 6a is better than 5, scenario 5 is better than 6b, and scenario 8 is better than 7. To summarize these findings, questions 3, 17, and 31 should be deleted for better quantitative findings. Based on the statistical analysis, question 3, 17, 31 can be deleted. Even though it was not directly coming out from the Chi-square difference test, deletion of question 21 can also be supported by CFA analysis and also by qualitative analysis findings. After making these changes, Digital Maturity Index as a final instrument is shown below. (Table 43)

Table 43: Final DMI Instrument

Main Constructs / Aspects	Questions	Is Question included in final DMI?
Culture	How do you apply the principles of agile product and service delivery across a broad spectrum of the organization, including business units and IT units?	Yes
Culture	How do you prioritize digital and analog (physical) process development?	Yes
Culture	How do digital developments in your organization and industry affect your company's digital priority?	No
Culture	How do digital leaders in teams organize and institutionalize digital activities?	Yes
Culture	What is the impact of digital technologies on the culture of the organization?	Yes
Data and Analytics	What is the scope, use and implementation of your data platform?	Yes

Data and Analytics	To what extent do you use advanced analytics and business intelligence (e.g., Power BI, etc.) applications and to what extent are they integrated into standard processes?	Yes
Data and Analytics	How is Data Lifecycle Management implemented for all data of the organization?	Yes
Data and Analytics	How is data quality ensured in the institution and set to a standard level?	Yes
Data and Analytics	How is data treated, processed and value created in your organization?	Yes
Data and Analytics	What does your data strategy and data roadmap include?	Yes
People, Structure and Organization	How is digital talent development done in your company?	Yes
People, Structure and Organization	Do you have the appropriate resources and skills for digital transformation?	Yes
People, Structure and Organization	How do you attract and recruit digital talent?	Yes
People, Structure and Organization	Have you identified new and established roles in your organization based on digital competencies? If yes, how would you define digital roles (such as digital marketing, data scientist, etc.) in your organization?	Yes
People, Structure and Organization	Where is digitization located in your organization and existing governance structures?	Yes
Processes and Systems	How do you conduct digital marketing?	No
Processes and Systems	Do you apply customization to enhance the customer experience? Do you leverage data for customization?	Yes
Processes and Systems	How do you use digital technologies and analytics to improve, change or innovate business channels to leverage competitive advantage?	Yes
Processes and Systems	What is the maturity of your cybersecurity governance, strategy and architecture?	Yes

Processes and Systems	Can you work effectively from home?	No
Processes and Systems	What does your data infrastructure cover and which feature does it have? (Efficient, flexible, complex, competitive advantage, etc.)	Yes
Processes and Systems	Do you use KPIs to measure digitalization?	Yes
Strategy	How does your organization digitalize?	Yes
Strategy	To what extent are digital technologies and opportunities integrated into corporate core functions? Is the digitization and expansion of core operations part of the roadmap and strategy?	Yes
Strategy	What does your company's digital strategy contain?	Yes
Strategy	What are your processes to prioritize and develop digital initiatives?	Yes
Strategy	In your digital-focused business strategy, do you have goals or targets for digitalization?	Yes
Strategy	How does your organization manage and control its digital transformation journey and its resources?	Yes
Strategy	How do you leverage digital and technologies for innovation?	Yes
Strategy	How do you evaluate and create digital business opportunities?	No
Strategy	How do you innovate your market? Do you play a pivotal role in the changes in your industry?	Yes
Technology	How do you use emerging technologies such as AI, RPA or IoT etc.?	Yes
Technology	How do you apply operations, development, application delivery, security, and continuous improvement principles for IT?	Yes
Technology	Do you use Information and Communication Technologies (ICT) partnerships?	Yes

5.7 Conclusions

The development of the digital maturity measurement tool is explained in Chapter 3. In this chapter, the following research questions are aimed to be answered: *What is the digital maturity level of the automotive company where the research is taking place at t0? And how do we measure the digital maturity level of the organization?*

To answer these research questions, a mix of qualitative and quantitative methods are used based on the data gathered from the case study at an automotive sales and aftersales company. By analyzing all the information coming from qualitative second round of interviews, quantitative statistical analysis, and performing measure quality tests such as reliability and validity, the questions which are not performing well based on the findings are excluded from the constructs. Finally, this chapter offered a strong argument for the finalization of the index. At the end of this chapter, it can be concluded that a digital maturity index (Table 43) is proposed as a final measurement norm.

CHAPTER VI

CONCLUSIONS, IMPLICATIONS, LIMITATIONS, AND FURTHER RESEARCH

The digital maturity model proposed in this study brings a new approach to both academics and practitioners in digital transformation literature towards the digital measurement of the organizations. This research mainly aimed to answer, “How can the digital maturity level of an organization be measured?”. The digital maturity measurement of organizations research was structured into four sub-research questions and parts. Findings of each part are as follows: (1) The Stages of digital business transformation, (2) Organizational aspects of digital maturity, (3) Digital Maturity Index as an instrument, (4) Digital Maturity Index implementation findings. This research contributes to literature by delivering a digital maturity measurement model which merges the academic and practitioner contributions and brings a new insight into organization’s digital maturity measurement literature. The developed index is a living and adoptable scale in coherence with the contingency theory and can be adoptable to different company, industry settings in future research. Based on the research findings, the major conclusions and implications are detailed below. The chapter ends with limitations of the study and further research areas.

6.1 Conclusions

The target of this research was to investigate digital maturity measurement of organizations. The main research question of this study is defined as: “How can we measure the digital maturity level of an organization?”

The findings of this dissertation suggested that for measuring the digital transformation stage of the companies, a DMI instrument would be beneficial. This research contributes to literature by delivering a digital maturity measurement model which merges the academic and practitioner contributions which is tested at an automotive company, but it was developed considering cross-industry implementation.

The instrument developed in this research consists of 31 questions corresponding to the 6 organizational aspects and their respective rubrics for the 5 digital business transformation stages. The final version of Digital Maturity Index (DMI) as a maturity assessment instrument is the output of “*Chapter 5 – Digital Maturity Index Testing*”. In Chapter 6, based on the output of Chapter 2, 3, 4, and 5 general findings are discussed; and limitations mentioned and proposals for further research are highlighted.

The major research question was focused on the following sub-research questions to address this overall research.

RQ1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?

RQ2: Which internal organizational aspects should be considered when measuring the digital business transformation of the company?

RQ3: How can the digital maturity level of an organization be measured?

RQ4: How can Digital Maturity Index (DMI) as an instrument be validated?

Towards the assessment of the organizations’ digital maturity stage, each research question is built on the outcome of the previous one. The general scope of this research was structured based on mixed research methods: literature review, qualitative research

through unstructured interviews, and quantitative analysis based on the index implementation.

This research utilized the literature review during each phase of the research: from the identification of the digital business transformation stages, the organizational aspects, during the development of the digital business maturity assessment instrument, and the discussion of DMI implementation results. The literature review was followed by expert interviews. This made possible the validation of the literature findings with the practitioner perspectives. The commonalities of these two finding methods created the digital maturity index, its rubrics, organization aspects and digital business transformation phases. At the later stage of the research, the same approach, which is literature, qualitative interviews and revisiting the literature cycle used for the assessment of DMI results and the finalization of the measurement as a tool.

At the beginning of the research these two research questions aimed to be answered: *“RQ1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?”*

For finding answers for the initial research question *“RQ1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?”* In the initial research question, perceived ambiguity in the distinctions between the core concepts of digital business transformation: digitization, digitalization, and digital transformation were discussed. Based on the analysis, it was found that there are fundamental distinctions between related concepts. The distinctions between digital passive, digitization and digitalization are

mostly clear and consistent. However, the distinctions between digitalization, digital transition and digital transformation are not always clear and used interchangeably. There is a consensus on the fundamental difference between digitization and digitalization. Digitization is a technical process, whereas digitalization is a socio-technical process using digitized data and information to automate business processes. Furthermore, there is no consensus on the difference between digitalization and digital transformation. Based on the findings of the literature review, it is concluded that digital business transformation is progressing and evolutionary in stages, where one stage is the successor of the previous stage. Specifically, this process starts from (i) *digital passive* to (ii) *digitization*, over (iii) *digitalization*, and (iv) *digital transition* to (v) *digital transformation*.

For finding answers for the second research question “RQ2: *Which internal organizational aspects should be considered when measuring the digital business transformation of the company?*” Findings of both the literature review and analyzed expert interviews analyzed the influence of digital technology on the internal organizational aspects investigated. While answering this research question, it was found that there are internal factors that should be considered measuring the digital transformation of the company. Like the difference between digital transformation related terminologies, these internal factors are also named differently from paper to paper. For instances, while several papers highlight “Culture” directly ([58]; [61]; [65]; [59]), several papers grouped “People and Culture” or “Structure and Culture” together ([2]; [64]; [69]); others highlighted the digital side of the culture ([62]; [68]). It was found that in all of these papers, culture is defined by agility, emerging set of values, practices, digital awareness, and development of digital and organizational culture to support progress along digital transformation journey. Therefore, it was found that “Culture,

Culture and Expertise, Digital culture” can be grouped under the umbrella of “Culture” aspect of the organizations.

When all the dimensions of 18 digital maturity models are listed, the most mentioned dimensions are sorted by descending order as strategy, technology, people, culture, organization, processes, systems, and data. Based on the literature review the most encountered internal organizational aspects as well as the most mentioned aspects during the interviews are investigated, namely *Strategy, Systems and Processes, Data and Analytics, Culture, People, Structure and Organization, Technology*.

For finding answers for the third research question “*RQ3: How can the digital maturity level of an organization be measured?*”, qualitative and quantitative methods were blended. The literature review and interview findings were used to define the digital business transformation stages which formed the Digital Maturity Index stage of maturity and to determine the organizational aspects which can be considered for the digital maturity measurement. Therefore, based on these findings a sample of research questions were generated and their corresponding rubrics were populated. A measure is developed based on the collected data and it is then tested with the practitioners. Based on their feedback and comments, measure, its questions, and their rubrics were revisited, and number of questions were reduced. Then the second test phase took place and this time rubrics were also discussed. At the end of these feedback sessions with the practitioners and as well as the PhD Committee’s feedback, the measure became ready for real implementation at the business side with 35 questions.

For finding answers for the fourth research question “*RQ4: How can Digital Maturity Index (DMI) as an instrument be validated?*”, a mix of qualitative and quantitative methods were used. By analyzing all the information coming from qualitative

second round of interviews, quantitative statistical analysis, and performing measure quality tests such as reliability and validity tests, the question set was reviewed and 4 questions which are not supported by the quantitative and qualitative analysis were excluded. At the end of these amendments, the final version of digital maturity index has been developed.

6.2 Scope Framing Based on Contingency and External Organizational Aspects

While answering the main research question and the four sub-research questions, contingency theory should also be considered. According to Burns and Stalker [115: 172], “A mechanistic management system is appropriate to stable conditions. The organic form is appropriate to changing conditions, which give rise constantly to fresh problems and unforeseen requirements for action which cannot be broken down and distributed automatically arising from the functional roles defined within a hierarchic structure.”

Furthermore, according to Lawrence and Lorsch [116: 4], “Since the primary concern was with the internal functioning of organizations, it appeared that one useful way to conceive of the environment of an organization was to look at it from the organization outward. This approach is based on the assumption that an organization is an active system which tends to reach out and order its otherwise overly complex surroundings so as to cope with them effectively. Then as the organization becomes differentiated into basic subsystems, it segments its environment into related sectors. Industrial organizations usually become segmented into three essential major subsystems here termed basic subsystems to distinguish them from integrative subsystems. These are the sales subsystem, the production subsystem, and the research and development subsystem.” Furthermore, in their research of analyzing stability versus change in the

environment, Lawrence and Lorsch [117: 207] considers important functions of sales, research, production and engineering, purchasing, finance, personnel, public relations and legal, and relevant environmental sectors as customers and competitors, science and technology, technology and equipment suppliers, suppliers, financial institution, labor and professional markets, press and legislative bodies, governmental regulatory agencies.

While deciding on the research scope, the scope was limited to internal organizational aspects. As stated by Lawrence and Lorsch [116], “One useful way to conceive of the environment of an organization was to look at it from the organization outward.” In this this research, external organizational aspects and contingency perspectives were left out. However, as the developed index is living, populating and adoptable scale, it is also in coherence with the contingency theory. Moreover, the model and internal organizational aspects were validated through expert interviews, quantitative and qualitative analysis both from the practitioner side and academical side as described in Chapter 2, 3, 4 and 5. Therefore, the developed instrument was validated academically and practically and tested at an automotive sales and aftersales company.

DMI was only implemented at an automotive sales and aftersales company in Turkey and scope decision was made considering internal organizational aspects. While deciding on the scope of the research, it was also realized that if DMI is tested at different company and surroundings, the results could be different. Considering the previous research conducted in the contingency area, in this research external aspects which might have an impact on the organization’s digital maturity level were intentionally excluded from this research scope. However, external dimensions which might affect contingency situations, organization’s digital maturity, and items and influence the rubrics of DMI tool such as network and ecosystems, digital platforms, industry, country, global economy, country-based developments, economic developments should be considered

for further research. Therefore, the organizational dimensions can be further expended towards covering network and ecosystems, digital platforms, industry, country, global economy, country-based developments, economic developments, as well as the questions of DMI can be further improved based on these external organizational and contingency factors.

However, this model can be generalizable considering the following logic. This research was conducted in an automotive company operating in the sales and aftersales sector. The automotive sales and aftersales company offer sales and aftersales services for the passenger cars, light and heavy commercial vehicles of producers from Germany, Spain, Czech Republic, and Sweden. Therefore, this DMI tool can be generalizable over countries in automotive industries. However, contingency factors can be isolated in future research.

6.3 Implications

This research has several implications and strengths. These can be grouped as follows: 1) *having both academic and practical implications*, 2) *proposing a clear definition of digital transformation and related terminologies*, 3) *offering an index validated for automotive industry*, 4) *integrating the views and inputs of 4 participant groups (IT experts, Managers, Beneficiaries, and Business Experts)*, 5) *offering a Digital Maturity Model validated through 2 pilot sessions*, 6) *avoiding the country bias tool is developed expert input across Europe (Germany, Turkey, Netherlands, and Austria)*, 7) *providing company implications*.

First implication is “*having both academic and practical implications*”, this research has both academic and practical implications. From the practical implications side, digital technologies and digitalization practices have been changing how people live

and how companies interact with their customers. To adapt to the rapidly changing business environment and ecosystems, organizations offer customers new experiences, and develop new business models, products, and services. However, to develop the right digital model meeting customer expectations and to leverage from the new digital technologies, companies need to fully understand where they are in the digital transformation journey and what digital transformation can be offered both to customers and to companies. Therefore, it is believed that the findings of this research can contribute to the literature and create a base for future research. From the academical implication side, this research contributes to the literature by defining digital business transformation stages, by driving the organizational aspects which should be considered measuring the digital transformation stage, and by proposing an instrument to measure the digital maturity of the organizations. The implication which is different than the other available maturity assessment models in the literature as this model is developed both academically and practically and later tested and validated both academically, statistically, and empirically.

The second implication is “*proposing a clear definition of digital transformation and related terminologies*”. For the initial research questions, “*RQ1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?*”. It is hoped that this review and investigated differences and similarities among digital passive, digitization, digitalization, digital transition, and digital transformation can guide researchers through the concept evolution and to help future researchers to explore the nature and the implications of digital transformation and related technologies.

The third implication is “*offering an index validated for automotive industry*”. Based on literature review, previous research mostly validated their models in or has a sector focus of manufacturing ([61]; [4]; [27]; [114]; [62]). The other research focuses are SMEs ([60]; [63]; [64]), energy ([65]), service sector ([61]; [59]), chemical industry ([4]; [27]) and telecommunications ([23]). However, none of the prominent 18 articles focuses on the automotive sector. Therefore, this research positions itself to fill this gap in the literature.

The fourth implication is “*integrating the views and inputs of 4 participant groups (IT experts, Managers, Beneficiaries, and Business Experts)*”. In the previous literature, among 18 prominent articles, consulting studies (BCG DAI [66]; KPMG [68]; Deloitte [69]) brings the practitioner contribution during the digital maturity model developments. In addition to consulting studies, Teichert [62] integrates academic, and practitioner split into the model. In the other models as well, developed questionnaires sent out to the experts to be filled out. However, this model was validated with Business Experts, IT Experts, Managers, and Beneficiaries at a workshop session. Therefore, during the implementation of the model participants had the opportunity to challenge the questions and directly give the verbal feedbacks in addition to statistical voting. Furthermore, none of these models from the literature review has the expert group split of Business Experts, IT Experts, Managers, and Beneficiaries, nor their expert group-based perspective comparison. As this group is not a random sample group, rather a selected group of digitalization experts, then it can be concluded that our sample is a representative of people dealing with digital transformation topics. Therefore, the risk of none-response bias is eliminated.

The fifth implication is “*offering a Digital Maturity Model validated through 2 pilot sessions*”. In comparison to the other models, in this research developed model was

validated twice through 2 pilot sessions with the industry experts covering Business Experts, IT Experts, Managers, and Beneficiaries.

The sixth implication is “*avoiding the country bias tool is developed expert input across Europe (Germany, Turkey, Netherlands, and Austria)*”. As the tool is developed with the input of literature review with a global focus and also the initial round of interviews was a sample of experts from Turkey, Germany, Netherlands and Austria, it can be concluded that country bias was also eliminated during the questionnaire development.

The seventh implication is “*providing company implication*”. The company received useful relevant insights based on the DMI testing and the expert interviews. Contributions to the company can be grouped as providing score-based insights, offering a digital maturity measurement tool, comparing scores between role-based groups, providing insights and ideas towards score improvement via specific actions. Due to confidentiality reasons, the impact and digital maturity index’s overall contribution to the company cannot be numericized. However, the improvement and progress of DMI testing scores after the implementation of the action plan items mentioned in Chapter 5 will be considered in future research. Furthermore, the company will use DMI instrument to identify and keep track of improvement actions and for the measurement of the company. Lastly, the company will use DMI instrument for measurement of its digital development and maturity at regular time intervals.

6.4 Limitations and Further Research

There are nine limitations in this research based on the scope of decisions which can be grouped as: (1) *small sample research with empirical data*, (2) *success of transformation not measured*, (3) *organizational aspect frequencies mentioned by*

interviewees, (4) internal organizational aspects, (5) detailing research in organizational sub-aspects, (6) only focused on contemporary technologies, (7) automotive focus and only focused on one company case and not cross case comparison, (8) the content of the rubrics - theory discussion per rubric, (9) only sources in English language. In this section, further research areas are explained corresponding to each research question.

First limitation is “*small sample research with empirical data*” for the initial research question of “*RQ1: What are the differences between the core concepts of digital business transformation, i.e., digitization, digitalization, and digital transformation? If so, how can these concepts be arranged as stages of digital business transformation?*”, there are some limitations of this research that suggest areas for further research. While stages (ii) digitization, (iii) digitalization and (v) digital transformation have been established in recent literature as stages of the digital business transformation process, the same is not yet true for stages (i) digital passive and (iv) digital transition. These stages should therefore be tested and confirmed in further research. Interviews with a larger group of experts could be helpful here. Based on this, further semantic analysis could be performed to isolate the frequencies of focal points mentioned by interviewees. The stages as proposed and the differentiation between them come from a literature review and have not been tested with empirical data. Future studies may focus on collecting empirical data that may generate better insights about what makes every one of the five stages unique and whether there are differences among industries. Larger-sample research within specific industries may be carried out to validate the stages.

Furthermore, the second limitation is “*success of transformation not measured*”. The research looks only from digitalization, digital transformation, technology, and company strategy perspectives. However, the success of the transformation is not

measured. Company implications were discussed in more detail in “Chapter 6.3 Implications” under seventh implication “*company implications*”.

The third limitation is “organizational aspect frequencies mentioned by interviewees”. For the second research question, “RQ2: *Which internal organizational aspects should be considered when measuring the digital business transformation of the company?*”, it is believed the findings of this research can create a base for future research by providing the analysis of both literature review and empirical data towards identifying and defining organizational aspects. As explained in Chapter 3, organization aspects frequently mentioned and considered during (Digital) Maturity Measurement Models are listed. Therefore, the frequency of mentioned organizational aspects based on the prioritized articles are considered in this research. However, further analysis could be performed to isolate the frequencies mentioned by interviewees.

The fourth limitation is “*internal organizational aspects*”. The scope is limited by only focusing on internal organizational aspects. Any other external factors and influences such as macro and micro economic factors, pandemic, etc. are excluded. For further research, other external factors such as competition, impact of pandemic, regulatory factors, topics can also be considered based on contingency theory.

The fifth limitation is “*detailing research in organizational sub-aspects*”. Furthermore, within the scope of this research, only internal organizational aspects were derived based on literature review and the expert interviews. Identified organizational aspects are *Strategy, Systems and Processes, Data and Analytics, Culture, People, Structure and Organization, Technology*. However, these organizational aspects can be further detailed under sub-aspects. Furthermore, external aspects can be investigated to support these driven internal organizational aspects.

Moreover, the sixth limitation is “*only focused on contemporary technologies*”. The research is focusing on and studying contemporary technologies, not investigating conventional technologies. Therefore, the research can be further extended by other technologies. Furthermore, even though focused digital technologies are coming outside of the organization, in this research the focus is on the digital transformation inside the organization. Therefore, external influencing factors of Digital Transformation are not under focus.

The seventh limitation is “*automotive focus and only focused on one company case and not cross case comparison*”. For the third research questions, “*RQ3: How can the digital maturity level of an organization be measured?*”, considering the scope of this research, there are questions with several limitations and further improvement areas for the upcoming research. The scope for research is modified for considering the dynamics of the automotive industry. This tool can also be reviewed and modified to be applicable for other industry dynamics. Therefore, the question set can be reviewed based on industry variants in future research. Furthermore, it can be applied to more than one company under contingency conditions. After implementing contingency conditions based on industry variants and country variants, DMI can be more generalizable for other industries and countries. Contingency and generalization conditions were discussed in more detail in “Chapter 6.2 Scope Discussion Based on Contingency and External Organizational Aspects”.

The eighth limitation of this question’s scope is “*the content of the rubrics - theory discussion per rubric*”. In this chapter how we developed the rubrics was discussed but the theory per rubric was not discussed. However, it should be emphasized that the rubric content was tested with the business side and additionally validated through interviews

with the practitioners. Therefore, for the upcoming research the content development of each rubric can also be covered in more detail for the further improvement of the research.

The ninth limitation is “*only sources in English language*”. The papers used in this literature review covered on the research conducted and published in English mediums. Therefore, research can also be further extended with the literature of other languages as well.

Regarding the mentioned scope decisions mentioned and limitations, there is some room for improvement and for “*further research*” after the thesis. By utilizing the findings and the organization’s structural elements, questionnaires were formulated to develop Digital transformation maturity index to be used as a measurement instrument.

As an outcome of Chapter 5, the number of questions at DMI as a final instrument consists of 31 questions. Therefore, the 35-question version of DMI was tested empirically and validated both statistically and empirically. However, it can be noted as a limitation that the final instrument with a reduced number of 31 questions the of DMI is not yet tested empirically. For further research, it can be tested empirically.

The Digital maturity index as a measurement instrument supports the company to get a better understanding of the state of Digital Transformation. It can also be expanded, covering other industries or the retail company too.

Furthermore, this measurement is being done for the initial assessment for the t0 measurement. Therefore, for a better assessment after a certain period (6 months to 1 year) the reassessment can be done to measure progress.

Moreover, the Digital Maturity Index is prepared as a tool to assess companies’ digital maturity level. Therefore, it does not cover the detailed action plan on how a

company can improve its digital maturity level. For further research, DMI's coverage can be extended by the detailed action plan and digital maturity improvement activity list.

Finally, in this research confirmatory factor analysis is implemented as the factors and constructs determined before the implementation. As for the confirmatory factor analysis, CFA results and reliability test look promising, the research can be further improved with principal component analysis and in future research Exploratory Factor Analysis can also be used.

Therefore, considering these listed nine limitations, the research can be further enriched by *enlarging the sample with empirical data, measuring the success of transformation, considering external organizational aspects, detailing research in organizational sub-aspects, focusing on conventional technologies, integrating cross case comparison, detailing the content of the rubrics - theory discussion per rubric, or extending literature review with non-English sources.*

Of special note, throughout history, industry has been through major changes. In the last decades, the improvement of new digital technologies has triggered digital innovation tremendously. The digital business transformation and measurement of digital maturity have taken an important place on the agenda of the organizations. To contribute into organization's digital maturity measurement literature, this research mainly aimed to answer, "How can the digital maturity level of an organization be measured?" Findings of the research deliver a digital maturity measurement model to literature which merges the academic and practitioner insight. To be among the survivors of the future's business world, organizations and decision makers should give priority to digital business transformation.

APPENDIX A

Appendix A.1 - Informed Consent Form

INFORMED CONSENT FORM

Informed Consent Form

Information and Purpose: The interview for which you are being asked to participate in, is a part of a research study that is focused on digital transformation. The purpose of this study is to gain a better understanding of the Digital Maturity Measurement based on the Stages of Digital Business Transformation.

Your Participation: Your participation in this study will consist of an interview lasting approximately one hour. You will be asked a series of questions about digital transformation, digital maturity, and digital technologies. You are not required to answer the questions. You may pass on any question that makes you feel uncomfortable. At any time you may notify the researcher that you would like to stop the interview and your participation in the study. There is no penalty for discontinuing participation.

Benefits and Risks: The benefit of your participation is to contribute information to the study. There are no risks associated with participating in the study.

Confidentiality: The interview will be tape recorded; however, your name will not be recorded on the tape. Your name and identifying information and contextual information from which your identity could be inferred will not be associated with any part of the written report of the research. All of your information and interview responses will be kept confidential. The researcher will not share your individual responses with anyone other than the research supervisor. In case of any direct quoting, the interviewee's direct permission will be asked. In case of the request of the interviewee requests, the interviewee will be able to see (and correct) either recording or transcript.

If you have any questions or concerns, please contact the researcher Irmak Mutlu or her supervisor Erik den Hartigh.

By signing below I acknowledge that I have read and understand the above information. I am aware that I can discontinue my participation in the study at any time.

Signature_____ Date_____

Özyegin University

Appendix A.2 – First and Second Round of Interview Questions

Table 44: First and Second Round of Interview Questions

1 st Round of Interview Questions (Generic & Conceptual Questions)			2 st Round of Interview Questions	
Digital Questions	Transformation	Related	General	
	1. What is digitization from your perspective?			1. In the second round of interview, the target is to fill in gaps between the DMI data analysis and getting the expert views.
	2. What is digitalization from your perspective?			2. How do you evaluate the culture score?
	3. What is digital transformation from your perspective? What do you understand from digital transformation?			3. How do you evaluate the data and analytics score?
	4. What is happening in the sector?			4. How do you evaluate the people, structure, and organization score?
	5. Do you see are relationship between technology and what's happening in your company? Do you see any influence at all?			5. How do you evaluate the processes and systems score?
	6. What technology options will enable a company's digital transformation journey?			6. How do you evaluate the strategy score?
	7. Were you involved in digital transformation projects? Do you consider this project successful or failed? How?			7. How do you evaluate the technology score?
	8. Do we have the appropriate skills and resources in-house to embark on this journey?			8. Why do Managers score higher in Culture, Data and Analytics, People, Structure and Organization, and Processes and Systems aspects in comparison to Beneficiaries, Business Experts, and IT Experts?
	9. Is digital transformation a controversial topic? If so, why?			9. Why do you think Data and Analytics score lower than other scores?
				10. Why do you think Culture and Strategy aspects scored higher on average?
				11. Why do you think IT Experts score highest in Strategy and Technology categories?
				12. Why do you think IT Experts score higher in Processes and Systems categories?

	13. Do you see any improvement area? Or any ideas for action development? (For the questionnaire & for the score improvement)
Digital Technology Related Questions 10. What is technology? 11. What is digital technology? 12. Which technologies are you aware of? 13. Are you implementing those technologies? 14. Which technology that you think have the highest impact at your industry? 15. How and why do you select those technologies?	Age 1. Why do you think culture, strategy and technology score increases by the increase of age? Education based 1. Why do you think social and positive science backgrounds scored higher on strategy and technology score? 2. Why does processes and system scores are closer? 3. Why do business administration and fundamental sciences such as math, physics backgrounds score higher on people, strategy, and organization scores? Experience 1. Why do you think people with 5-10 years and more than 20 years of work experience scored higher on culture score? 2. Why do you think people with 2-5 years of work experience scored higher on data analytics, people, structure and org and strategy, technology aspects? Digital Work Frequency 1. Why do you think people who declare that they work frequently on digital topics scored higher than all other scores?

Appendix A.3 - Digital Maturity Index Questions

Items by Construct

a. Culture

Culture 1.1

- **Question:** Çevik (Agile) ürün ve hizmet sunma ilkelerini, iş birimleri ve bilgi teknolojileri birimleri dahil olmak üzere kuruluşun geneline nasıl uygularsınız?
- **Question:** How do you apply the principles of agile product and service delivery across a broad spectrum of the organization, including business units and IT units?

Rubrics:

- **Score 1 – Dijital Pasif:** Waterfall (şelale) proje modelleri ve yöntemlerini kullanıyoruz.
- **Score 1 – Digital Passive:** We use waterfall projects models and methods.
- **Score 2 – Sayısallaştırma:** Çevik (Agile) deneysel süreçleri deneyimliyoruz ve denemeler yapıyoruz. Scrum master, çeviklik koçu gibi yeni agile roller tanımladık.
- **Score 2 – Digitization:** We experiment with agile processes. We defined agile roles such as scrum master and agility coach.
- **Score 3 – Dijitalleşme:** Çevik (Agile) çalışma modelimiz tanımlandı ve sürekli gelişmeye devam etmektedir. Çevik ekiplerden oluşan sabit bir portföyümüz var ve bu ekipler organizasyonun geri kalanıyla başarıyla çalışmaktadır.
- **Score 3 – Digitalization:** We use an agile working model, that continues to evolve. We have a stable portfolio of agile teams that work with the rest of the organization.

- **Score 4 – Dijital Geçiş:** Çevik (Agile) kültür ve çeviklik ilke ve prensiplerini çoğu iş birimlerinde ve tüm geliştirme süreçlerinde (iş birimleri ve bilgi teknolojileri genelinde) gözlemliyoruz.
- **Score 4 – Digital Transition:** We observe the principles of agile culture and agile in all development processes (across business units and information technologies) in most business units.
- **Score 5 - Dijital Dönüşüm:** Çevik çalışma yöntemleri, dijital ürün, hizmet sunumunun ötesine geçerek organizasyonun diğer departmanlarına taşınır. Tüm iş kararları ve süreçleri çevik süreçlerle oluşturulur. Şirkette her bireyin çevik rolü vardır.
- **Score 5 - Digital Transformation:** Agile working methods move beyond digital product and service delivery to other departments of the organization. All business decisions and processes are created with agile processes. Every individual in the company has an agile role.

Culture 2.1

- **Question:** Dijital ve analog (fiziksel) süreçlerin gelişimine nasıl öncelik veriyorsunuz?
- **Question:** How do you prioritize digital and analog (physical) process development?

Rubrics:

- **Score 1 – Dijital Pasif:** İş alanımızın tamamına analog süreçler hakimdir
- **Score 1 – Digital Passive:** Analog processes dominate our entire business.
- **Score 2 – Sayısallaştırma:** Bazı süreçlerimiz dijitalleşmiştir. Önce analog hakimdir, sonra dijital takip eder

- **Score 2 – Digitization:** Some of our processes are digitized. Analog dominates, followed by digital.
- **Score 3 – Dijitalleşme:** Dijitalleşme çalışmalarına yoğun kaynak ayrılmaktadır. Dijital, analog süreçleri geliştirir
- **Score 3 – Digitalization:** Intensive resources are allocated to the digitalization effort. Digital enhances the analog processes.
- **Score 4 – Dijital Geçiş:** Dijital ve analog birlikte hareket ederler. Analog her sürecin dijitalleşmesi için yol belirlenmiştir
- **Score 4 – Digital Transition:** Digital and analog work together. A path is determined for the digitalization of every analog process.
- **Score 5 - Dijital Dönüşüm:** Tüm süreçler dijital odaklıdır. Geri kalan analog süreçler dijital odaklı olarak yönetilir.
- **Score 5 - Digital Transformation:** All processes are digital-driven. Remaining analog processes are digital-driven.

Culture 3.1

- **Question:** Kuruluşunuzdaki ve sektörünüzdeki dijital gelişmeler şirketinizin dijitalleşme önceliğini nasıl etkiliyor?
- **Question:** How do digital developments in your organization and industry affect your company's digital priority?

Rubrics:

- **Score 1 – Dijital Pasif:** Sektör hiçbir zaman tamamen dijital olmayacaktır, ve dijital stratejimiz yoktur.
- **Score 1 – Digital Passive:** The industry will never be fully digital, and we have no digital strategy.

- **Score 2 – Sayısallaştırma:** Dijital unsurların sektörü etkileyebileceğinin farkındayız ancak henüz bir dijital strateji tanımlamadık.
- **Score 2 – Digitization:** We are aware that digital elements can affect the industry, but we have not yet defined a digital strategy.
- **Score 3 – Dijitalleşme:** Dijitalleşmenin sektöre yönelik etkilerini öngörerek, stratejimizi oluşturduk. Dijital stratejiler, trendlerin ve dijital etkilerin analiz edildiği çeşitli işlevlerde mevcuttur.
- **Score 3 – Digitalization:** We created our strategy by anticipating the threats of digitalization for the industry. Digital strategies are available in various functions where trends and digital influences are analyzed.
- **Score 4 – Dijital Geçiş:** Kurumumuz için dijital hedef durumu belirlenmiş ve kurum genelinde vizyon ifade edilmiştir. Sektörde birçok süreç dijital olabilir, stratejimizin sektör ortalamasının üzerinde olduğu boyutlar vardır.
- **Score 4 – Digital Transition:** The digital target situation for our institution has been determined and the vision has been expressed throughout the institution. There are dimensions where our strategy is above the industry average.
- **Score 5 - Dijital Dönüşüm:** Sektörün tüm dinamikleri dijitalleşecektir. Her bir sürecimizi dijitalleştirmede öncüyüz. Derinliğimiz diğer sektörlerle rekabet eder. Dijital vizyon, üst yönetim gündeminin en önemli önceliği ve ayrılmaz bir parçasıdır. Güncellenmesi için net bir süreç tanımlanmış ve uygulama döngüsü oluşturulmuştur.
- **Score 5 - Digital Transformation:** All the dynamics of the industry will be digitized. We are ahead of the competition in digitalizing each of our processes. Our depth competes with other industries. Digital vision is the top priority and an

integral part of the senior management agenda. A clear process has been defined for its updating and the application cycle has been established.

Culture 4.1

- **Question:** Ekiplerdeki dijital liderler dijital faaliyetleri nasıl organize ediyor ve kurumsallaştırıyor?
- **Question:** How do digital leaders in teams organize and institutionalize digital activities?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital girişimlere liderlik edecek belirli bir lider bulunmamaktadır, ya da organizasyondaki yönetim dijitalleşmeyi yönetmezler. Ayrıca farkındalık eksikliği vardır ve dijital kurumsal hedeflerle uyumlu değildir.
- **Score 1 – Digital Passive:** There is no specific leader to lead digital initiatives, or management in the organization does not manage digitalization. There is also a lack of awareness and digital is not aligned with corporate goals.
- **Score 2 – Sayısallaştırma:** Dijital inisiyatife liderlik edecek belirli bir lider yoktur. Girişimler geleneksel yöntemlerle yürütülmektedir. Birimlerde dijitalleşme inisiyatiflerle ilerler, eşgüdüm/koordinasyon yoktur. Dijital kurumsal hedeflerle tam uyumlu değildir.
- **Score 2 – Digitization:** There is no specific leader to lead the digital initiative. Initiatives are carried out with traditional methods. Digitization in units progresses with initiatives, but there is no coordination. Digital is not fully aligned with corporate goals.
- **Score 3 – Dijitalleşme:** Dijital ofis ve sahiplik vardır.

- Dijital yetenekler yeni rollere yerleştirilmektedir. Kurum, dijitalle uyum sağlamaya başlamıştır. Fakat her birim süreci aynı istek ve seviyede yönetmemektedir. Dijital farkındalık artmakta ve kısmen kurumun stratejisi ile uyumlu hale gelmektedir.
- **Score 3 – Digitalization:** There is a digital office and ownership. Digital capabilities are being placed in new roles. The institution has started to adapt to digital. However, not every unit manages the process at the same request and level. Digital awareness is increasing and is partially aligned with the organization's strategy.
- **Score 4 – Dijital Geçiş:** Dijital ofis ve birimler eşgüdümlü hedeflerle ilerlemektedir. Dijital liderler teşvik edilir. Organizasyon açıkça dijital ortama uyum sağlar. Dijital ve kurumsal strateji güçlü bir şekilde uyumlu çalışmaktadır
- **Score 4 – Digital Transition:** Digital offices and units are progressing with coordinated goals. Digital leaders are encouraged. The organization clearly adapts to the digital environment. Digital and corporate strategy are strongly aligned
- **Score 5 - Dijital Dönüşüm:** Dijitalleşme koordinasyonu ve iş stratejisi doğrultusunda dijital, tüm ekipler ve liderler tarafından benimsenmiştir. Dijital liderler tam yetkiye sahiptir ve karar alma organlarında güçlü bir yere sahiptir. Dijital yeni normaldir ve dijitalleşme organizasyon stratejisinin özüdür.
- **Score 5 - Digital Transformation:** Digital has been adopted by all teams and leaders in line with the digitalization coordination and business strategy. Digital leaders have full authority and have a strong position in decision-making bodies. Digital is the new normal and digitalization is the essence of the organizational strategy.

Culture 5.1

- **Question:** Dijital teknolojilerin, kurum kültürü üzerinde nasıl bir etkisi vardır?
- **Question:** What is the impact of digital technologies on the culture of the organization?

Rubrics:

- **Score 1 – Dijital Pasif:** Organizasyonda dijital bilinç yavaş yavaş yerleşmektedir. Ancak, şirketlerin performansı artırmak için dijital teknolojilerden yararlanabilecekleri mekanizmalar net olarak tanımlanmamıştır. Gerekli araçlar sadece parça parça bulunmaktadır
- **Score 1 – Digital Passive:** Digital consciousness slowly develops in the organization.
The mechanisms by which the company can benefit from digital technologies to improve performance are not clearly defined. Necessary tools are only piecemeal available
- **Score 2 – Sayısallaştırma:** Şirketlerin performansı artırmak için dijital teknolojilerden yararlanabilecekleri mekanizmalar tanımlanmıştır. Organizasyonda dijitalleşme bazı adım ve süreçlerde gözlemlenmektedir. Birimler gerekli araçları kullanmakta serbesttir.
- **Score 2 – Digitization:** Mechanisms by which the company can benefit from digital technologies to improve performance have been defined. Digitization in the organization is observed in some steps and processes. Units are free to use the necessary tools.
- **Score 3 – Dijitalleşme:** Kurumsal performansı iyileştirme nihai hedefi ile dijital bir organizasyon kültürü geliştirir, iş dijitalleştirme süreci ve dijital araçlardan değer üretimini kolaylaştırır. Kurumun bu konulardaki farkındalığı yüksektir.

Organizasyonda her birey dijitalleşme ile ilgili sorumluluğunu bilir, ortam ve araçlar hazırlanmaktadır

- **Score 3 – Digitalization:** A digital organizational culture develops, with the goal to improve corporate performance facilitates the business digitization process and value generation from digital tools. The awareness of the institution on these issues is high. Every individual in the organization knows their responsibility for digitalization. The environment and tools are prepared.
- **Score 4 – Dijital Geçiş:** Her birey dijital iş süreçlerinde sorumluluğunu bilir, uygular, araç ve ortamları talep eder. Eş güdüm ve koordinasyon vardır. İşletmenin kültürü, dijital işyeri uygulamalarını içerecek şekilde genişlemiştir.
- **Score 4 – Digital Transition:** Every individual knows and applies responsibility in digital business processes, demands tools and environments. There is coordination. The culture of the business has expanded to include digital workplace practices.
- **Score 5 - Dijital Dönüşüm:** Dijital organizasyon kültürü, dijital organizasyonun işleyişi hakkında bir dizi ortak varsayım ve anlayışla kavramsallaştırılmıştır. Dijitalleşme şirketin tüm birimlerine nüfuz etmiştir ve strateji doğrultusunda gelişim planları vardır.
- **Score 5 - Digital Transformation:** Digital organizational culture is conceptualized with a set of shared assumptions and understandings about the functioning of the digital organization. Digitization has permeated all units of the company and there are development plans in line with the strategy.

Data and Analytics D3.1

- **Question:** Veri platformunuzun kapsamı, kullanımı ve uygulanması nasıldır?

- **Açıklama:** Bir veri platformu / veri gölü, bir kuruluşun uçtan uca veri ihtiyaçlarını toplu olarak karşılayan entegre bir teknolojiler kümesidir. Veri herkesin kendi kopyasını oluşturmaya gerek olmadan gelecekteki bir erişim için kullanıma hazır durumdadır. Verilerinizin alınmasını, depolanmasını, hazırlanmasını, teslim edilmesini ve yönetilmesinin yanı sıra kullanıcılar ve uygulamalar için bir güvenlik katmanı sağlar.
- **Question:** What is the scope, use and implementation of your data platform?
- **Description:** A data platform/data lake is an integrated set of technologies that collectively meet an organization's end-to-end data needs. The data is available for future access without anyone needing to make their own copy. It provides a layer of security for users and applications as well as the retrieval, storage, preparation, delivery and management of your data.

Rubrics:

- **Score 1 – Dijital Pasif:** Veri platformu yoktur.
- **Score 1 – Digital Passive:** There is no data platform.
- **Score 2 – Sayısallaştırma:** Veri platformu kısmen veya birkaç modüle dayalı olarak mevcuttur.
- **Score 2 – Digitization:** A partial data platform is available or a data platform based on several modules.
- **Score 3 – Dijitalleşme:** Tüm modülleri kapsayan bir veri platformu mevcuttur.
- **Score 3 – Digitalization:** A data platform is available covering all modules.
- **Score 4 – Dijital Geçiş:** Veri platformu bileşenleri karmaşıklığı önleyecek şekilde dokümanite edilmiştir.
- **Score 4 – Digital Transition:** Data platform components are documented to avoid complexity.

- **Score 5 - Dijital Dönüşüm:** Veri platformu uygulaması, veri stratejisi hedeflerini destekler ve kuruluş genelinde aktif olarak kullanılır.
- **Score 5 - Digital Transformation:** The data platform implementation supports data strategy objectives and is actively used across the enterprise.

Data and Analytics D1.1

- **Question:** Gelişmiş analitik ve iş zekası (ör: Power BI vb. analizler) uygulamalarını ne ölçüde kullanıyorsunuz ve standart süreçlere ne ölçüde entegre oluyorlar?
- **Question:** To what extent do you use advanced analytics and business intelligence (eg, Power BI, etc.) applications and to what extent are they integrated into standard processes?

Rubrics:

- **Score 1 – Dijital Pasif:** Sadece rapor kullanıyoruz. Sistematik bir raporlama mekanizmamız yok. Yalnızca geçici raporlar kullanılmaktadır.
- **Score 1 – Digital Passive:** We only use reports. There is no systematic reporting mechanism. Only ad-hoc reports are used
- **Score 2 – Sayısallaştırma:** Kendi raporlarımızı oluşturabiliyoruz.
- **Score 2 – Digitization:** We can create our own reports.
- **Score 3 – Dijitalleşme:** Dashboardlar ile analizler yapıyoruz. Gelişmiş analitiğe giriş seviyesinde çalışmalarımız var.
- **Score 3 – Digitalization:** We make analyses with dashboards. We have introductory level studies in advanced analytics.
- **Score 4 – Dijital Geçiş:** Sürece entegre edilmiş gelişmiş analitik çalışmamız var ve yenileri üzerinde çalışıyoruz.

- **Score 4 – Digital Transition:** We have advanced analytics work integrated into the process and we are working on new ones.
- **Score 5 - Dijital Dönüşüm:** Gelişmiş analitik çalışmalarımızın benchmark olarak aktarılabilir seviyede katma değeri var. İş zekası ve raporlama için veriler için tek bir doğruluk kaynağına sahip bir veri platformu mevcuttur. Veri platformundan paydaşlar BT'den bağımsız olarak kendi analitik çalışmalarını yaparlar.
- **Score 5 - Digital Transformation:** Our advanced analytical studies have added value that can be transferred as benchmarks. A data platform is available with a single source of truth for data for business intelligence and reporting. Data platform stakeholders do their own analytics independently of IT.

Data and Analytics D2.1

- **Question:** Veri Yaşam Döngüsü Yönetimi, kuruluşun tüm verileri için nasıl uygulanır?
- **Açıklama:** Veri Yaşam Döngüsü Yönetimi (DLM), verinin başlangıç anından imhaya kadar ömrü boyunca geçtiği farklı aşamalar olarak tanımlanabilir. Veri yaşam döngüsü aşamaları oluşturma, kullanma, paylaşma, depolama ve silmeyi kapsar.
- **Question:** How is Data Lifecycle Management implemented for all data of the organization?
- **Description:** Data Lifecycle Management (DLM) can be defined as the different stages that data goes through throughout its life, from inception to destruction. Data lifecycle stages include creation, use, sharing, storage and deletion.

Rubrics:

- **Score 1 – Dijital Pasif:** Veri yaşam döngüsü yönetimi yoktur.
- **Score 1 – Digital Passive:** There is no data lifecycle management.
- **Score 2 – Sayısallaştırma:** Veri yaşam döngüsünü yönetecek farklı veri grupları sorumluları belirlenmiştir. İş süreçleri ve veri kaynakları arasındaki bağımlılıklar tanımlanmıştır.
- **Score 2 – Digitization:** Responsibilities for designated data groups have been determined to manage the data lifecycle. Dependencies between business processes and data sources are defined.
- **Score 3 – Dijitalleşme:** Veri yaşam döngüsünün yönetimi için standartlar belirlenmiş ve dokümanite edilmiştir.
- **Score 3 – Digitalization:** Standards for the management of the data lifecycle have been set and documented.
- **Score 4 – Dijital Geçiş:** Veri yaşam döngüsü aktif olarak çalışmaktadır, yeni veri kaynakları oluştuğu sürece dahil edilir.
- **Score 4 – Digital Transition:** The data lifecycle is active, new data sources are included as they are created.
- **Score 5 - Dijital Dönüşüm:** Veri yaşam döngüsü KPI'lar ile ölçülür ve sürekli iyileştirilir.
- **Score 5 - Digital Transformation:** The data lifecycle is measured with KPIs and continuously improved.

Data and Analytics D4.1

- **Question:** Veri kalitesi, doğruluk, eksiksizlik, tutarlılık, güvenilirlik ve güncel olup olmadığı gibi faktörlere dayalı olarak verilerin durumunun bir ölçüsüdür. Kurumda veri kalitesi nasıl sağlanır ve standart bir düzeye ayarlanır?

- **Question:** How is data quality ensured in the institution and set to a standard level?
- **Description:** Data quality is a measure of the health of data based on factors such as accuracy, completeness, consistency, reliability, and up-to-dateness.

Rubrics:

- **Score 1 – Dijital Pasif:** Standart veri düzenlemesi yoktur. Sadece amaca özel, gecici veri düzenlemeleri vardır.
- **Score 1 – Digital Passive:** There is no standard data arrangement. There are ad-hoc data regulations.
- **Score 2 – Sayısallaştırma:** Sınırlı alanda ve kısmi veri kalitesi kontrol uygulamaları mevcuttur.
- **Score 2 – Digitization:** Partial data quality control applications are available in limited space.
- **Score 3 – Dijitalleşme:** Veri kalite kontrolü ve hedefleri belirlenmiştir.
- **Score 3 – Digitalization:** Data quality control and objectives are determined.
- **Score 4 – Dijital Geçiş:** Veri grupları tarafından bir veri kalitesi stratejisi oluşturulur ve yönetilir
- **Score 4 – Digital Transition:** A data quality strategy is established and steered by the data groups
- **Score 5 - Dijital Dönüşüm:** Veri kalitesi için KPI'lar tanımlıdır ve sürekli takip edilir ve iyileştirilir.
- **Score 5 - Digital Transformation:** KPIs for data quality are defined and constantly monitored and improved.

Data and Analytics D5.1

- **Question:** Kuruluşunuzda veriler nasıl işlenir ve veriden nasıl değer yaratılır?
- **Question:** How is data treated, processed and value created in your organization?

Rubrics:

- **Score 1 – Dijital Pasif:** Veri varlıktan ziyade, destekleyeci faktör olarak kabul edilir
- **Score 1 – Digital Passive:** Data is considered the enabler rather than the asset.
- **Score 2 – Sayısallaştırma:** Analitik potansiyelin farkındalığı vardır. İş zekası (BI) uygulamaları ağırlıklı olarak kullanılmaktadır.
- **Score 2 – Digitization:** There is awareness of the analytical potential of data. Business intelligence (BI) applications are mainly used.
- **Score 3 – Dijitalleşme:** Verilerin Yapay Zeka (AI) / Makine öğrenmesi (ML) potansiyelini değerlendirilmeye başladık. Öncü gelişmiş analitik çalışmalar yapılmaktadır.
- **Score 3 – Digitalization:** We start to evaluate the AI/ML potential of data. Advanced analytical work is carried out.
- **Score 4 – Dijital Geçiş:** Veriler, gelişmiş analitik süreçlerde ve stratejik karar vermede kullanılır. Bu deneyimler, veri kalitesini artırır ve yeni işleri tetikler.
- **Score 4 – Digital Transition:** Data is used in advanced analytical processes and strategic decision making. This increases the quality of data and triggers new work.
- **Score 5 - Dijital Dönüşüm:** Gelişmiş analitik, değer in temel itici gücü haline gelmiştir ve yeni iş modelleri ve parasallaştırma imkanları sunar. AI / ML teknikleri, karar verme ve gerçek zamanlı destek için kuruluş genelinde tutarlı bir şekilde kullanılmaktadır.

- **Score 5 - Digital Transformation:** Advanced analytics is a key driver of value and offers new business models and monetization possibilities. AI/ML techniques are used consistently across the organization for decision making and real-time support.

Data and Analytics D6.1

- **Question:** Veri stratejinizin ve veri yol haritanızın kapsamı nedir ve nasıl işletilir?
- **Question:** What does your data strategy and data roadmap include?

Rubrics:

- **Score 1 – Dijital Pasif:** Veri stratejisi ve yol haritası belirlenmemiştir.
- **Score 1 – Digital Passive:** A data strategy and roadmap are not determined.
- **Score 2 – Sayısallaştırma:** Veri stratejisi ve yol haritası kapsamı belirlenme aşamasındadır.
- **Score 2 – Digitization:** A data strategy and roadmap are being determined.
- **Score 3 – Dijitalleşme:** İş hedefleri ile uyumlu veri stratejisi tanımlanmıştır. Yol haritası oluşturulmuştur.
- **Score 3 – Digitalization:** A data strategy compatible with business objectives has been defined. A roadmap has been created.
- **Score 4 – Dijital Geçiş:** İş birimleri ve IT ekipleri yol haritasına uygun hareket eder, yeni süreçleri de dahil ederek çalışmalarını iyileştirir.
- **Score 4 – Digital Transition:** Business units and IT teams act in accordance with the roadmap and improve work by including new processes.
- **Score 5 - Dijital Dönüşüm:** Veri stratejisi periyodik olarak güncellenir, ilerleme sistematik olarak izlenir.

- **Score 5 - Digital Transformation:** The data strategy is updated periodically; progress is systematically monitored.

People, Structure and Organization PE1.1

- **Question:** Şirketinizde dijital yetenek geliştirme nasıl yapılmaktadır?
- (Örnek: Şirketinizdeki çalışanların dijital yetkinliğini artırmaya yönelik programlar ya da dijital beceriler konusunda çalışan eğitim programlarınız var mıdır? Dönüşüm yeteneğinizi ve yetkinlik gelişiminizi ne ölçüde ölçeklendiriyorsunuz?)
- **Açıklama:** Dijital yeterlilik, çalışanların teknolojiyi benimsemelerini, başkalarıyla işbirliği yapmalarını ve modern, dijital bir ortamda etkin bir şekilde çalışmalarını sağlayan yetenektir.
- **Question:** How is digital talent development done in your company?
- (Example: Do you have programs to increase the digital competence of your employees in your company, or do you have employee training programs on digital skills? To what extent do you scale your transformation ability and competence development?)
- **Description:** Digital competence is the ability that enables employees to embrace technology, collaborate with others, and work effectively in a modern, digital environment.

Rubrics:

- **Score 1 – Dijital Pasif:** Bir program uygulanmamaktadır.
- **Score 1 – Digital Passive:** A program is not implemented.
- **Score 2 – Sayısallaştırma:** İlgiye dayalı sınırlı sayıda program merkezi olmayan yapıda yürütülmektedir.

- **Score 2 – Digitization:** A limited number of interest-based programs are run in a decentralized manner.
- **Score 3 – Dijitalleşme:** Tüm çalışanların dijital farkındalığını artırmak ve bilinçlendirmek için bir program yürütülmektedir. Tüm birimlerin dijital olarak yetkin çalışanları vardır. İş birimleri çevik çalışmaya başlamıştır. Genel seviye dijital eğitimler verilmektedir.
- **Score 3 – Digitalization:** A program is carried out to raise digital awareness of all employees. All units have digitally competent employees. Business units started to work agile. (High level trainings)
- **Score 4 – Dijital Geçiş:** Şirket, çalışanlarının belirli dijital teknolojiler, ürünler ve hizmetlerdeki becerilerini geliştirmek için büyük ölçekli bir program yürütmektedir. Dijital konularda sistematik ve özelleşmiş eğitimler verilmektedir.
- **Score 4 – Digital Transition:** The company runs a large-scale program to develop the skills of its employees in specific digital technologies, products and services. (Systematic specialized trainings)
- **Score 5 - Dijital Dönüşüm:** Şirket, tüm çalışanlarının zorunlu olarak katıldığı eğitimler düzenleyerek, dijital becerileri hem üst düzeyde hem de detaylı olarak geliştirmeyi hedeflemektedir. Zorunlu eğitimler verilmektedir.
- **Score 5 - Digital Transformation:** The company aims to develop digital skills both at an advanced level and in detail, by organizing trainings in which all of its employees are required to attend. (Mandatory)

People, Structure and Organization PE1.2

- **Question:** Dijital dönüşüm için uygun kaynak ve becerilere şirket olarak sahip misiniz?

- **Question:** Do you have the appropriate resources and skills for digital transformation?

Rubrics:

- **Score 1 – Dijital Pasif:** Sahip değiliz.
- **Score 1 – Digital Passive:** We do not have any.
- **Score 2 – Sayısallaştırma:** Sınırlı beceri ve kaynaklar mevcuttur.
- **Score 2 – Digitization:** Limited skills and resources are available.
- **Score 3 – Dijitalleşme:** Tanımlanmış beceriler ve kaynaklar mevcuttur. Daha fazla gelişme, yönetim tarafından tamamen desteklenmektedir.
- **Score 3 – Digitalization:** Defined skills and resources are available. Further development is fully supported by management.
- **Score 4 – Dijital Geçiş:** Beceriler ve kaynaklar şirket ölçeğinde mevcuttur
- **Score 4 – Digital Transition:** Skills and resources are available at company scale
- **Score 5 - Dijital Dönüşüm:** Beceriler ve kaynaklar stratejik olarak koordine edilir.
- **Score 5 - Digital Transformation:** Skills and resources are strategically coordinated.

People, Structure and Organization PE1.3

- **Question:** Dijital yetenekleri nasıl çeker ve işe alırsınız?
- **Question:** How do you attract and recruit digital talent?

Rubrics:

- **Score 1 – Dijital Pasif:** Özel bir program bulunmuyor.
- **Score 1 – Digital Passive:** There is no special program.

- **Score 2 – Sayısallaştırma:** Süreçlerimizde dijitalleşmenin artmasıyla birlikte iş profillerimizi gözden geçirmeye başladık. Buna uygun yeteneklere ağırlık veriyoruz.
- **Score 2 – Digitization:** With the increase in digitalization in our processes, we started to review our business profiles. We focus on the appropriate talents.
- **Score 3 – Dijitalleşme:** İş profillerinde dijital ihtiyaçlar tanımlıdır. İşe alımda, dijital yetenekler ön plandadır. İşe alım pozisyonlarımız gerekli ihtiyaçlar konusunda deneyimlidir.
- **Score 3 – Digitalization:** Digital needs are defined in job profiles. In recruitment, digital skills are at the forefront.
- **Score 4 – Dijital Geçiş:** Dijital yetenekleri çekiyor, kazanıyor ve elimizde tutuyoruz. Tüm çalışanların becerilerini geliştirmek için girişimlerde bulunuyoruz. Dijital araçlar yaygındır ve çoğu çalışan etkin bir şekilde kullanma becerisine sahiptir.
- **Score 4 – Digital Transition:** We attract, acquire and retain digital talent. We take initiatives to develop the skills of all employees. Digital tools are common and most employees have the skills to use them effectively.
- **Score 5 - Dijital Dönüşüm:** Dijital için strateji ve kariyer yönetimimiz bulunmaktadır. Dijital yetenekler kurumumuz tarafından işe alınmakta ve kritik pozisyonlara getirilmektedir. Tüm organizasyonun dijital ve çevik bir anlayışa sahip olmasını sağlamak için eğitimler ve dijital akademiler sağlıyoruz. Dijital araçları ilgili tüm çalışanlarımızın kullanıma sunduk ve çalışanlarımız bu araçları uzaktan ve mobil çalışarak etkin bir şekilde kullanabilmektedir.
- **Score 5 - Digital Transformation:** We have a strategy and career management path for digital topics. Digital talents are recruited and placed in critical positions

by our organization. We provide trainings and digital academies to ensure that the entire organization has a digital and agile understanding. We have made digital tools available to all relevant employees and they can use these tools effectively by working remotely and mobile.

People, Structure and Organization ST1.1

- **Question:** Kuruluşunuzda dijital yetkinliklere dayalı yeni ve yerleşik roller belirlediniz mi? Evet ise, kuruluşunuzda dijital rolleri (dijital pazarlama, veri bilimcisi vb. gibi) nasıl tanımlarsınız?
- **Question:** Have you identified new and established roles in your organization based on digital competencies? If yes, how would you define digital roles (such as digital marketing, data scientist, etc.) in your organization?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital roller bulunmamaktadır
- **Score 1 – Digital Passive:** No digital roles are defined
- **Score 2 – Sayısallaştırma:** Bazı alanlarda dijital roller oluşturulmuştur. Genellikle yan iş olarak yürütülür.
- **Score 2 – Digitization:** In some areas, digital roles have been created. They are usually run as a side job.
- **Score 3 – Dijitalleşme:** Dijital roller, çeşitli birimlerde tam zamanlı işler olarak tanımlanmıştır.
- **Score 3 – Digitalization:** Digital roles are defined as full-time jobs in various units.
- **Score 4 – Dijital Geçiş:** Tüm şirket bölümlerine tam zamanlı dijital roller yayılmıştır.

- **Score 4 – Digital Transition:** Full-time digital roles are spread across all company divisions.
- **Score 5 - Dijital Dönüşüm:** Dijital beceriler ve kaynaklar stratejik olarak koordine edilir ve dijital roller stratejik olarak geliştirilir ve ayarlanır
- **Score 5 - Digital Transformation:** Skills and resources are strategically coordinated and digital roles are strategically developed and adjusted

People, Structure and Organization ST2.1

- **Question:** Dijitalleşme, kuruluşunuzda ve mevcut yönetim yapılarının neresinde bulunmaktadır?
- **Question:** Where is digitization located in your organization and existing governance structures?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijitalleşme yok ya da sınırlıdır.
- **Score 1 – Digital Passive:** Digitization is absent or limited.
- **Score 2 – Sayısallaştırma:** Departmanlarda (örneğin: IT ya da iş geliştirme) bağımsız dijital çalışmalar yürütülür. Merkezi bir yapı bulunmamaktadır.
- **Score 2 – Digitization:** Digitalization is located in isolated departments (e.g., IT or Business development). There is no central structure.
- **Score 3 – Dijitalleşme:** Dijital için merkezi küçük bütçeli, sınırlı sorumluluğu olan bir yapı vardır. Dönüşüm konularında sınırlı bir fikir birliği bulunmaktadır.
- **Score 3 – Digitalization:** There is a central, low-budget, limited-responsibility structure for digital. There is limited consensus on transformation issues.
- **Score 4 – Dijital Geçiş:** Dijitalleşme, merkezi bir dijital organizasyon veya iş birimlerinde ve işlevlerde dijital mükemmellik merkezleri aracılığıyla

gerçekleştirilir. Fonksiyonlar arası bilgi ve deneyim paylaşımı söz konusudur. Dijitalleşme teşvik edilir ve ölçülür.

- **Score 4 – Digital Transition:** Digitization is accomplished through a central digital organization or digital centers of excellence in business units and functions. There is knowledge and experience sharing between functions.
- **Score 5 - Dijital Dönüşüm:** Dijital, tüm organizasyonun içine yerleştirilmiştir. Gelişimi için yukarıdan aşağıya teşvikler bulunur.
- **Score 5 - Digital Transformation:** Digital is embedded within the entire organization. There are top-down incentives for its development.

Processes and Systems PR1.1

- **Question:** Dijital pazarlamayı nasıl yürütüyorsunuz?
- **Question:** How do you conduct digital marketing?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital araçlarımız (websiteleri, uygulamalar) vardır. Fakat sınırlı trafiğe sahiptir.
- **Score 1 – Digital Passive:** We have digital tools (websites, apps). But it has limited traffic.
- **Score 2 – Sayısallaştırma:** Dijital araçlarımız müşteri tarafından etkin kullanılmaktadır. Fakat bu uygulamalar üzerinde önemli bir etkimiz yoktur.
- **Score 2 – Digitization:** Our digital tools are used effectively by the customer. We have no significant influence on these practices.
- **Score 3 – Dijitalleşme:** Dijital uygulama yatırımlarımız, müşterinin önemli temas noktalarına odaklanarak yapılır. Ancak yatırım getirisi (ROI) takip edilemez.

Dijital pazarlama uzmanlarımız "geleneksel" pazarlama tekniklerinden yararlanmaktadır.

- **Score 3 – Digitalization:** Our digital application investments are made by focusing on key customer touchpoints. However, return on investment (ROI) cannot be tracked. Our digital marketing experts use "traditional" marketing techniques.
- **Score 4 – Dijital Geçiş:** Tüketicilerle segmentlerine göre ve iki yönlü bir etkileşim vardır. Yatırım getirisini (ROI) takip edilir, karar destekleyici olarak kullanılır. Veriye erişim mevcuttur. Dijital kampanya uygulamalarında etkin bir şekilde sorgulayabilen dijital uzmanlarımız vardır.
- **Score 4 – Digital Transition:** There is a two-way interaction with consumers by segment. Return on investment (ROI) is tracked and used as a decision supporter. We have digital experts who can query effectively in digital campaign applications.
- **Score 5 - Dijital Dönüşüm:** Dijital pazarlamanın yatırım getirisini (ROI) net bir şekilde ölçebiliyoruz. Tüketicilerimizin önemli bir kısmıyla doğrudan ilişkimiz bulunmaktadır. Dijital, organizasyondaki tüm pazarlamacıların temel becerilerinden biridir. Etkili tüketici ilişkileri stratejisi tasarlamak için pazarlama, medya, ajans ve teknoloji ekipleri arasında etkili bir işbirliği vardır.
- **Score 5 - Digital Transformation:** We can clearly measure the return on investment (ROI) of digital marketing. We have a direct relationship with a significant portion of our consumers. Digital is one of the core skills of all marketers in the organization. There is effective collaboration between marketing, media, agency and technology teams to design an effective consumer relationship strategy.

Processes and Systems PR1.2

- **Question:** Müşteri deneyimini geliştirmek için kişiselleştirme yöntemlerini uyguluyor musunuz? Kişiselleştirme için veriden yararlanıyor musunuz?
- **Question:** Do you apply customization to enhance the customer experience? Do you leverage data for customization?

Rubrics:

- **Score 1 – Dijital Pasif:** Müşterilerimizle makro segmentler halinde iletişim kuruyoruz.
- **Score 1 – Digital Passive:** We communicate with our customers in macro segments.
- **Score 2 – Sayısallaştırma:** Müşterilerle basit kural bazlı mikro segment bazında etkileşim kurabiliyoruz. Kişiselleştirilmiş iletişim yol haritası oluşum aşamasında.
- **Score 2 – Digitization:** We can interact with customers on a simple rule-based micro segment basis. A personalized communication roadmap is under development.
- **Score 3 – Dijitalleşme:** Uzun vadeli bir stratejimiz ve yol haritasına sahibiz. Müşterilere kişiselleştirilmiş iletişim ve deneyim sunabiliyoruz. Veri toplama ve analizi yapabiliyoruz. Çapraz satışı bulunmuyor.
- **Score 3 – Digitalization:** We have a long-term strategy and roadmap. We are able to provide personalized communication and experience to customers. We are able to collect and analyze data. We do not have cross-selling.
- **Score 4 – Dijital Geçiş:** Uzun vadeli yol haritamızı baz alarak, farklı platformlardan (web sitesi, sosyal medya) gerçek zamanlı müşteri içgörülerini çıkararak analiz ediyoruz. Çapraz satış yapabiliyoruz.

- **Score 4 – Digital Transition:** Based on our long-term roadmap, we analyze by extracting real-time customer insights from different platforms (website, social media). We can cross sell.
- **Score 5 - Dijital Dönüşüm:** Müşterilerimize tüm kanallarda gerçek zamanlı olarak tamamen kişiselleştirilmiş deneyimler sunuyoruz. Analizimiz derin öğrenme (DL) ile geliştirilmiştir ve sürekli test yoluyla daha fazla değer optimizasyonu elde etmek için pazarlama teknolojisi tam olarak kullanılır. Platformumuz tüm birimlere ölçeklenebilir
- **Score 5 - Digital Transformation:** We provide our customers with fully personalized experiences in real time across all channels. Our analysis is developed with deep learning and marketing technology is fully utilized to achieve further value optimization through continuous testing. Our platform is scalable to all units

Processes and Systems PR1.3

- **Question:** İş süreçlerinizi iyileştirmek, değiştirmek veya yenilemek ve rekabet avantajından yararlanmak için dijital teknolojileri ve analitiği nasıl kullanıyorsunuz?
- **Question:** How do you use digital technologies and analytics to improve, change or innovate business channels to leverage competitive advantage?

Rubrics:

- **Score 1 – Dijital Pasif:** Kanalların kendileri bağımsız birimler olarak optimize edilmiştir. Odak genellikle satış iyileştirmesinden ziyade ürün üzerindedir.
- **Score 1 – Digital Passive:** The channels themselves are optimized as silos. The focus is often on the product rather than on sales improvement.

- **Score 2 – Sayısallaştırma:** Kanallar optimize edilmiştir. Temel fiyatlandırma ilkeleri geçerlidir ve basit fiyatlandırma araçları mevcuttur
- **Score 2 – Digitization:** Channels are optimized. Basic pricing principles apply and basic pricing tools are available
- **Score 3 – Dijitalleşme:** Çok kanallı entegrasyon uygulanmıştır ve dijital mağazalar gibi yeni kavramlar keşfedilmektedir. Ana segmentler hedeflenerek basit yapıda çok kanallı fiyatlandırma yapılır.
- **Score 3 – Digitalization:** Multi-channel integration has been implemented and new concepts such as digital stores are being explored. Multi-channel pricing is made in a simple structure by targeting the main segments.
- **Score 4 – Dijital Geçiş:** Çoklu kanallar CRM verisi ile desteklenir.
- Gelişmiş fiyatlandırma araçlarıyla desteklenen gelişmiş kişisel fiyatlandırma, çok kanallı ve dinamik fiyatlandırma mevcuttur.
- **Score 4 – Digital Transition:** Multiple channels are supported by CRM data.
- Advanced personal pricing, omnichannel, and dynamic pricing are available, supported by advanced pricing tools.
- **Score 5 - Dijital Dönüşüm:** Yüksek otomasyonlu ve çok kanallı bir satış yapısına sahiptir. Dijital olarak tamamen etkinleştirilmiş, gelişmiş, çok kanallı, kişiselleştirilmiş ve dinamik fiyatlandırma araçları mevcuttur, makine öğrenimi ile tamamen otomatikleştirilmiştir
- **Score 5 - Digital Transformation:** It has a highly automated and multi-channel sales structure. Fully digitally enabled, advanced, omnichannel, personalized and dynamic pricing tools available, fully automated with machine learning

Processes and Systems PR2.1

- **Question:** Siber güvenlik yönetişiminizin, stratejinizin ve mimarinizin olgunluğu nedir?
- **Question:** What is the maturity of your cybersecurity governance, strategy and architecture?

Rubrics:

- **Score 1 – Dijital Pasif:** Herhangi bir kurumsal politika veya süreç belirlenmemiştir. Sadece bazı BT uzmanları tarafından yönetilir. Süreçler koordinasyonsuz ve personelsiz bir şekilde yönetilir.
- **Score 1 – Digital Passive:** No institutional policy or process has been determined. It is managed by isolated IT professionals. Activities unstaffed or uncoordinated.
- **Score 2 – Sayısallaştırma:** Siber güvenlik yetkinlikleri geliştirilmeye başlanmıştır. Temel yönetişim ve risk yönetimi süreci hazırlanmaya başlanmıştır. Limitli teknik kontroller geliştirme aşamasındadır.
- **Score 2 – Digitization:** Cyber security competencies have begun to be developed.
- Basic governance and risk management process are started to be prepared. Limited technical controls are in development.
- **Score 3 – Dijitalleşme:** Güvenlikle ilgili hususlar dikkate alınarak politika ve süreçler yeniden tasarlanmakta ve çalışanlara siber güvenlik eğitimleri verilmektedir. Sınırlı roller ve sorumluluklar belirlenmiştir. Daha fazla kontrol geliştirilmiş ve belgelenmiştir.
- **Score 3 – Digitalization:** Policies and processes are redesigned considering security-related issues, and cyber security trainings are provided to employees.
- Limited roles and responsibilities established. More controls are developed and documented.

- **Score 4 – Dijital Geçiş:** Artan siber güvenlik farkındalığı ve siber güvenlik yetkinlikleri iş birimleri ile ortaklaşa geliştirilmiştir. Roller ve sorumluluklar net bir şekilde tanımlanmıştır. Çalışanlara siber güvenlik eğitimi verilmiş ve kurumsal politika ve süreçler tanımlanmıştır. Resmi komiteler ve ölçüm süreçleri oluşturulmuş. Kontroller, uygunluk konuları dikkate alınarak ölçülmekte ve izlenmektedir.
- **Score 4 – Digital Transition:** Increased cyber security awareness and Cyber security competencies have been developed jointly with business units. Roles and responsibilities are clearly defined. Employees were given cyber security trainings. Corporate policies and processes defined. Formal committees and measurement processes are established. Controls are measured and monitored considering compliance topics.
- **Score 5 - Dijital Dönüşüm:** Siber güvenlik, üst düzey yöneticiler için sürekli bir gündem maddesidir. Tüm dijital girişimler, tasarım aşamasından itibaren siber güvenliği dikkate alır. Güçlü siber güvenlik yetkinlikleri edinilmiştir. Kültür, güvenlik konularında sürekli iyileştirmeyi destekler. Süreçler kapsamlı bir şekilde uygulanmaktadır. Tüm bilgi varlıkları güvence altına alınmış ve tehdit önleme araçları kullanılmıştır. Genişletilmiş ekosistem, ortak yetkinlik geliştirme dahil olmak üzere siber güvenlik konseptine bütünsel olarak dahil edilmiştir.
- **Score 5 - Digital Transformation:** Cybersecurity is a constant agenda item for senior executives. All digital initiatives consider cybersecurity from the design stage. Strong cyber security competencies have been acquired. Culture supports continuous improvement to security topics. Processes are comprehensively implemented. All information assets are secured and threat prevention tools are

used. The expanded ecosystem is integrally integrated into the cybersecurity concept, including joint competency development.

Processes and Systems PR3.1

- **Question:** Evden etkili bir şekilde çalışabiliyor musunuz?
- (Örnek: Her çalışan için ölçeklenebilir mi? Şirketin verilerine her yerden ulaşılabiliyor, erişilebilir mi?)
- **Question:** Can you work effectively from home?
- (Example: Is it scalable for every employee? Is the company's data accessible and accessible from anywhere?)

Rubrics:

- **Score 1 – Dijital Pasif:** Home office uygulaması, ofis çalışanları için mevcut değildir
- **Score 1 – Digital Passive:** Home office is not available for office employees
- **Score 2 – Sayısallaştırma:** Home office yalnızca birkaç işlev için kullanılabilir (arka ofis, vb.). Tüm çalışanların %0-25'i tarafından kullanılabilir.
- **Score 2 – Digitization:** Home office can only be used for a few functions (back office, etc.). It can be used by 0-25% of all employees.
- **Score 3 – Dijitalleşme:** Home-office uygulaması, ofis çalışanlarının %25-50'si tarafından kullanılabilir
- **Score 3 – Digitalization:** Home-office can be used by 25-50% of all office employees
- **Score 4 – Dijital Geçiş:** Home-office uygulaması, ofis çalışanlarının %50-75'i tarafından kullanılabilir

- **Score 4 – Digital Transition:** Home-office can be used by 50-75% of all office employees
- **Score 5 - Dijital Dönüşüm:** Home-office uygulaması, ofis çalışanlarının %75-100'ü tarafından kullanılabilir
- **Score 5 - Digital Transformation:** Home-office can be used by 75-100% of all office employees

Processes and Systems PR3.2

- **Question:** Veri altyapınız neleri kapsar ve hangi özellikleri vardır? (verimli, esnek, karmaşık, rekabet avantajı, vb.)
- **Tanım:** Veri altyapısı, uygulamaları desteklemek ve veriye dayalı karar vermeye olanak sağlamak için büyük miktarda verinin toplanması, depolanması ve analizi için verimli, yüksek performanslı, güvenilir platformlar sunar. Veri altyapısı verimliliği, üretkenliği artırır ve operasyonel maliyetleri azaltır.
- **Question:** What does your data infrastructure cover and which features does it have? (efficient, flexible, complex, competitive advantage, etc.)
- **Definition:** Data infrastructure delivers efficient, high performer, reliable platforms for collection, storage, and analysis of large amount of data to support applications, and to provide basis for the business in order to make data driven decision. Data infrastructure enhances the efficiency, productivity, and reduce operational costs.

Rubrics:

- **Score 1 – Dijital Pasif:** Master Data Mgmt (MDM) işlevlerine sahip değildir ve veri tutarlılığı eksiktir. Veri mimarisinin karmaşıklığının düzeyi bütünsel ve kapsamlı olarak izlenemez. Bu nedenle, yüksek çaba ve maliyet vardır

- **Score 1 – Digital Passive:** Data infrastructure lacks Master Data Mgmt (MDM) functions and lacks data consistency. The level of complexity of the data architecture cannot be monitored holistically and comprehensively.
- **Score 2 – Sayısallaştırma:** Hazır BI ve veritabanı araçları mevcuttur. BT mimarisi iş ihtiyaçlarını karşılar, ancak karmaşıklık nedeni ile yeni ekleme ve değişiklik yapmak zordur. Veri mimarisi standartları belirlenmiştir. Çabalar, iş taleplerine ayak uydurmaya ve maliyetleri düşürmeye odaklanmıştır.
- **Score 2 – Digitization:** Ready-made BI and database tools are available. IT architecture meets business needs, but it is difficult to add and change because of complexity. Data architecture standards have been determined. Efforts are focused on keeping up with business demands and reducing costs.
- **Score 3 – Dijitalleşme:** Çoğu MDM sorunu çözülmüştür. BT mimarisi bulut uygulamalarını ve süreç otomasyonunu destekler, esnektir. Ancak birçok eski bileşen ve geçici arayüz çözümleri kullanılmaktadır. Tüm veri projeleri hedef veri mimarisine katkıda bulunur veya onunla uyumludur. BT karmaşıklığı en aza indirmeye çalışmaktadır ancak genel performans üzerinde sınırlayıcı etkisi vardır.
- **Score 3 – Digitalization:** Most MDM issues have been resolved. IT architecture is flexible, supports cloud applications and process automation. However, many legacy components and temporary interface solutions are used. All data projects contribute to or are compatible with the target data architecture. IT tries to minimize complexity.
- **Score 4 – Dijital Geçiş:** Amaca uygun, kurumsal düzeyde bir veri platformu vardır. MDM sorunları tamamen kurumsal düzeyde ele alınmaktadır. Veri platformu yeni analiz olanakları sunar. BT mimarisi bulut uygulamalarını ve süreç otomasyonunu destekler, esnektir. Kısmen bölünebilir ve kullanıma hazır

ölçeklenebilir. Veri mimarisi standartlarından sapmalar izlenir. BT karmaşıklığı önemli ölçüde azaltılmıştır.

- **Score 4 – Digital Transition:** There is a purpose-built, data platform on an enterprise level. MDM issues are handled entirely at the enterprise level. The data platform offers new analysis possibilities. IT architecture is flexible, supports cloud applications and process automation. Partially divisible and scalable out-of-the-box. Deviations from data architecture standards are monitored. IT complexity has been significantly reduced.
- **Score 5 - Dijital Dönüşüm:** Veri altyapısı, sınıfının en iyisi teknolojilere dayalı olarak tamamen optimize edilmiştir. Depolar tamamen işlevseldir ve gelişmiş gerçek zamanlı analitik araçlarını destekler. Tamamen bölünebilir, esnek ve ölçeklenmeye hazırdır. İş birimleri, iş ortakları ve tedarikçilerden gelen dijital talepleri karşılar. Hem iş hem de BT, veri mimarisiyle ilgili kararlara dahil olur, iş ve teknik gereksinimler tanımlanır. Karmaşık iş dönüşümleri sırasında bile BT basitliğini koruyabilir (optimize edilmiş talep, düşük risk, BT uyumluluğu)
- **Score 5 - Digital Transformation:** Data infrastructure is fully optimized, based on best-in-class technologies. Repositories are fully functional and support advanced real-time analytics tools. It is fully divisible, flexible and ready to scale. It meets digital demands from business units, partners and suppliers. Both business and IT are involved in data architecture decisions, business and technical requirements are defined. It can maintain IT simplicity even during complex business transformations

Processes and Systems PR1.4

- **Question:** Dijitalleşme çalışmalarını ölçümlemek için KPI'lerden yararlanıyor musunuz?

- **Question:** Do you use KPIs to measure digitalization?

Rubrics:

- **Score 1 – Dijital Pasif:** Kullanılabilir KPI bulunmamaktadır
- **Score 1 – Digital Passive:** There are no available KPIs
- **Score 2 – Sayısallaştırma:** Kısmen departmanlarda mevcut olan ancak organizasyona duyurulmamış ya da ileilmeyen KPI'lar mevcuttur
- **Score 2 – Digitization:** There are undelivered KPIs that are partially available in departments but not communicated to the organization
- **Score 3 – Dijitalleşme:** KPI'lar her projenin başlangıcında belirlenir ve şirkete duyurulur
- **Score 3 – Digitalization:** KPIs are determined at the beginning of each project and announced to the company.
- **Score 4 – Dijital Geçiş:** Her proje için KPI'lar mevcuttur ve ölçüm mekanizmaları oluşturulmuştur.
- **Score 4 – Digital Transition:** KPIs are available for each project and measurement mechanisms have been established.
- **Score 5 - Dijital Dönüşüm:** Proje portföyündeki tüm projeler için KPI'lar mevcut olup, ölçüm mekanizmaları otomatik olarak belirlenmekte ve ölçülmektedir. Tüm sonuçlar gerçek zamanlı verilere dayalı olarak görselleştirilir
- **Score 5 - Digital Transformation:** KPIs are available for all projects in the project portfolio, and measurement mechanisms are automatically determined and measured. All results are visualized based on real-time data

Strategy ST2.2

- **Question:** Kuruluşunuz nasıl dijitalleşmektedir?

- **Question:** How does your organization digitalize?

Rubrics:

- **Score 1 – Dijital Pasif:** Özel bir öncelik verilmemektedir.
- **Score 1 – Digital Passive:** No particular priority is given
- **Score 2 – Sayısallaştırma:** Kapsamlı dijital dönüşüm hedefimiz belirlenmiştir.
- **Score 2 – Digitization:** Overarching digital transformation goal is determined
- **Score 3 – Dijitalleşme:** Birincil hedef üzerinde çalışmaya başlamadan önce, başarılması kolay, hızlı ve çok fazla yatırım yapmadan hemen sonuç vermeye başlayacak şekilde yapılabilir işleri belirliyoruz. Öncelikli hedefimize en fazla etki edecek daha küçük projeler belirledik.
- **Score 3 – Digitalization:** Before starting working on the primary goal, we are selecting for low-hanging fruits (things can be done quickly, easily, and without much investment that will start paying off immediately). We defined smaller projects which will have the biggest impact on our primary goal are determined.
- **Score 4 – Dijital Geçiş:** Öncelikli bir hedef belirleyip, başarılması kolay ve hızlı dönüşü olan projeleri seçtikten sonra, başarıya giden yolda hedefimizi destekleyen ve verimliliği artıran orta ölçekli projeleri imza attık. Kurum genelinde bu çalışmalara yüksek derecede öncelik verilmektedir
- **Score 4 – Digital Transition:** After we committed to one primary goal and selected the low hanging fruit projects, we engaged engage in mid-level projects that support our goal, and boost efficiency on the path to success. A high priority is given to these studies throughout the institution.
- **Score 5 - Dijital Dönüşüm:** Dijital girişimler, şirketin gündemindeki en değerli ve büyük önceliklerdir. Hedefimizi destekleyen orta ve büyük ölçekli birçok projeyi içeren şirket genelinde büyük ölçekli dijitalleşme programı yürütüyoruz.

- **Score 5 - Digital Transformation:** Digital initiatives are the most valuable and top priorities on the company's agenda. We engage in large scale digitalization program throughout the company which includes many mid-size and large-size projects that support our goal.

Strategy ST3.1

- **Question:** Dijital Teknolojiler ve fırsatlar, kurumsal merkez işlevlerine ne ölçüde entegre edilmiştir? Temel operasyonların dijitalleştirilmesi ve yayılması yol haritasının parçası mıdır?
- **Tanım:** Sayısallaştırma, analog bilginin dijital formata dönüştürülmesi, dijitalleşme, sayısallaştırılmış veri ve bilgilerin mevcut operasyonları otomatikleştirmek için kullanılması ve dijital dönüşüm, dijital teknolojinin kullanımının bir sonucu olarak sosyo-ekonomik yapıların (iş modelleri, tedarik zincirleri, platformlar veya ekosistemler gibi) değişmesi olarak tanımlanabilir.
- **Question:** To what extent are digital technologies and opportunities integrated into corporate core functions? Is the digitization and expansion of core operations part of the roadmap and strategy?
- **Definition:** Digitization can be defined as the conversion of analog information to digital format, digitalization as using digitized data and information to automate existing operations, and digital transformation as the change of socio-economic structures (such as business models, supply chains, platforms or ecosystems) as a consequence of the use of digital technology.

Rubrics:

- **Score 1 – Dijital Pasif:** Dijitalleştirme derecesi, geçici veya tesadüfi gereksinimlerle sınırlıdır

- **Score 1 – Digital Passive:** The degree of digitization is limited to temporary or incidental requirements
- **Score 2 – Sayısallaştırma:** Düşük derecede sayısallaştırma ve dijitalleşme var. Fırsatlar gözlenir, ancak takip edilmez veya teşvik edilmez.
- **Score 2 – Digitization:** There is a low degree of digitization and digitalization. Opportunities are observed, but not pursued or encouraged.
- **Score 3 – Dijitalleşme:** Dijitalleşme ve sayısallaştırma aktif olarak uygulanmaktadır. Strateji süreçler için tanınmıştır ve fırsatları keşfetmek için pilot projeler başlatmıştır.
- **Score 3 – Digitalization:** Digitization and digitalization are actively implemented. The strategy has been recognized for processes and has initiated pilot projects to explore opportunities.
- **Score 4 – Dijital Geçiş:** Seçilen merkezi işlevler, kanıtlanmış kullanım örneklerine göre dijital gündemi yönlendirir. Karar desteği ve uzmanlık gerektiren süreçlerde yapay zeka ve gelişmiş analitik kullanılmaya çalışılmaktadır. Ancak kapsayıcı bir kavram, inovasyon yaklaşımı ve yol haritası eksiktir.
- **Score 4 – Digital Transition:** Selected central functions drive the digital agenda according to proven use cases. Artificial intelligence and advanced analytics are used in decision support and processes that require expertise. However, an inclusive concept, innovation approach and roadmap are missing.
- **Score 5 - Dijital Dönüşüm:** Merkezi işlevler için dijitalleşme, gündemin başında yer almakta ve bütünsel bir dijital dönüşüm hareketi vardır. Dijitalleşmenin insan hatası ve arızalarını azaltma, daha iyi karar verme gibi faydaları gözlemlenmektedir. Yapay zeka ve makine öğrenimi, temel işlevler için önemli

bir sağlayıcıdır ve süreçleri, analizi ve koordinasyonu daha rahat ve esnek hale getirir

- **Score 5 - Digital Transformation:** For central functions, digitalization is at the top of the agenda and there is a holistic digital transformation movement. Digitalization benefits such as reducing human error and malfunctions, and better decision making are observed. AI and machine learning are a key enabler for core functionality and make processes, analysis, and coordination more convenient and flexible

Strategy S1.1

- **Question:** Şirketinizin dijital stratejisi neler içeriyor?
- **Question:** What does your company's digital strategy contain?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital strateji bulunmamaktadır. Dijital strateji yok. Dijital projeler izole ve tesadüfidir.
- **Score 1 – Digital Passive:** There is no digital strategy. Digital projects are isolated and incidental.
- **Score 2 – Sayısallaştırma:** Dijital strateji geliştirilmektedir. Tesadüfi projeler gerçekleşir, ancak her zaman strateji ile uyumlu değildir.
- **Score 2 – Digitization:** A digital strategy is being developed. Incidental projects take place but not always in line with the strategy.
- **Score 3 – Dijitalleşme:** İş hedeflerimize ulaşmak için bir dijital dönüşüm yol haritası vardır. İlk projeler, hedeflere yönelik olarak başlatılmıştır.
- **Score 3 – Digitalization:** There is a digital transformation roadmap to achieve our business goals. Initial projects have been started up working towards the goals

- **Score 4 – Dijital Geçiş:** Dijital dönüşüm gereksinimlerini karşılamak için çeşitli projeler ve ilgili adımlar ve sistemler kuruludur.
- **Score 4 – Digital Transition:** Various projects and related steps and systems have been established to meet the digital transformation requirements.
- **Score 5 - Dijital Dönüşüm:** Dijital dönüşüm gereksinimlerini karşılamak için ilgili tüm projeler ve ilgili tüm adımlar ile sistemler kurulmuştur.
- **Score 5 - Digital Transformation:** All relevant projects and all related steps and systems have been established to meet digital transformation requirements.

Strategy S1.2

- **Question:** Dijital girişimleri önceliklendirme ve geliştirme süreçleriniz nasıldır?
- **Question:** What are your processes to prioritize and develop digital initiatives?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital girişimlere öncelik vermek için geleneksel portföy süreci uygulanmaz.
- **Score 1 – Digital Passive:** The traditional portfolio process is not applied to prioritize digital initiatives.
- **Score 2 – Sayısallaştırma:** Portföy süreci sadece sınırlı pilot alan ile uygulanır. Dijital girişimlerin performansı izlenmez
- **Score 2 – Digitization:** The portfolio process is implemented only with a limited pilot area. The performance of digital initiatives is not monitored
- **Score 3 – Dijitalleşme:** Bazı iş birimlerinde veya işlevlerde, dijital girişimlerin önceliklendirilmesi için özel yönetim süreçleri oluşturulmuştur. Performans ölçümü için KPI'lar tanımlanmaya başlanmıştır

- **Score 3 – Digitalization:** In some business units or functions, specific governance processes have been established to prioritize digital initiatives. For performance measurement KPIs are started to be defined
- **Score 4 – Dijital Geçiş:** Dijital projelerin belirli metriklere göre düzenli olarak nasıl değerlendirileceği ve önceliklendirileceği konusunda ortak prensipler (süreç, sorumluluklar, karar verme) tanımlanmıştır. Dijital girişimlerin önceliklendirilmesi ve geliştirilmesi süreci takip edilir.
- **Score 4 – Digital Transition:** Common principles (process, responsibilities, decision making) are defined on how to regularly evaluate and prioritize digital projects according to certain metrics. Process of prioritization and development of digital initiatives is monitored
- **Score 5 - Dijital Dönüşüm:** Kurumsal strateji içerisinde dijital girişimlerin önceliklendirilmesi ve organizasyonda (bilgi teknoloji, iş birimi, bölgeler, fonksiyonlar) uyumlarının sağlanması için resmi bir süreç bulunmaktadır. Dijital girişimlerin performansı ve gerçekleşen sinerjiler ölçülür ve değerlendirilir. Sonuçlar sistematik bir şekilde değerlendirilir ve yeniden önceliklendirme için tekrar kullanılır.
- **Score 5 - Digital Transformation:** Within the corporate strategy, there is a formal process for prioritizing digital initiatives and ensuring their alignment in the organization (information technology, business unit, regions, functions). The performance of digital initiatives and realized synergies are measured and evaluated. Results are evaluated in a systematic way and used again for re-prioritization

Strategy S1.3

- **Question:** Dijital odaklı iş stratejisinde, dijitalleşme için hedefleriniz var mıdır?

- **Question:** In your digital-focused business strategy, do you have goals or targets for digitalization?

Rubrics:

- **Score 1 – Dijital Pasif:** Hedef yoktur
- **Score 1 – Digital Passive:** There is no available target
- **Score 2 – Sayısallaştırma:** Hedef yoktur. Ancak organizasyonun nasıl daha dijital hale gelebileceğine dair fikirler ve seçenekler geliştirilmiştir.
- **Score 2 – Digitization:** There is no target. However, ideas and options have been developed on how the organization can become more digital.
- **Score 3 – Dijitalleşme:** Organizasyonun nasıl dijitalleştirilebileceğine dair senaryolar geliştirilmiştir. Ancak herhangi bir hedef seviye üzerinde anlaşma sağlanamamıştır.
- **Score 3 – Digitalization:** Scenarios have been developed on how the organization can be digitalized. However, no agreement was reached on any target level.
- **Score 4 – Dijital Geçiş:** Hedef seviyesi belirlenmiş, tüm taraflar (iş birimleri ve bilgi teknolojileri) tarafından anlaşılmış ve hedefe ulaşmanın ne anlama geldiği niteliksel ve niceliksel kriterlerle tanımlanmış ve liderlik ekibi tarafından onaylanmıştır.
- **Score 4 – Digital Transition:** The target level has been determined, understood by all parties (business units and information technologies), and what it means to reach the target has been defined by qualitative and quantitative criteria and approved by the leadership team.
- **Score 5 - Dijital Dönüşüm:** Dijital hedef, tüm organizasyon genelinde ifade edilir. Herkes tarafından anlaşılır ve benimsenir. Genel hedefler, organizasyonu hedefine doğru harekete geçirmek için basamaklandırılır ve belirlenir.

- **Score 5 - Digital Transformation:** The digital goal is expressed throughout the entire organization. It is understood and accepted by everyone. Overall goals are cascaded and set to move the organization towards its goal.

Strategy S1.4

- **Question:** Kuruluşunuz dijital dönüşüm yolculuğunu ve bu süreçteki kaynaklarını nasıl yönetmekte ve kontrol etmektedir?
- **Question:** How does your organization manage and control its digital transformation journey and its resources?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital girişimler her iş birimi, bölge veya fonksiyonda ayrı ayrı yönetilir. Kontrol mekanizması mevcut değildir
- **Score 1 – Digital Passive:** Digital initiatives are managed isolated in each business unit, region or function. Control mechanisms are not available
- **Score 2 – Sayısallaştırma:** Dijital girişimler her iş birimi, bölge veya fonksiyonda ayrı ayrı yönetilir. Çalışanlarımız dijitalleşmenin bir öncelik olduğunu bilmektedir. Yönetişim sınırlıdır
- **Score 2 – Digitization:** Digital initiatives are managed isolated in each business unit, region or function. Our employees know that digitalization is a priority. Governance is limited
- **Score 3 – Dijitalleşme:** Bazı dijital girişimler, iş birimleri, işlevler ve bölgeler arasında yönetilir. Yönetişim, temel / temel işlevlere genişletilmiştir.
- **Score 3 – Digitalization:** Some digital initiatives are managed across business units, functions and regions. Governance is extended to the key / core functions.

- **Score 4 – Dijital Geçiş:** Dijital girişimlerin yol haritası, dijital hedefimize ulaşmak için iş birimleri, işlevler ve bölgeler arasında bütünsel olarak geliştirilir. Sık sık gözden geçirilir. Tüm paydaşlar katılır. Yönetişim kapsamlıdır ve tüm işlevleri kapsar.
- **Score 4 – Digital Transition:** The roadmap of digital initiatives is developed holistically across business units, functions and regions to achieve our digital goal. It is reviewed frequently. All stakeholders participate. Governance is comprehensive and covers all functions.
- **Score 5 - Dijital Dönüşüm:** Entegre bir dijital dönüşüm yolculuğu tanımlanmıştır. İlerleme sürekli olarak izlenir ve dijital için ayrılan bütçenin büyümesi, proje KPI'ları gibi belirli göstergeler ölçülür. Pilot projeleri ve MVP'ler organizasyonda dijitalin yönünü belirler ve potansiyelinin organizasyon genelinde bilinmesini ve yayılmasını sağlar. Yönetişim çok büyük ölçüdedir
- **Score 5 - Digital Transformation:** An integrated digital transformation journey has been defined. Progress is constantly monitored and specific indicators are measured, such as the growth of the digital budget and project KPIs. Pilot projects and Minimum Viable Products (MVPs) set the direction of digital in the organization and ensure that its potential is recognized and disseminated throughout the organization. Governance is universal

Strategy S2.1

- **Question:** İnovasyon için dijital ve teknolojilerden nasıl yararlanıyorsunuz?
- **Question:** How do you leverage digital and technologies for innovation?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital inovasyonu yeni düşünmeye başlıyoruz.

- **Score 1 – Digital Passive:** We are just beginning to consider digital innovation.
- **Score 2 – Sayısallaştırma:** Temel hizmetlerimizi dijital servislerle desteklemeye başladık.
- **Score 2 – Digitization:** We started to support our core services with digital services.
- **Score 3 – Dijitalleşme:** Temel hizmetlerimizi dijital servislerle desteklemeye başladık. Tüketici tarafından yönlendirilen yenilikleri deneyimlemeye ve yeni değer havuzları belirlemeye başladık, ancak bu süreç doğaçlama ve yapılandırılmış değil.
- **Score 3 – Digitalization:** We started to support our core services with digital services. We have begun to experiment with consumer driven innovations and identify new value pools, but this process is improvised and unstructured.
- **Score 4 – Dijital Geçiş:** Temel ürünlerimizin ve hizmetlerimizin çoğunu dijital alana kaydardık. Kalan dijital olmayan diğer ürünleri ve hizmetleri dijitalleşme kanalıyla geliştirdik. Yeni ürünleri hızla devreye alıyoruz
- **Score 4 – Digital Transition:** We have shifted most of our core products and services into the digital area. We developed the remaining non-digital products and services through digitization. We launch new products quickly
- **Score 5 - Dijital Dönüşüm:** Pazarı ve yeni yıkıcı oyuncuları izliyoruz ve temel ürünlerimizi ve hizmetlerimizi dijitalleştirmek için proaktif olarak yenilik yapıyoruz. Entegre tekliflerle pazarın önündeyiz.
- **Score 5 - Digital Transformation:** We proactively innovate to digitize our core products and services. We are ahead of the market with integrated offers.

Strategy S2.3

- **Question:** Dijital iş fırsatlarını nasıl değerlendirir ve onlardan yaratırsınız?

- **Question:** How do you evaluate and create digital business opportunities?

Rubrics:

- **Score 1 – Dijital Pasif:** Rakiplerimizle karşılaştırmalı analizlerimizi manuel olarak yapıyoruz.
- **Score 1 – Digital Passive:** We do our comparative analysis with our competitors manually.
- **Score 2 – Sayısallaştırma:** Rakiplerimizle karşılaştırmalı analizimizi yapıyoruz ancak herhangi bir yıkıcı organizasyonla ilişkimiz yok. Henüz yıkıcı organizasyona yatırım yapmadık.
- **Score 2 – Digitization:** We do our comparative analysis with our competitors, but we are not affiliated with any disruptive organization. We have not yet invested in the disruptive organization.
- **Score 3 – Dijitalleşme:** Start-up'lara yatırım yaptık ve yeni kurulan şirketlerle işbirliği yapıyoruz. Dış ekiplerle kuluçka merkezi çalışmalarına başladık
- **Score 3 – Digitalization:** We have invested in start-ups and cooperate with start-ups. We started to work on the incubation center with external teams
- **Score 4 – Dijital Geçiş:** Yıkıcı işleri ve ortak girişimleri başarıyla başlattık. Ortaklık ve girişim için tanımlanmış bir şirket birleşmeleri (M&A) stratejimiz var
- **Score 4 – Digital Transition:** We have successfully launched disruptive businesses and joint ventures. We have a defined M&A strategy for partnership and venture
- **Score 5 - Dijital Dönüşüm:** Dijital dünyada ilerlemek için tüm seçenekleri kullanıyoruz: kuluçka, işletme, M&A. Yıkıcı kavramları sürekli olarak etkinleştirip, ölçeklendiriyoruz.

- **Score 5 - Digital Transformation:** We use all options to move forward in the digital world: incubation, business, M&A. We are constantly enabling and scaling disruptive concepts.

Strategy S2.2

- **Question:** Pazarınızı nasıl yenilersiniz? Sektörünüzdeki değişikliklerde önemli bir rol oynuyor musunuz?
- **Question:** How do you innovate your market? Do you play a pivotal role in the changes in your industry?

Rubrics:

- **Score 1 – Dijital Pasif:** Müşteri yolculuğunu sistematik bir şekilde değil, geçici taleplere göre tesadüfi değiştiriyoruz
- **Score 1 – Digital Passive:** We change the customer journey incidentally, not systematically
- **Score 2 – Sayısallaştırma:** Belirli ürünler/hizmetler için müşteri yolculuklarını değiştiriyoruz.
- **Score 2 – Digitization:** We change the customer journeys for certain products/services.
- **Score 3 – Dijitalleşme:** Ürünlerimizi/hizmetlerimizi ve müşteri deneyimimizi geliştirmek için dijitalleşmeyi kullanıyoruz.
- **Score 3 – Digitalization:** We use digital to enhance our products/services and customer experience.
- **Score 4 – Dijital Geçiş:** İş modelimizi değiştirmek ve yeni iş modelleri geliştirmek için dijitalleşmeyi kullanıyoruz.

- **Score 4 – Digital Transition:** We use digital to change our business model and develop new business models.
- **Score 5 - Dijital Dönüşüm:** Sektörümüzde karlı bir dijital iş modelini başarıyla hayata geçirdik. Yeni ürün/hizmetlerle sektörümüzde yeni iş modelleri geliştiriyoruz.
- **Score 5 - Digital Transformation:** How would you evaluate business opportunities by taking an example from other organizations that were born digitally or have realized digital transformation?

Technology T1.1

- **Question:** AI, RPA veya IoT vb. gibi gelişen teknolojileri nasıl kullanıyorsunuz?
- **Question:** How do you use emerging technologies such as AI, RPA or IoT etc.?

Rubrics:

- **Score 1 – Dijital Pasif:** Kuruluş, yakın zamanda geliştirilen yeni teknolojiler hakkında sınırlı veya tesadüfi bilgiye sahiptir.
- **Score 1 – Digital Passive:** The organization has limited or incidental knowledge of recently developed technologies
- **Score 2 – Sayısallaştırma:** Kuruluş, yeni geliştirilen teknolojiler hakkında temel bilgilere sahiptir, ancak onları kullanmaz.
- **Score 2 – Digitization:** The organization has basic knowledge of newly developed technologies, but does not use them.
- **Score 3 – Dijitalleşme:** Kuruluşta yeni geliştirilen teknolojilerin ana kullanım alanları hakkında bilgi ve farkındalık vardır. Ön pilot projeler yürütülmektedir.

- **Score 3 – Digitalization:** There is knowledge and awareness about the main usage areas of newly developed technologies in the organization. Pilot projects are being carried out.
- **Score 4 – Dijital Geçiş:** Yeni teknolojilerin ana kullanım durumları tanımlanmış ve önceliklendirilmiştir. Pilot uygulamalar oluşturulmuş ve sorumluluklar netleştirilmiştir. Odak noktası, değer zincirindeki öncelikli süreçlerdir.
- **Score 4 – Digital Transition:** The main use cases of new technologies have been identified and prioritized. Pilot practices were created and responsibilities were clarified. The focus is prioritized processes in the value chain.
- **Score 5 - Dijital Dönüşüm:** Hem yapay zeka hem de yeni teknolojiler, sunulan ürün, hizmet ve süreçlerde başarıyla kullanılmakta ve rekabet avantajı sağlamaktadır. Değer zincirindeki tüm adımları ve süreçleri kapsayacak şekilde sürekli yapay zeka uygulamaları bulunmaktadır
- **Score 5 - Digital Transformation:** Both AI and new technologies are successfully used in the products, services and processes offered and provide competitive advantage. There are continuous applications of artificial intelligence to cover all steps and processes in the value chain.

Technology T2.1

- **Question:** Bilgi teknolojileri için BT operasyonlarını, geliştirme, uygulama teslimi, güvenlik ve sürekli iyileştirme ilkelerini nasıl uygularsınız?
- **Question:** How do you apply operations, development, application delivery, security and continuous improvement principles for IT?

Rubrics:

- **Score 1 – Dijital Pasif:** Dijital ürün ve hizmet geliştirmenin organizasyonda sahibi yoktur. Süreçler tanımlanmamıştır.
- **Score 1 – Digital Passive:** Digital product and service development has no owner in the organization. Processes are not defined.
- **Score 2 – Sayısallaştırma:** Dijital ürün ve hizmet geliştirmenin organizasyonda net bir sahibi yoktur. Geliştirme ve dağıtım için departmanlarda belirli süreçler vardır.
- **Score 2 – Digitization:** Digital product and service development has no clear owner in the organization. There are specific processes in departments for development and distribution.
- **Score 3 – Dijitalleşme:** Yazılım geliştirme ve dağıtım süreçleri için aynı düzeyde sorumluluk vardır. Ekipler kod depolarını kullanır ve süreçler, dağıtım dışında tüm yazılım geliştirme yaşam döngüsü aşamalarında benzerdir.
- **Score 3 – Digitalization:** There is the same level of responsibility for the software development and distribution processes. Teams use code repositories and processes are similar throughout all software development lifecycle phases except deployment.
- **Score 4 – Dijital Geçiş:** İş birimleri ve geliştirme ekipleri işbirliği içinde çalışır. Geliştirme ve dağıtım sürecine alt yapı/donanım gereksinimleri, test otomasyonları, bilgi güvenliği ve self servis uygulamalar dahil edilmiştir
- **Score 4 – Digital Transition:** Business units and development teams work collaboratively. Infrastructure/hardware requirements, test automation, information security and self-service applications are included in the development and distribution process.

- **Score 5 - Dijital Dönüşüm:** Tam hizmet sorumluluğuna sahip kendi kendini koordine eden, işbirliği yapan ekipler vardır. Kesintisiz sürekli devreye alım, altyapıda otomatik ölçeklendirme mevcuttur.
- **Score 5 - Digital Transformation:** There are self-coordinating, collaborative teams with full service responsibility. Uninterrupted continuous deployment, automatic scaling of the infrastructure is available.

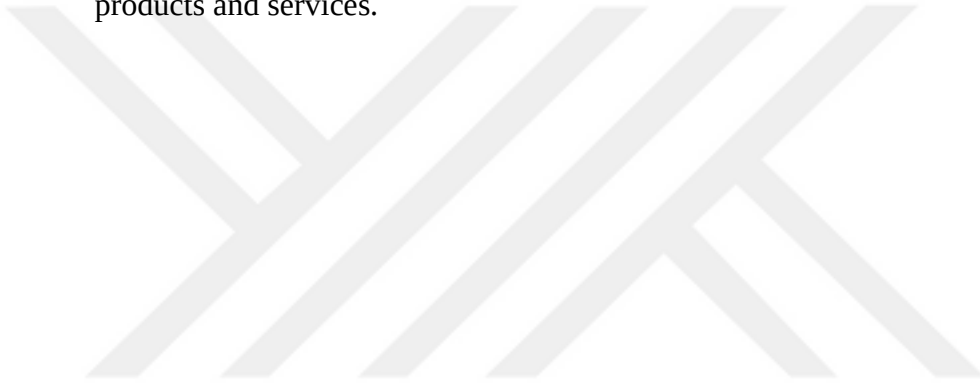
Technology T3.1

- **Question:** Bilgi ve İletişim Teknolojileri (BİT) ortaklıkları yapıyor musunuz?
- **Question:** Do you use Information and Communication Technologies (ICT) partnerships?

Rubrics:

- **Score 1 – Dijital Pasif:** Platformlarımızda dijital çözümler veya hizmetler sunmak için harici ortaklar ve taraflarla çalışmıyoruz
- **Score 1 – Digital Passive:** We do not work with external partners and parties to provide digital solutions or services on our platforms
- **Score 2 – Sayısallaştırma:** Dijital bilgi teknolojileri (BT) ve tamamlayıcı hizmetler sunmak için harici ortaklarla çalışmayı düşünüyoruz.
- **Score 2 – Digitization:** We consider working with external partners to provide digital information technology (IT) and complementary services.
- **Score 3 – Dijitalleşme:** Ortaklıklar kurmak ve dijital oyuncuları aday göstermeye başlamak ve ilk pilot projeleri yürütmek için bir stratejimiz var.
- **Score 3 – Digitalization:** We have a strategy to build partnerships. We start nominating digital players. We run pilot projects.

- **Score 4 – Dijital Geçiş:** Dijital BT oluşturmak için ortaklıklarımız var. Tamamlayıcı ürün ve hizmetler ile denemeler yapıyoruz.
- **Score 4 – Digital Transition:** We have partnerships to build digital IT. We experiment with complementary products and services.
- **Score 5 - Dijital Dönüşüm:** Birçok iş ortağını (ajans, start-up vb) uyum içinde bir araya getiriyor, tamamlayıcı ve katma değerli ürün ve hizmetler oluşturuyoruz.
- **Score 5 - Digital Transformation:** We bring together many business partners (agency, start-up, etc.) in harmony and create complementary and value-added products and services.



Appendix A.4 - Results of First Round of Interview Nvivo Qualitative Analysis

In total 9 interviews conducted with the digitalization experts from different industries from automotive industry to banking, from high-tech industry to digital native-born organizations from Turkey, Germany, Netherlands, and Austria. Most mentioned words and topics during the interviews are shown in the charts listed below.

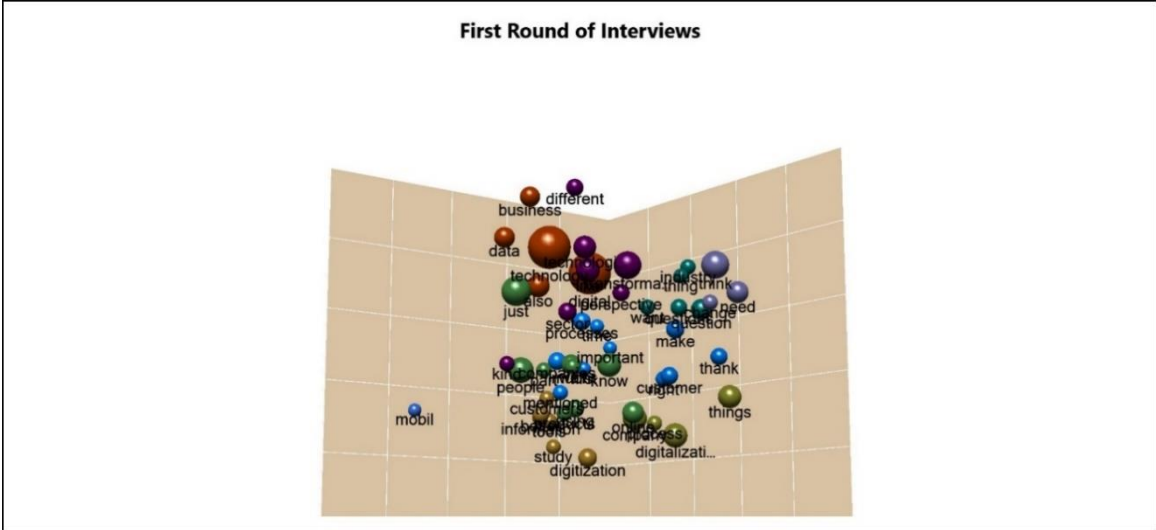


Figure 27: First Round of Interviews Cluster Analysis Bubble Chart

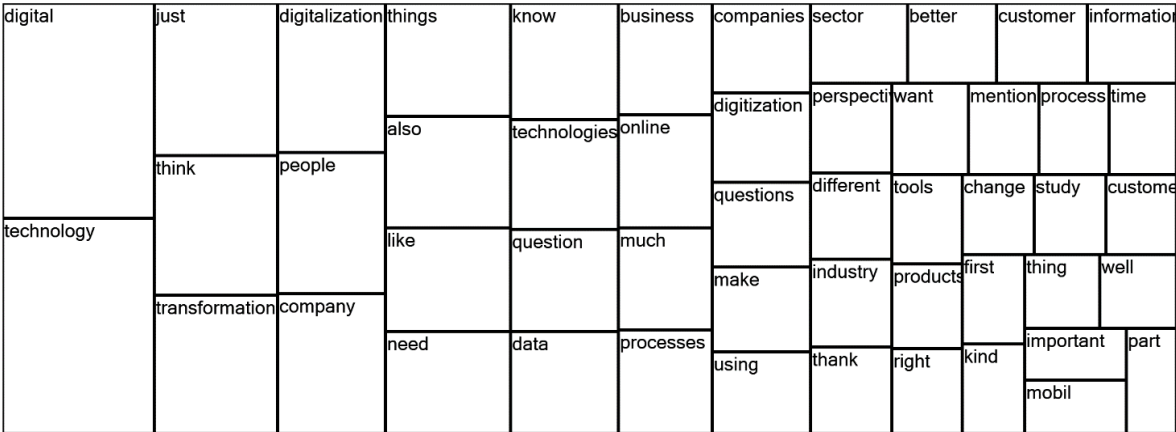


Figure 28: First Round of Interviews Tree Map

Appendix A.5 - Comparison Chart of Quantitative and Qualitative Findings

Table 45: Comparison Chart of Quantitative and Qualitative Findings

Construct	Quantitative Findings	Qualitative Findings
Culture	Among the culture questions, question Q3 might be subject to deletion.	Q5: “This question has high variance. Sales and operations might have stronger digital culture in comparison towards back end functions such as audit, legal departments.” Q5: “Corporate culture and its coverage might have been interpreted differently by the participant.” Q5: “There was a question of how much the person using in their daily job. If the person is well using the digital tools in their daily job, then their awareness on digital topics would be high. If the people are scored low on this question, they would probably be thinking that it is not reaching to him / her.”
Data and Analytics	Among the data analytics questions, Q7 might be subject to deletion.	Q6: “There might be a gap in the understanding of the data infrastructure.” “The answer to this question might be varying based on the person’s capability of data usage.” “Questions were quite good. However, people who do not know about this topic cannot answer then.” “They might not understand the ‘modules’. The person who uses ERP systems, would probably answer this question thinking ERP system. Person who uses web/mobile would be answering thinking web/mobile. Legal department might me answering by thinking ticket system. Maybe it is better to use ‘application’ wording instead of module, platform for the sake of the question’s understandability.” Q7: “This question is clear. That’s why answers are different.” “Criteria are variable. In this question, it is stated standard process, but there is no standard processes.” “People who are using reporting function, ” Q8: “Data life cycle management is not well known.” “Open end question.” “Only limited number of employees are working

		on data life cycle E2E. Some of these are working on the generation, some of them are working on the usage, some of them are working on the system upload.” Q9: “People know a little about the data quality. The knowledge is limited with the usage and technical details are not well known.” Q11: “Beneficiaries might not be well informed enough to answer this question. The projects might have started from the central office and might not be well spread towards the end user.” “Data strategy is not well known. I am using reporting functions only. On my daily work life, I am not thinking about the data quality improvement”. “There is lack of knowledge on data strategy. It is not well announced to the company. Therefore, there might be lack of awareness.”
People, Structure and Organization	No question is coming forward towards deleting a question from the construct based on Cronbach alpha value.	Q14: “Everyone would be answering based on their point of view.” “There might be department based or role-based awareness.”
Processes and Systems	Among processes and systems questions, exclusion of Q21 is not affecting the results. This is also confirming the feedback received during the qualitative interviews. Second question which is not affecting the total Cronbach alpha score is Q17.	Q18: “This question should be asked based on the positions. Marketing and customer focused functions would be utilizing more from data. On the other hand, it is not relevant to legal department.” “Employees who have customer touch would have higher expectation, therefore they would be voting lower scores. The employees who do not have customer touch, they would be scoring higher. Managers might be comparing with the market. The business experts’ expectations would probably be higher.” Q19: “This question should be asked based on the positions. IT functions would be using more as they are involving technology in the operation work as well. On the other legal department would be dealing less, 1-2 times per year with this topic.” “Question is good, but there might be confusing because of pricing. Is it customer based, segment based, customer based pricing, etc?”

		Q22: "Question number 22 sounds complicated." "This question can only be answered by the employees who are working on data and related topics. 80% of the people would probably be not heard about MDM."
Strategy	Exclusion of Q28, Q30 and Q32 separately is not affecting the end Cronbach alpha score. There these questions are candidate for deleting.	Q23: "This question might be answered based on the KPI maturity in the related department." "Some of them might have tough about the cost benefits when they are voting for KPIs. Some of them might be thinking that they should be doing more." Q25: "People who are working on the operation might be scoring lower, as they are working more hands on and they have higher expectations."
Technology	No question is coming forward towards deleting a question from the construct based on Cronbach alpha value.	Q35: "There are department who are only working with technology subsidiary, some of them are working with agencies, or other service providers. Therefore, the answer to this question varies."

Appendix A.6 - Results of Second Round of Interview after DMI Implementation and DMI Implementation Findings Nvivo Qualitative Analysis

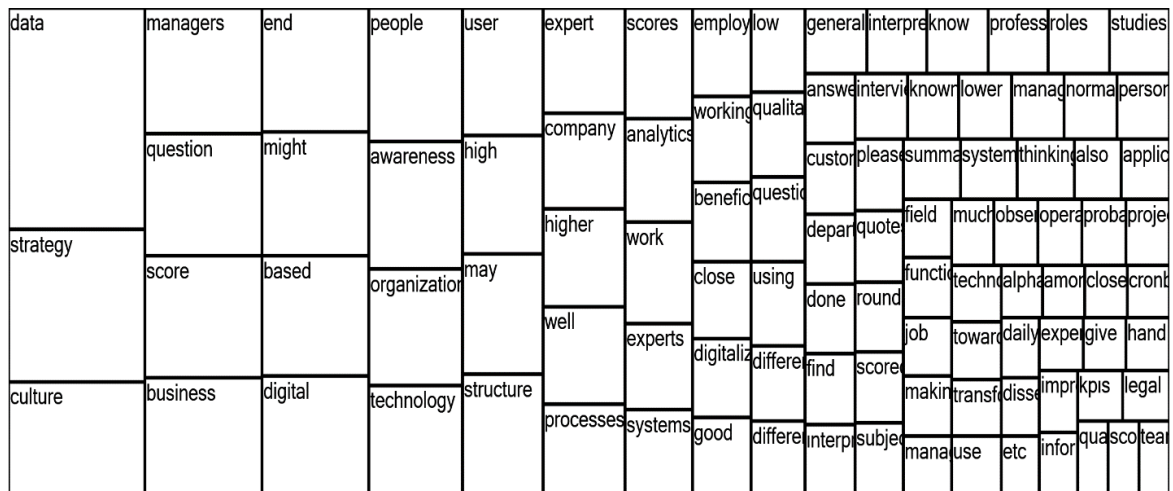


Figure 30: Second Round of Interviews and DMI Implementation Findings Tree Map



Figure 31: Second Round of Interviews and DMI Implementation Findings Word

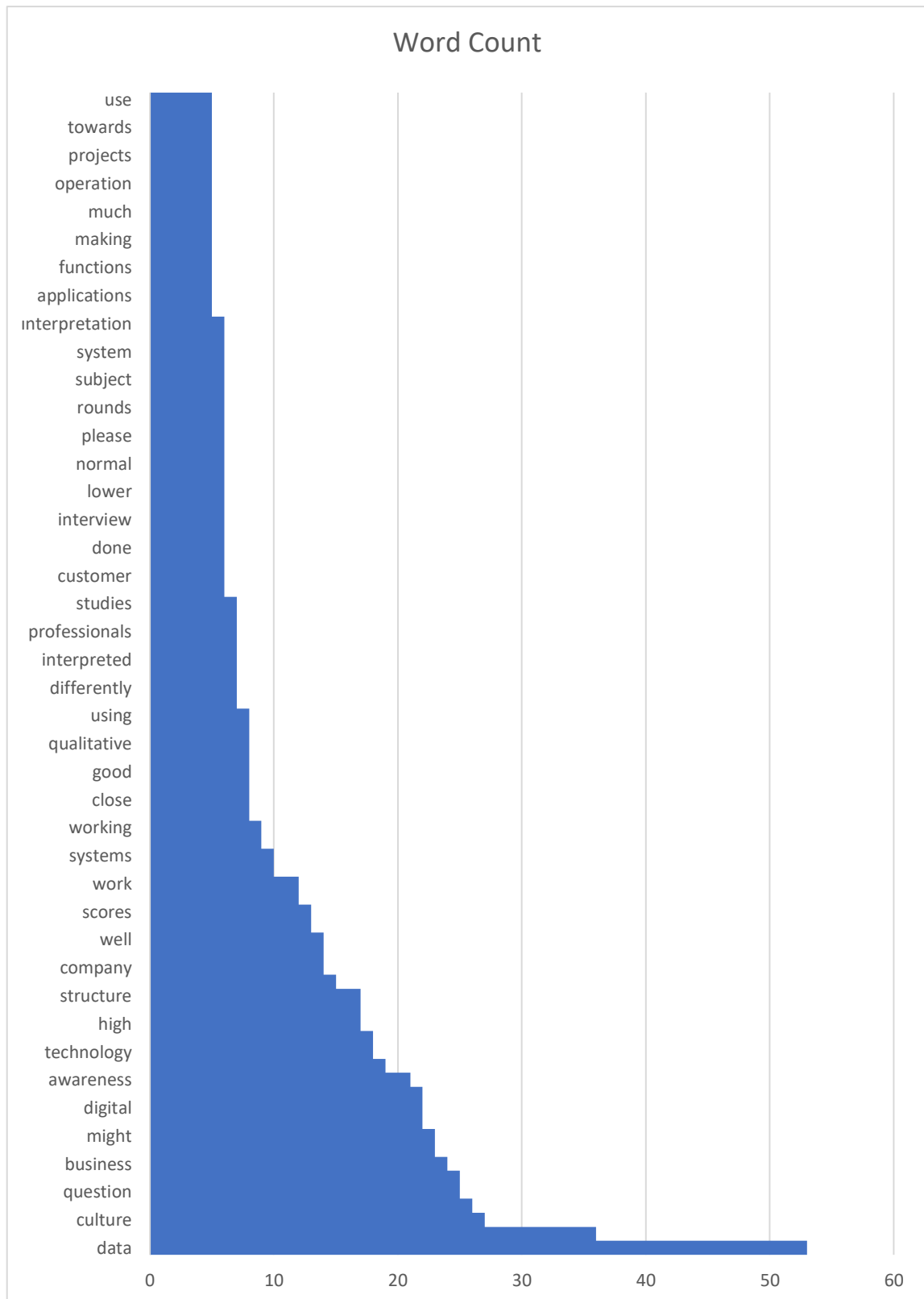


Figure 33: > 5 times mentioned words during Second Round of Interviews and DMI

Implementation

Appendix A.7 - Results of First and Round of Interview after DMI Implementation Nvivo Qualitative Analysis

technology	business	also	think	use	managew	like	might	thing	aware	compa	structu	user
		need	based	online	questio	one	import	used	done	inform	making	produan
	people				technol	score	some	every	proces	way	call	digitiz
		transform	company						want	make	let	score
data	strategy			end	work	high			actual	part	big	open
	processes	just			know	may		well	much			sales
digital	digitalization	now	things		different	industry	organiz	lot	vehicl	softwa	good	even
												resou
												tryin
												empl

Figure 34: First and Second Round of Interviews Tree Map



Figure 35: First and Second Round of Interviews Word Count



Figure 36: First and Second Round of Interviews Word Count 2

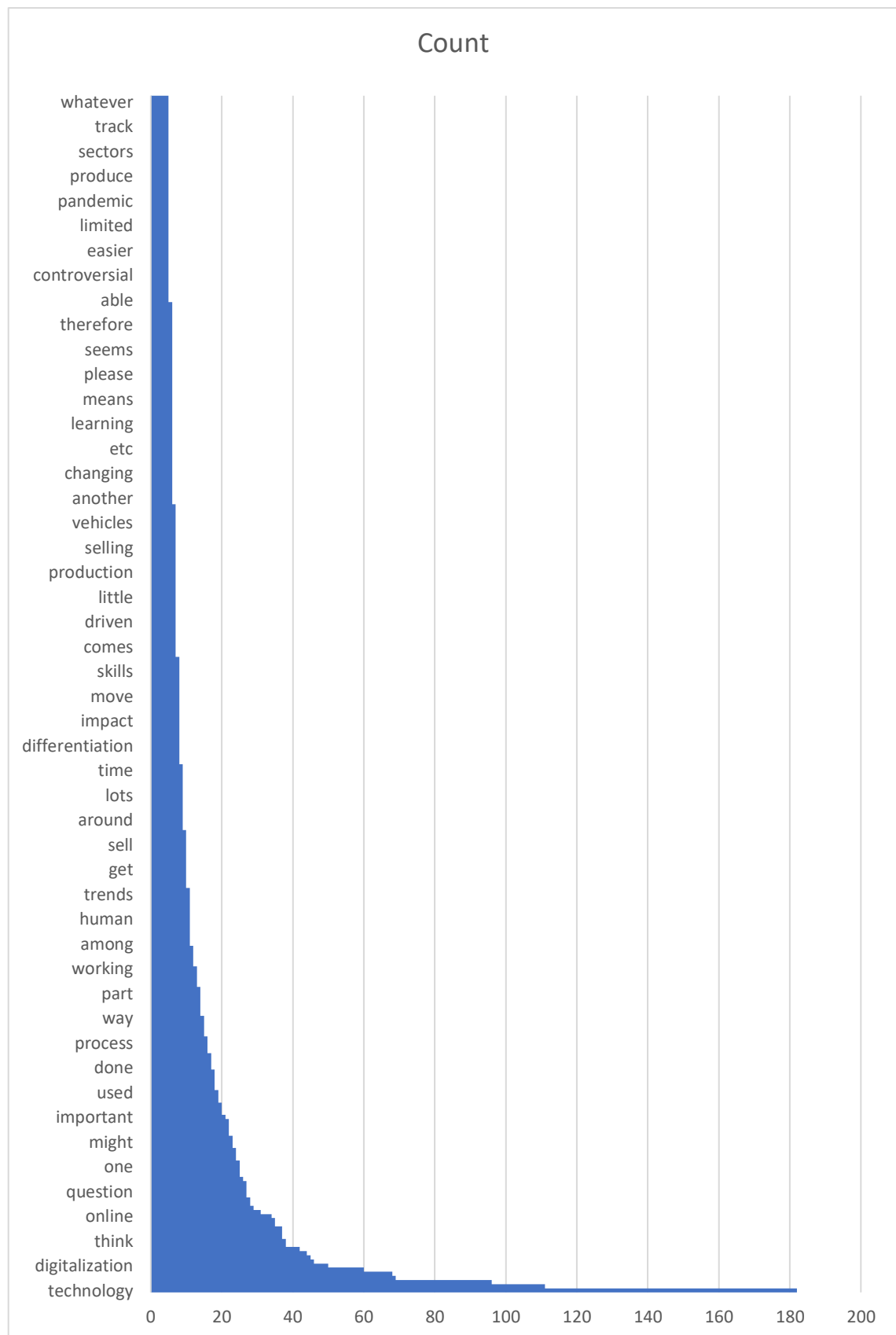


Figure 37: > 5 times mentioned words during First and Second Round of Interviews

and DMI Implementation

Part 1		
Category	Interview Quotes	Organizational Aspects
(1) Differentiation Among Digitalization Concepts	Quote 1: “I think there are two concepts, digitization and digitalization. And sometimes it seems to me that they are intertwined. In fact, I can say that they are slightly different things and complement each other. Digitization actually means the number you look at. Digitalization means digitization. In Digitization, I think it is necessary to focus more on data.” Quote 2: “Digitalization is you make something digital what you are doing in a physical source. You can digitize something. There is a paper you can scan this to your computer. Physical things comes to digital thing. This is the digitization. For the digitalization, I think you do not need the paper anymore. You are doing it on the sources and then you are saving it on the digital sources. That is the difference I think. Digitalization is the converting a process into totally digital source.” Quote 3: “Digital Transformation is an idea, I think. So, you can’t transform to digital, if you cannot think digital. This is not a process, it is a mindset If you can think that you can transform digital, then truly you can do it. It is an idea. If you are ready to make something over digital sources, then this is the digital transformation. You should think that what can I do to improve my processes. That is why the transformation of the process’s digital is a mindset, it is an idea. You need to be aware of that”	Digital Transformation Stages Culture Processes and Systems
(2) Confusion Among Technology Terminologies	Quote 11: “Digitization in my perspective, is going to a stage in which everything is more online, everything is more databased, AI, algorithm based. So it just helps in less human driven more data driven more online more AI based execution I would say.” “So what is digitalization from your perspective?” “Yeah, I think I explained my perspective in here, in the previous question. Or no?”	Culture

(3) Technology Differentiation Types	Quote 14: "Technology is himm .. I would say human made machine or algorithm m or program-based way of thing doing anything that you could made it easier" Quote 24: "So when I think of technology, I think of 2 different types. One is analog technology and the other is digital technology" Quote 33: "Software is software, but everything you automate it is information technology. 1 line of code goes to information technologies, 5000 lines of code goes to information technologies. Any integration tool also falls within information technology. In fact, when it comes to information technology, it seems to me like software and the integrated things around it. The part that goes from hardware to software. It doesn't stay in hardware anymore or it is in soft environment. Therefore, all of them can be considered as information technology." Quote 36: "In the technology side, there are lots of trends. Especially when we are entering in 2021, there are three lets say important topics. One of them is people centricity. All of the processes and the new trends are aiming to Centrify people. Second one is location independence. Because as the effects of the current pandemic, people need to work from various locations. And has to reach business lines from different locations. So, location independence is the second trend. Then there is also resilient delivery which means that you can just deliver your products in a more flexible way, and you use AI, data, and hyper automation"	Technology
(4) Technologies Based the Sector	Quote 15: "I think I am aware of mobile technologies because I am using smart phone. I am using computer, I am using cars. Those technologies of which I am aware. Algorithm based, ai based technologies like big data, analysis" Quote 25: "In my sector I think fundamental technologies that we use. One is obviously telecommunications; you know we have an app that we connect users. So that kind of connectivity is one. We need to have GPS technology because it is transportation. We also have distinct functions that use different technologies like we would have ML to analyse enormous size of data. It is not just a sector thing; it is a business intelligence thing. Or we have video chat technology to talk to our customers."	Technology

	Quote 32: "Cloudification is one of the issues of detachment from the physical environment" Quote 35: "Bitcoin and blockchain for the production company is not important for my opinion."	
(5) Strategy and Technology Linkage	Quote 4: "In the high-tech industry, company strategy is being shaped by the technological trends" Quote 5: "In the past, business was driving technology. Now technology drives business."	Strategy
(6) Sociological Perspective	Quote 31: "When we graduated from the first university, only mechanical engineers and computer engineers were working on the web and app. Now psychologists, biologists, computer and industrial engineers are employed."	Culture People, Structure and Organization
(7) Enablers of Digital Transformation	Quote 9: "The technology helped the rise of ecommerce" Quote 16: "I think most successful skill is to be open and to be data driven practical and to follow all the changes and adverts to be on the top of your sector. For that sense, be open be up to date and alert and open. Otherwise, you are going to miss out. " Quote 22: "I would say curiosity. You need to be curious. about innovative technologies. What can we do more for the customer to create the value? What can we do for the company to shorten the processes to be more valuable? I would sum all of these terms on behalf of curiosity. For the skills I would say that one. For the resources, you need an IT company. You need a high ability IT team. And the team which is more aware about the IT structure. It is not enough to have a team do marketing; a team can do sales. They need to be aware of the technology." Quote 23: "I think technology is the main driver of the change what is happening. I would say technology is enabling."	Strategy Technology Culture People, Structure and Organization
(8) Controversiality	Quote 26: "I think there are some contexts where it would be controversial. For example, privacy could be an important thing." Quote 27: "That is a big transformation, which is a big change. It can be controversial one because people do not want you suddenly to start interacting with them in a different way." Quote 28: "Depending on where you live, maybe laws are not protecting well the customer data very much or	Processes and Systems Data and Analytics

	people do not agree with how you use the data whether you are showing them adds or selling your data to third parties. So there can be controversial elements there. So obviously there are security issues that you think about providing services digitally. So I can definitely think about several ways where it can be controversial."	
Part 2		
Category	Interview Quotes	Organizational Aspects
(9) Industry Nature and Technology Usage	Quote 13: "Which technology do you have the highest impact in your industry? I would say internet and fintech. Because if financial institutions were not on par with digital advancements, then people would not be comfortable with making purchases online and give their credit cards. I would say internet and financial institutions on top" Quote 21: "Technology with the highest impact on the industryTechnology with the highest impact on the industry. I would say IoT technology. Now vehicle has an internet. So, this helps to connect to the cloud. Now you can connect to your vehicle anytime anywhere. Material of the product. Now we have more composite parts for the automotive. So, the vehicles are lighter. IoT is the future of the industry. The industry wants to go there. The second one is the material las especially important. I would say robotic processes. In the industry lots of things are going with robotics. The pandemic showed us that it is very important to produce a car with a robot. Because you know human can be sick but robots cannot be sick. It is also very important to check the processes with the robots. It is also feasible with the robots. It is very important for automotive industry to have AI and ML in your processes. Because of the increase of the digital software of the vehicles. Everything is digital on the vehicle. You need some AI on your product. Because you cannot generate everything in your vehicle. So if you have any AI know how vehicle can learn itself and create value for the customer"	Technology

(10) Drivers of Technology Usage	Quote 12: "Everyone is more and more comfortable with making purchases online and that comes with technology"	Technology
(11) Digital Transformation Impact of Organizational Aspects	Quote 34: "With the pandemic, the acceleration in the technology sector has increased incredibly. Because people now have to do some things from virtual platforms, mobile platforms and online due to the end of physical contact" Quote 37: "There are a lot of things you can achieve using possibilities of technology. So digital transformation is you know for business digital transformation looking for what you do today and compare it to the different possibilities that are currently enabled by the latest technology and adapting to it. Not just the technological possibilities but also your stakeholders as a business acquire new preferences and habits. Basically, technology is affecting everything, and digital transformation is looking at how your landscape is changing and adapting your operations your proposition how you work as a business to this new reality."	Processes and Systems Culture People, Structure, Organization Strategy
(12) Customer Behavior	Quote 8: "People more and more accustomed to make the purchases them online and customer go online. Customer behaviour is changed, and they are more open. So, it is a good way of tacking to the market. You know the demand in end customer, It does help with sales growth"	Processes and Systems Culture
(13) Industry Dynamic Changes	Quote 6: "We are a selling company. Whereas right now, because of digitalization and digital transformation of our age, we moved towards ecommerce where we are using market places, all other big marketplaces as a way of having new stores to sell in where we can access to millions of other users who are not connected to prior dealers or stores and we can just go retail and sell anyone who goes and online who want to purchase our products. So, I think digital transformation help to grow in that sense where we have access to many household where we used not enter." Quote 7: "We are launching our own ecommerce website where we want even to rely on these marketplaces and agencies in between we will have our own website directly sell to retail customers any product or services in our marketing mix."	Strategy

	Quote 10: "for the purchase of domestic appliances you used to go to store. They are available there. Whereas now we do not need to physically put your inventory anywhere or any marketplace that I just described" Quote 18: "Maybe automotive industry could be one of the most affected sectors in the world from digitalization. Competition is extremely high. Costs are remarkably high. The industry wants to transform because of the environmental issues. They want to change their business model. They cannot produce internal combustion engine (ICE) anymore, so they need to transform their businesses. Also, the behaviour of the customers is changing. New generation does not want to have any vehicle. So, companies would try to find new way to attract the young customers. Digitalization is the important weapon. For the companies because they want to spend more time on these digital things. When they are driving, they want to be always connected. Vehicles should be smarter than ever. It could be autonomous vehicle or connected vehicles. This is transforming the industry" Quote 19: "Most of the companies making partnerships with each other. And also they are making partnership with the IT companies. They are looking for another partner outside of the industry. Aim is to increase their effect on digitalization. I think in 5 years what could be more important for the customer, connected services. Connected services will be more important. I mean it could be the most valuable thing to purchase a vehicle, but they do not know to make a connected car. So, they are making for partnerships. So that is why we can see more competitors in the automotive industry who are not producing vehicles. Because digitalization could be more important than making a car."	
(14) Information, Data, and Cyber Security	Quote 20: "Now we can talk about the privacy. Lots of companies want to use the blockchain technology to protect data privacy. Now everything is on the cloud. Your data and vehicles data will be on the cloud. That is, we are talking about the connected vehicles. Everybody is talking about blockchain technology to protect the data. They are rethinking about the processes, which is more secure, valuable, profitable".	Data and Analytics

(15) Data Driven Decision Making	Quote 29: "In the past few years, a lot of companies are using social platforms to reach customer or to advertise their products. Mass mailing is a must. People no longer give advertisements on newspapers." Quote 30: "Footprints of the customers convey data. Because you are able to keep track of the customers that come to your website. You try to catch a customer or just to a spectator. But the person does not have to buy from you but the person comes to your website and looked at a particular page. You try to catch his or her attention. Again and again so that you can turn him or her into a customer. So there you have digital footprint that is usually tied to their IP addresses is very important. It is not a 100% accurate tool. However it helps to turn visitors to customers"	Data and Analytics
(16) Digitalization Benefit and Nature	Quote 17: "The digital transformation is very helpful to shorten the processes and increase the return on investments."	Strategy

Appendix A.8 - Coding of First Round of Interview

Coding: Please find below the coding table indicating first order categories, open codes, and DMI axis.

Table 46: Example of Data, Categories and Aspect or DMI Dimension

Representation Data / Open Code	First Order Categories	Organization Aspect / DMI Dimension
<i>“In the high-tech industry, company strategy is being shaped by the technological trends”</i> <i>. “In the past, business was driving technology. Now technology drives business.”</i> <i>“Digitization in my perspective, is going to a stage in which everything is more online, everything is more databased, AI, algorithm based. So it gives, it helps companies, you know or any medium that is using digitization process going through less human based way of doing thing and helped going more online and more data driven methods of executing anything becomes of what digitization is based on sector, based on industry, based on business. So it just helps in less human driven more data driven more online more AI based execution I would say.”</i> <i>“So what is digitalization from your perspective?”</i> <i>“Yeah, I think I explained my perspective in here, in the previous question. Or no? Hmmm... I am not sure that good with the differentiation of both you know digitization and digitalization.”</i> <i>“I think there are two concepts, digitization and digitalization. And sometimes it seems to me that they are intertwined. In fact, I can say that they are slightly different things and complement each other. Digitization actually means the number you look at. Digitalization means digitization. In Digitization, I think it is necessary to focus more on data. In</i>	Strategy and Technology Linkage	Strategy
	Strategy and Technology Linkage	Strategy
	Differentiation Among Digitalization Concepts	Digital Business Transformation Stages
	Differentiation Among Digitalization Concepts	Digital Business Transformation Stages

other words, getting the data, collecting the data, being able to store them appropriately, visualizing the data, making sense of the data, and even reporting it, I think digitization is the part. Afterwards, I think that the concept of digitalization came into play in the part of creating a product by combining these data with different technologies. I think the combination of these two actually creates the concept we call digital transformation. I can describe digitization as digitization, I can describe digitalization as digitization.”

“Digitalization is you make something digital what you are doing in a physical source. You can digitize something. There is a paper you can scan this to your computer. Physical things comes to digital thing. This is the digitization. For the digitalization, I think you do not need the paper anymore. You are doing it on the sources and then you are saving it on the digital sources. That is the difference I think. Digitalization is the converting a process into totally digital source.”

“Digital Transformation is an idea, I think. So, you can’t transform to digital, if you cannot think digital. This is not a process, it is a mindset If you can think that you can transform digital, then truly you can do it. It is an idea. If you are ready to make something over digital sources, then this is the digital transformation. It I not something like, we are not getting some signatures on physical papers, we are not transformed to digital. This is not true. You should think that what can I do to improve my processes. That is why the transformation of the process’s digital is a mindset, it is an idea. You need to be aware of that”

“I think our move is going towards e-commerce, because we have a more conventional business model where we used to rely heavily on dealership. and you know selling to the dealers to the stores Because we are the distributors, we have our suppliers; we have brands that

Differentiation Among Digitalization Concepts	Digital Business Transformation Stages
Differentiation Among Digitalization Concepts	Digital Business Transformation Stages, Culture, Processes and Systems
Platforms and Ecosystems	Processes and Systems, Strategy, Technology

are selling exclusively to us. We used to have conventional selling. We are a selling company. Whereas right now, because of digitalization and digital transformation of our age, we moved towards ecommerce where we are using market places, all other big marketplaces as a way of having new stores to sell in where we can access to millions of other users who are not connected to prior dealers or stores and we can just go retail and sell anyone who goes and online who want to purchase our products. So, I think digital transformation help to grow in that sense where we have access to many household where we used not enter. We are also thinking about launching our own ecommerce website where we want even to rely on these marketplaces and agencies in between we will have our own website directly sell to retail customers any product or services in our marketing mix.”

“Also end customer behaviour has also changed. They are now more open for purchase online. It has been around for couple of years and now people are accustomed to purchases online and they make queries and research online or just go to the store to look at the product and they just go up online again and purchase the product from there. So, in that sense, even if our appliances are big, because they are domestic appliances and products, in terms of monetary wise they are big purchases, but still **people more and more accustomed to make the purchases them online and customer go online. Customer behaviour is changed, and they open. So, it is a good way of tacking to the market. You know the demand in end customer, it is table, and it is always up so dealer problems do not affect It does help with sales growth.**”

“The technology helped the rise of ecommerce. Because of the rise of the technology because of the digitalization you know both I do not know in what ways they are different, but they are changing doing things. People are more are

Customer Centric Processes	Processes and Systems,
Digital Services and Products	Strategy, Technology

accustomed to doing things online. Well, it will definitely help our company. I mean **for the purchase of domestic appliances you used to go to store. They are available there. Whereas now we do not need to physically put your inventory anywhere or any marketplace that I just described.** You just need to put your inventory only on warehouse. Beyond you do not have to do anything else.”

“Then customer just go up and buy. And also, people are more comfortable by giving their credit cards. Credit card purchases are safe and secure. People know that and more accustomed to that. It all goes to technology changes. This all because of the technology changes. All those transactions are secure and safe. Everyday people do not have to be educated or literate and socioeconomic level person does not matter. As long as they have a credit card, they have access to anything. They also feel safe and secure. It is all because of growth of the technology. **Everyone is more and more comfortable with making purchases online and that comes with technology.**”

“Which technology do you have the highest impact in your industry? I would say internet and fintech. Because if financial institutions were not on par with digital advancements, then people would not be comfortable with making purchases online and give their credit cards. I would say internet and financial institutions on top. Because electronic appliances and domestic products are technological products. Even if it is 60s technologies people would buy them, so it is not about that. It is about making purchases online part. It is people’s readiness to make purchase online”

“Technology is humm .. I would say human made machine or algorithm m or program-based way of thing doing anything that you could made it easier”

“I think I am aware of mobile technologies because I am using smart phone. I am using computer, I am using

Trust, Value	Technology
Digital Technology	Technology
Definition of Technology	Technology
Technology Types, Artificial Intelligence	Technology

cars. Those technologies of which I am aware. Algorithm based, ai based technologies like big data, analysis”

“Very successful digital transformation project, AI based algorithm. Program based like products listed online when a customer makes a purchase online, all the customer info goes into the software, invoice comes out. Pricing and you are alerted when there is lower price. When you have a high volume of purchasing voices must go smoothly, our reporting process is also data driven. Otherwise, you cannot receive the orders and track the orders. Remarkably successful sales are skyrocketed so much. especially during seasons, black Friday, big seasons, campaign seasons. Sales passes online passes sales conventional sales. It had significant contribution to the company. An also because Ecommerce has a very short cash conversion cycle. It is very good. ”

“I think most successful skill is to be open and to be data driven practical and to follow all the changes and advents to be on the top of your sector. You have to try to understand how your business model can adopt to this change how can you go online and what you can pull online. I know there are some parts you cannot, but I am sure there are some parts you can and better done by algorithms and ai based. You can do some part of it digitally. So, in that sense, be open be up to date and alert and open. Otherwise, you are going to miss out. Who acts fast they will move. I think being open is the key.”

“First one is the competition. The competition is very important. If you do not have a competitor, then you do not need to think about transforming you processes to digital. You do not need to be more valuable, because your customer is there. You do not have any competitor. You are gaining more money and etc. I think the first one is the competition, the market”

Impact of Digital Technology	Technology
Skills, Resources	People, Structure, and Organization
Triggering Reasons of Digital Transformation	Strategy

“The digital transformation is very helpful to shorten the processes and increase the return on investment if you really want to do this. Then you need to look to digital transformation. So, if you do not have these concerns in your company, then you do not have to look these digital transformation things. These are the first problems, starting point”

“Maybe automotive industry could be one of the most affected sectors in the world from digitalization. Competition is extremely high. Costs are remarkably high. The industry wants to transform because of the environmental issues. They want to change their business model. They cannot produce internal combustion engine (ICE) anymore, so they need to transform their businesses. Also, the behaviour of the customers is changing. New generation does not want to have any vehicle. So, companies would try to find new way to attract the young customers. Digitalization is the important weapon. For the companies because they want to spend more time on these digital things. When they are driving, they want to be always connected. Vehicles should be smarter than ever. It could be autonomous vehicle or connected vehicles. This is transforming the industry”

“Most of the companies making partnerships with each other. And also they are making partnership with the IT companies. They are looking for another partner outside of the industry. Aim is to increase their effect on digitalization. I think in 5 years what could be more important for the customer, connected services. Connected services will be more important. I mean it could be the most valuable thing to purchase a vehicle, but they do not know to make a connected car. So, they are making for partnerships. So that is why we can see more competitors in the automotive industry who are not producing vehicles. Because digitalization could be more important than making a car.”

Triggering Reasons of Digital Transformation	Strategy
Digital Focused Business Strategy	Strategy
Partnerships, Technology Functions	Technology, Strategy

“Both change processes and business models. Let’s think about an Electric Vehicle. You cannot gain any money with the service spending. You do not have to go service any more frequently. So, you have to find another thing to sell to the customers. That is the digital transformation. You need to unlock the vehicle like Apple iPhone. You can purchase something on the vehicle for the weekend, you can add 20 hp power more for your vehicle only for limited time. You can do it from your mobile phone because it is connected to your vehicle. This is also changing the processes, because now we can talk about the privacy. Lots of companies want to use the blockchain technology to protect data privacy. Now everything is on the cloud. Your data and vehicles data will be on the cloud. That is, we are talking about the connected vehicles. Everybody is talking about blockchain technology to protect the data. They are rethinking about the processes, which is more secure, valuable, profitable. Business model because they do not sell the vehicle anymore, now they sell services after the vehicle but not after sales thing. They are selling other services with the car now.”	Process Changes, Business Model Changes	Processes
“So if you can create 100% functioning software, you can also sell this software to other automotive companies. That is the enormous impact of the technology in this industry. Because you cannot sell a bumper or wiper to your competition. But you can sell it. This is not something that is branded. It is like Bosch company. So yes, I see true relationship with the technology and technology companies.”	Technology and Industry Relationship	Technology
“Technology with the highest impact on the industry. Not the battery technology. Because it is the vice versa. Industry ones to transform to electric vehicle. It is not that. I would say IoT technology. Now vehicle has an internet. So, this helps to connect to the cloud. Now you can connect to your vehicle anytime anywhere. Material	Technology Types, IoT, Robots, Chemistry, Artificial Intelligence	Technology, Data and Analytics

of the product. Now we have more composite parts for the automotive. So, the vehicles are lighter. Everything is easier than before. So, I would say chemistry.

IoT is the future of the industry. The industry wants to go there. The second one is the material las especially important. Further the cars are very higher. You just have iron for the engine. Weight is especially important if you have something to move. It is lighter, safer, and you need less energy to move that thing. After the invention of the new materials to product the vehicle, we saw lots of super cars. Then we are coming back from super cars to standard cars. The industry invested lots of equipment's from super cars to regular car.

I would say robotic processes. In the industry lots of things are going with robotics. The pandemic showed us that it is very important to produce a car with a robot. Because you know human can be sick but robots cannot be sick.

It is also very important to check the processes with the robots. It is also feasible with the robots.

It is very important for automotive industry to have AI and ML in your processes. Because of the increase of the digital software of the vehicles. Everything is digital on the vehicle. You need some AI on your product. Because you cannot generate everything in your vehicle. So if you have any AI know how vehicle can learn itself and create value for the customer."

"I would say curiosity. You need to be curious about innovative technologies. What can we do more for the customer to create the value? What can we do for the company to shorten the processes to be more valuable? I would sum all of these terms on behalf of curiosity. For the skills I would say that one.

For the resources, you need an IT company. You need a high ability IT team. And the team which is more aware about the IT structure. It is not enough

Skills and Resources, Curiosity, Awareness	People

to have a team do marketing; a team can do sales. They need to be aware of the technology. It does not matter if you are doing or selling the technology. Because the technology can change. You need to be aware of what is going on in the earth”

“So digital transformation to me refers to .. Oh, I mean obviously technology has progressed amazingly fast. So, its speed of progresses even accelerating day by day. There are a lot of possibilities. **There are a lot of things you can achieve using possibilities of technology. So digital transformation is you know for business digital transformation looking for what you do today and compare it to the different possibilities that are currently enabled by the latest technology and adapting to it. Not just the technological possibilities but also your stakeholders as a business acquire new preferences and habits. Basically, technology is affecting everything, and digital transformation is looking at how your landscape is changing and adapting your operations your proposition how you work as a business to this new reality. ”**

“Let’s call it transportation industry because I think that would be most relevant when we talk about digital transformation. If you look at how we used to go from one place to another 10 years ago. You would need to have a phone number to call a taxi, or you would need to check schedules and today you can look at maps that already gives you several options where to go from one place to another. And then you only need to go your phone to buy a ticket or call a car or whatever. Just from the industry perspective it is remarkably similar to what happens in other industries that it is very easy to arrange things like search effort that you need to expand to find something or arrange something is very much reduced simply because of the smart phones and the app ecosystems that we have today. Then within my company. One difference is that the company is founded after the smart phone app become a thing.

Digital Technology Impact	Technology
Industry Transformation, Digital Transformation, Strategy, Innovative Business Models	Strategy

I would call it digital native organization. From that perspective, I guess level of digital transformation that we need to do is a little bit less compared to some of the other companies that I work at. Because the technology is changing so much, word is changing so much, even in a company like that we do need to think about virtualizing things. Whatever limited face to face interaction we still have our users, even though we are now thinking about virtualizing and having them accomplished.”

“I think technology is the main driver of the change what is happening. I would say technology is enabling. Many different things especially the smart phone and app ecosystem is changed. What you can do just from a technical perspective and because it is becoming too prevalent what people expect, what consumer expect and what you should be able to offer. I would say technology is definitely a big driver of what is happening in the industry and the change that is happening in the industry those two ways.”

“I want to define what technology is. I guess there is science. Technology is build based on science. I guess this is the simplest definition that I can think of.

So when I think of technology, I think of 2 different types. One is analog technology and the other is digital technology. And if we think about analog technology, let’s just think about watches for example. Just a simple wristwatch that does not have any kind of processor in it. I would say it is analog and then obviously watch and things like that would be digital technology. I do not know what I can pinpoint on that makes it analog to go digital. I would just say the processor I do not know if that be the right technical element that makes it digital. But that is the thing that I am thinking about. So there is a small computer.”

“In my sector I think fundamental technologies that we use. One is obviously telecommunications; you

Technology as a Driver	Technology, Strategy, Processes and Systems
Technology Types, Technology, Digital Technology	Technology
Technology Types, Business Intelligences, Data,	Technology, Data and Analytics

know we have an app that we connect users. So that kind of connectivity is one. We need to have GPS technology because it is transportation. What else? In different areas of business that we have different kind of things that is also apply, in addition to those 2 fundamental elements of technology. Existential elements of technology we use just for the very existential elements of business literally. **We also have distinct functions that use different technologies like we would have ML to analyse enormous size of data. It is not just a sector thing; it is a business intelligence thing. Or we have video chat technology to talk to our customers** like to match an agent and a customer to have a virtual support conversation. I would say first to the telecommunications, and GPS technology are the fundamental elements and for enabling distinct functions in our business we also make use of it a lot of technologies. ”

“I think there are some contexts where it would be controversial. For example, privacy could be an important thing. If your previous marketing strategy does not rely on involve, or let me put it this way. If you are a bank and you did not use to have an app, now you have an app and you ask your customers to do a lot of things on the app. **That is a big transformation, which is a big change. It can be controversial one because people do not want you suddenly to start interacting with them in a different way.** They are used to services that you used to provide to anything that is on the phone would be collecting data and what you do with that data. You know **depending on where you live, maybe laws are not protecting well the customer data very much or people do not agree with how you use the data whether you are showing them adds or selling your data to third parties. So there can be controversial elements there. So obviously there are security issues that you think about providing services digitally. So I can definitely think about**

Machine Learning,
Telecommunications,
GPS, Mobile,
Chatbot

Criticism
Controversiality,
Privacy, Concerns

Skepticism

several ways where it can be controversial.”

“Two major things you would need. One, people who can understand very well what new capability should look like. So, if you are for example trying to build. Let’s say you know you have a 20-year-old data system and now you are trying to build completely new data language, bringing them together different systems across the world making sure that everything is compatible with each other, adaptable as everybody calls that future proof. You really need technical expertise, to make sure that what you are building is good quality and resilient. So that is one thing and then the second thing is these are really complex projects. One reason is that they are so technical, and they are very fundamental changes that effect very large part of existing set up. So you also I think need very strong program managers. Someone who can only track what needs to happen but also is able to buy in and get it done. So those are the two things that come up very often in Digital Transformation discussions. I would say those are the 2 main things. But of course, there are also bunch of ancillary things that you need. You need persuasive communication professionals. You need good leader who can rally people behind the vision, etc.”

“Since last year, digitalization has been a must for distributors because there has been a lot of competition. Since the country has a lot of exposure to foreign brands and they all trying to get a piece of the pie. And since there is a lot of competition, you must understand your customers better and you have to reach them. And as well as since print advertisement or physical advertisement in Turkey is really expensive, it is more cost effective to reach customers using digital platforms. So **in the past few years, a lot of companies are using social platforms to reach customer or to advertise their products. Mass mailing is a must. People no longer give**

Skills, Resources	Culture, People
Industry Transformation, Marketing	Strategy, Processes and Systems

advertisements on newspapers. It is mostly done online. Or they still use flyers or templates or holiday booklets, but a lot of them has been done online so that there is no physical cost or you just have to. There is a much wider range that you can option online platforms at a much lower price.”

“Social media or use of online service. You know connectivity. It helps to move as social media marketing became the thing. You know the most important channel that companies sue nowadays. So the whole usage of social media became a very cost effective way of breeding desire about your products. So that out of everything we use, we use social media tools that they built around it are the most important. Social media tools Instagram, websites that help you to better make you posts, or better keep track of those. You have to pay for these programs that we used to use called hot suit. They help you to gather better information and to help you to put out of messaging in better ways in more efficient ways.

A lot of purchasing has been done on smartphones because it provides the ability for people to access information easier, and on the go easily. So that they do not have to be at home actually in front of a computer to access whatever they wanna access. They can do it on the bus, then can do it at work. And a lot of the sales are also being done one mobile platforms. So it is very important to not just build your marketing on desktop computers, it is also gain mobile users. We also operate on our website where we are able to sell our products. It is an ecommerce website that we cooperate ourselves where we have to create new products or product pages or to keep track of our users. But we are also periodically we have to upgrade the website. We are in the process of, we are trying to implement new tools into our website to create better campaigns for our customers.”

“Footprints of the customers convey data. Because you are able to keep track

Technology Types, Social Media Platforms, Digital Marketing	Technology
Technology Types, Digital Marketing	Technology, Data and Analytics

of the customers that come to your website. There are tools that help with that from Google called remarketing. **You try to catch a customer or just to a spectator. But the person does not have to buy from you but the person comes to your website and looked at a particular page. You try to catch his or her attention. Again and again so that you can turn him or her into a customer. So there you have digital footprint that is usually tied to their IP addresses is very important. It is not a 100% accurate tool.** It is not always the same person. Maybe there is more than one person in that house. It could be targeting their spouse or sibling. But still it can help you to turn visitors into customers”

“It has to be open to try new things. In a lot of the, a lot of what we do, what people are comfortable with doing. There is a new tool or there is a new way of doing business. People should be open to try it out. But it also needs to be done very carefully. There is a lot of processes, if implemented poorly in running a business. People should be open to try new tools or just getting better at figuring how things to work. Not just stick to whatever they work worse for them. Being open to change.

Nowadays a lot of companies are using cloud resources for storage for accounting process for cooperation processes for cooperation processes. Since Everyone is starting e-meetings as well so that is part of it which people easily adapted. There is Just taking your systems online and making it much more accessible from anywhere your employees can use from another resource is to use. Because it makes you nimble and it makes you more capable in responding to any kind of setbacks such as pandemic.”

“Digital transformation is the adaptation of all these technologies. It can either new technologies or current technologies to embed into current life structure and having the benefits of the lets say new trends. That is what I call a digital

Skills and Resources	Culture, People
Differentiation Among Digitalization Concepts	Digital Business Transformation Stages

transformation. If you embed any technology to your current business processes, and would be having a benefit from that, then you may be doing a digital transformation.”

“In the technology side, there are lots of trends. Especially when we are entering in 2021, there are three lets say important topics. One of them is people centricity. All of the processes and the new trends are aiming to Centrify people. Second one is location independence. Because as the effects of the current pandemic, people need to work from various locations. And has to reach business lines from different locations. So, location independence is the second trend.

Then there is also resilient delivery which means that you can just deliver your products in a more flexible way, and you use AI, data, and hyper automation.

Hyper automation is a technology that you use for business decisions. Or like current use of your digitalization processes like RPA or something. Automation. Let’s say business outcomes, you may use data of course. But to have the data and turning them to related business decisions you may use AI engineering that would be a trend in 2021. Resilient delivery is just an end definition that you use for all of these technologies which embed in your business for delivering digital products in a more flexible way. It is just a new topic”

“OEM side of the automotive company and also the IT providers are aiming to provide a total experience. So we were just used to listen customer experience or user experience. Those are the familiar words. But now multi experience and also employee experience has gained into the circle of experiences. And with the combination they call it a total experience. Like all the OEM companies they are trying to build an ecosystem that serves to customers fully lets say in a relation manner. From the day one, you get interacted with the customer, and then

Technology Trends	Technology
Industry and Technology Intersection	Strategy, Technology

not after just sales but also in the daily lives of the customers you would be in touch. You would have your customer in front. In the middle let say. That is why they are trying to build clouds for now to obtain all user data and then they provide some features to new sales channels and also new interactions with their customers. It is a new trend”

“Digital technology. It can be called. Like the processes that you see on web, or you use digital devices then it can be called it digital technology. If you have any interaction, I can call it digital technology Interaction between the user and the device”

“The new ones RPA, ML, AI. All of these ones are the trends of this year and also the upcoming 3 years.”

“first look into the daily operations of the users and then if we see any recurring operation that does not need to be accomplished by a human let say then we implement RPA. If we have sufficient and enough meaningful data then we are just trying to learn from those data by machine learning techniques and they provide different reports and solutions from the outcomes of those machine learnings and then trying to convert them into new features and new opportunities let say for our sectors. Not just for only for auto life for all the sectors that we are working for. And also at the last part, we are trying to make the decision part by AI because we have all the data for ML again in different sectors.”

“I have been working for a technology company. I am seeing the relation of just converting into ML techniques and some decisions or some tasks that would be accomplished by machines. It all started with RPA 3-4 years ago. The main complain by the users that they would lose their jobs, because they have some RPA applications in the companies. And also in the different sectors by the use of machines that people would afraid that they would lose their jobs. But then they

Digital Technology	Technology
Technology Types, RPA, ML, AI	Technology
Technology Implementation	Technology
Criticism Controversiality, Privacy, Concerns	Skepticism

started to gain their benefits. They understood that it is not just decreasing the employee amount, but it is decreasing the recurring work amount and leaving time for quality work. Then they felt ok. And now when we are in ml there are different techniques used by IT. They are not touching they are not contacting by themselves, so thee will be less contact. In future it would be new normal. People will be more related to technology and also machine work by means of AI.”

“In automotive side I guess the most important would be automated driving. It is the most valuable technology that will change the automotive industry that automotive drive would begin. Let say city much different.

In the technology side, AI would be the most making impact most in the upcoming future. Because the data has been more meaningful in our lives right now. Because we use data for previously making a decision some rule based solutions. Like if you have this kind of data do that, if you have this kind of data do that. But now we are just teaching machines how to make decisions. I guess that is why AI will be much more invested and much more in use in the upcoming future.”

“Autonomous driving is a machine technology, it has sensors and it has AI. But there are lots of discussions about it AI is not human. There are some paradox about how it will be in the daily lives if it has any problems. What will the choice of the AI be? For example, walking baby, grandmother, and on the other side there is pregnant women. Question is which one the vehicle pick to hit if it cannot escape from both. There are some ethical issues that has been discussed. Main and first barrier will be I guess ethical side of AI.”

“RPA part is easy to implement. It is cheap and also it saves lots of time means of man day in production. Especially in the digital working companies when you

Technology Impact	Technology
Data, Artificial Intelligence, Ethics	Data and Analytics
Technology Trends, Technology Implementation	Technology

implement that you get a serious quality time.

For ML you need data. Because 5-10 years ago, there were not so many data providing devices not so many interactions of digital data. As the technology increase, there are lots of smart devices around, and we have smart phones, wearable accessories, and our homes are just providing lots of data. That is why there is a data pool in front of ourselves and also in front of companies of course. That is why the machine learning is important, because people just started to understand the value of the data and data can effect their business positively. That is why I told about ML. I mean people are getting used to it. Especially technology mature companies or processes let say. I guess AI is the next start. Because we just try to get data. The meaningful of the data, we provide ML techniques and try to increase our business. At the end of the day, in very near future people would want machines to decide and make the actions not triggered manually.”

“We may talk about the glass technology. I does not have the place that it can go right now. There is much more way to go. It is the best technology I guess to combine both the real world and the digital world as a means of vision. People are just starting newly to use glass technology in their businesses. But it will have the other most coming impact in the upcoming future.”

“Let's take an example of tools. For example, what do we do to use technology? Here we are using a database. There is a method we use as database, channel web bases, or at work the golden gate. We can see data in 5 different places at the same time. In my field things like driver apps, security apps. And most importantly, mobile phones. This is also technology. Which allows the creation of everything used in the background. You act accordingly. There is a screen behind it to see what I can do.

Technology Trends, Virtual Reality	Technology
Technology Types, UX/UI, Data	Technology

UX/UI is a bit more of the experience part. So what you can do to the user. It has a psychological dimension. They study human psychology, not technology. For example, there is such a thing as A/B testing. For some reason, when you look at the screen on mobile, you can see the menu bar with three lines on the left, select the menu from the left and look down to the right for some reason. For example, the popups come out from below, people close the pop-ups that come out from above. UX/UI is a bit more psychological. Of course you use technology.”

“Mobile technologies and information security applications that affect the banking industry the most. Mobile applications, mobile technologies, information security technologies, database”

‘It shapes our industry a little bit. It used to be business drives technology. In the past, business would take decisions, and we would get the appropriate tools to make them. We used them. But now a technology is emerging. It is necessary to develop them. They push us to do something. With the increase in the use of mobile applications since the emergence of mobile phones in the world, you cannot say that you will develop over the web as before. You come back and develop the mobile app.

Here, technology is both a cause and an effect. Because, for example, I used to want to activate the card at the branches, when we were going to the bank. But now you say that I get this information on the tablet and go to people. For example, as a result of digitalization, people no longer come to the bank. People's habits have changed. There is digital input, the application of the bank now, and people no longer need to come to the bank. Such a cause-and-effect story`

“I have 3 simple steps called in Agile analysis - test- production. I analyze the product, test it, then put it into production.

Technology Types, Web/Mobile, Database, Cybersecurity, Information Security	Technology
Technology Impact on Business	Strategy
Agile	Culture

These processes were normally done by humans. People were testing. After the next test phase, there was the cleaning phase of the bugs. Then I had to go into production. In the past, we used to say upload to apple environment. We have now automated these processes.”

“When we graduated from the first university, only mechanical engineers and computer engineers were working on the web and app. Now psychologists, biologists, computer and industrial engineers are employed. For this reason, human resources from every sector are needed as human resources. It is also important for technology that mobile technologies can develop different resources.”

“The processes and the things needed step by step. The processes itself is transforming from what we have now. In the past final result would have never been happen. It is always a process. The way is transforming. From non digitalization to digitalization. At the end, it is forming step by step in my opinion”

“Now a lot of things are E2E solutions even in the finance in the banking sector. You can do everything online. Even the signature you can do it online. You can create a contract with a signature and everything you never have to meet with the supplier or customer or even somebody from bank. You can do everything let’s say in the space, cloud, online, or internet. It is a big change in the sector. It is automation by digitalization. Maybe speeded up with covid for sure. But yes, you can do everything in virtual space now. Without to meet personally. It is personally an outcome for me digitalization and automatization”

“Bitcoin and blockchain for the production company is not important for my opinion. To store things in cloud in the right direction but not linked to our company. The 5G solutions yes of course. GPS is also. If you produce something, and you can search all over the worldi is

Skills, Resources	People, Structure and Organization
Differentiation Among Digitalization Concepts	Digital Business Transformation Stages
Digitalization, Implementation, Differentiation Among Digitalization Concepts	Digital Business Transformation Stages
Technology Types, 5G, Blockchain, AI	Technology

very important. Therefore, not all of the things. If your product easy and handmade things you need the digitalization not so deeply for the product for the process yes, but for the product themselves it is our situation. If you are an IT company or a service provider, you needed more than the production company and trailers, passenger cars, or whatever. Not for the production.

If you develop things like robot or things you give in something brain that is AI. Computers or robots can learn themselves. To steer and to drive them and they get them self direction or these kind of things.”

“I think the higher technical impact is the more impact is digitalization. They are correlated. The higher technical things in the product, the more digitalization needed. If you produce plastic or play football, that is not require high digitalization, I think. But if you are using robotics systems, then there is an high impact on digitalization.”

“Other thing that I see is desocialization by digitalization. If you see younger people, everybody is on computers or in front of screens. They are not looking at somebody’s eyes when they speak. Desocialization. In my idea, it is controversial.”

“You need not only equipped but also educated IT team. If you decide to go on digitalization, it cannot be only driven by the IT department. You need a special department. You need to have all parties, all departments, all companies involved in the process. It won’t work, because they are affected by the somebody else, it is the whole process. Like the automatization of leasing contract E2E solution. You need on one side the financing company, you need to have all people who is involved, you need supplier, and the customer. It has to be all on the same level. You have to bring all of them on the same level to steer. You need: departments, IT,

Technical Impact and Produced Product Dependency	Processes and Systems, Technology
Criticism, Controversiality, Concerns	Skepticism
Communications, Management Support	Culture

department digitalization, and the communication from top down to communicate to take all on the boat. The decision makers make decision that nobody knows. Communication is everything.”

“The higher level of digitalization is the higher educated staff must be. But on the other side what we learned, lower jobs or easier jobs would be needed in other jobs in the process of digitalization. It will change. The jobs will change. Job descriptions will change and the jobs change. Not all of the jobs are much more difficult, but they are a little bit of another way. ”

“With the pandemic, the acceleration in the technology sector has increased incredibly. Because people now have to do some things from virtual platforms, mobile platforms and online due to the end of physical contact, I can say that as of now, compared to 1 year ago, digitalization continues in technology and actually accelerates it. So the transformation here was always in the opposite direction. While technology is trying to drive digital transformation, now life actually pushes technology more. About something going fast. Especially during the pandemic period, such a transformation took place. In fact, this has required technology to progress faster and to find faster solutions in the last period. I will say solutions, ideas and inventions regarding both platforms, online platforms and the transfer of physical to online, the emergence of some solutions accelerated them. If we look at it, while technology was pushing digitalization and digital transformation, companies in the market had to push the opposite a little bit. Because they are physically unable to work. To move this online, the trigger location has changed. In fact, it worked for the technology.”

“In fact, we can say that things are built around technology. So a little bit of business models were more intellectual,

Skills, Resources	People, Structure, and Organization
Technology Impact	Technology
Technology and Business Interaction,	Strategy

now the business idea, that business model is more built around a technology. So let's say online shopping.. People are starting to establish more businesses based on what you call connectivity or contactlessness. In other words, they are starting to look at what need I can meet this technology with. Things have changed a bit like that.

First there was a business idea. There were technologies that supported this business idea. Or there were technologies that could improve that business idea. Now a business model can be built around a technology. So the biggest thing about it is actually an online platform that goes through contactlessness and creates that contactlessness. How shall we say it? Processing a data is with smart things, here's what we call learning structures, we call smart structures, we call AI. Using these, people actually started to build business models around it. They started to build business models around artificial intelligence. Technology is more in the middle and at the centre. Before it was, it was like this. First you set up the business model, it would go without technology with manual work. Now she can't walk without it. In fact, it's somewhere in the center, a bit addictive at many points. There is such a change right now."

"Technology trends are published every year. Whatever the trend is, there is a point of view of what we can do as a response to that trend, something that is done in order not to miss this train, to be a pioneer at some point and not to be left behind. This actually affects the company's strategy. What shall we say? Data is the most talked about thing right now. Data technologies, machine learning, AIs, what we call business intelligence, the visibility of this data, learning something from this data, and creating a product about it, we can call it everything. What's happening? Since this is the agenda this time, you are setting up the right strategy. Actually, that's how it is because I'm in a tech company. The

Business Models,
Digital Innovation

Technology Trends
and Strategy
Intersection

Strategy

technology, which was on the agenda and was actually trending at that time, actually constitutes a kind of strategy. It creates the company's strategy. It's actually pretty central. Partly because of the industry.

Cloudification is one of the issues of detachment from the physical environment. I'm trying to disconnect from the physical server and move to the cloud. Why? Because it is both lower in cost and easier to maintain. It has many advantages such as expanding when I want, contracting whenever I want. In terms of these advantages, the transformation of technology equals the change or transformation of the company's strategic decisions. The direction it goes actually determines the direction the company is going.”

“Technology is actually a very broad concept. Of course, now that we work on the information technology side, the first thing that comes to our mind is information technology, software technology, but when we say technology, it seems like a study to be a pioneer of a branch, it can be a science.

After all, every branch of science has a technology. It's not just software related, it can be device related as well. For example, there is such a thing as gene technology. While what is being done here is playing with genes, it may be playing with codes in my industry, it may be using a different software language, it may be a transition to different databases. When I say technology, it actually seems to me as the whole of the work done to advance a little. But I'm talking about something independent of branch and industry.”

“Software is software, but everything you automate it is information technology. 1 line of code goes to information technologies, 5000 lines of code goes to information technologies. Any integration tool also falls within information technology. In fact, when it comes to information technology, it seems to me like software and the

Technology Types	Technology
Technology, Digital Technology, Information Technology, ICT	Technology

integrated things around it. The part that goes from hardware to software. It doesn't stay in hardware anymore or it is in soft environment. Therefore, all of them can be considered as information technology."

` Is hardware starting to become software?

Yes, with the cloud. Somewhere, of course, there are hardware machines somewhere. But gradually they turn into soft ones. You talk about soft forms, virtual presentations, cloud databases. Virtual virtual realities, AR and VR are all about creating something independent of the physical device. It all turns into software. You are moving towards producing larger software with smaller physical hardware. Or you don't use any hardware at all. Maybe you are softly uploading what many devices can do with one device.`

Technology, Digital Technology, Hardware, Software, Cloud	Technology

Appendix A.9 - CFA Factor Loadings for DMI Constructs

Table 47: CFA Factor Loadings for DMI Constructs

DMI Clusters	Estimate
Q1 C1 <-- F1 Culture	0.57
Q2 C2 <-- F1 Culture	0.59
Q3 C3 <-- F1 Culture	0.45
Q4 C4 <-- F1 Culture	0.85
Q5 C5 <-- F1 Culture	0.82
Q6 D1 <-- F2 Data and Analytics	0.67
Q7 D2 <-- F2 Data and Analytics	0.61
Q8 D3 <-- F2 Data and Analytics	0.68
Q9 D4 <-- F2 Data and Analytics	0.81
Q10 D5 <-- F2 Data and Analytics	0.65
Q11 D6 <-- F2 Data and Analytics	0.77
Q12 PE1 <-- F3 People, Structure and Organization	0.80
Q13 PE2 <-- F3 People, Structure and Organization	0.68
Q14 PE3 <-- F3 People, Structure and Organization	0.78
Q15 ST1 <-- F3 People, Structure and Organization	0.70
Q16 ST2 <-- F3 People, Structure and Organization	0.62
Q17 PR1 <-- F4 Processes and Systems	0.32
Q18 PR2 <-- F4 Processes and Systems	0.65
Q19 PR3 <-- F4 Processes and Systems	0.65
Q20 PR4 <-- F4 Processes and Systems	0.69
Q21 PR5 <-- F4 Processes and Systems	0.33
Q22 PR6 <-- F4 Processes and Systems	0.70
Q23 PR7 <-- F4 Processes and Systems	0.58
Q24 ST1 <-- F5 Strategy	0.67
Q25 ST2 <-- F5 Strategy	0.60
Q26 S1 <-- F5 Strategy	0.62
Q27 S2 <-- F5 Strategy	0.65
Q28 S3 <-- F5 Strategy	0.56
Q29 S4 <-- F5 Strategy	0.79
Q30 S5 <-- F5 Strategy	0.52
Q31 S6 <-- F5 Strategy	0.43
Q32 S7 <-- F5 Strategy	0.59
Q33 T1 <-- F6 Technology	0.70
Q34 T2 <-- F6 Technology	0.64
Q35 T3 <-- F6 Technology	0.68

Appendix A.10 - Composite Reliability and Average Variance Extracted (AVE) Analysis

Table 48: Composite Reliability and Average Variance Extracted Analysis

DMI Clusters	Estimate
Q1 C1 <-- F1 Culture	0.57
Q2 C2 <-- F1 Culture	0.59
Q3 C3 <-- F1 Culture	0.45
Q4 C4 <-- F1 Culture	0.85
Q5 C5 <-- F1 Culture	0.82
Q6 D1 <-- F2 Data and Analytics	0.67
Q7 D2 <-- F2 Data and Analytics	0.61
Q8 D3 <-- F2 Data and Analytics	0.68
Q9 D4 <-- F2 Data and Analytics	0.81
Q10 D5 <-- F2 Data and Analytics	0.65
Q11 D6 <-- F2 Data and Analytics	0.77
Q12 PE1 <-- F3 People, Structure and Organization	0.80
Q13 PE2 <-- F3 People, Structure and Organization	0.68
Q14 PE3 <-- F3 People, Structure and Organization	0.78
Q15 ST1 <-- F3 People, Structure and Organization	0.70
Q16 ST2 <-- F3 People, Structure and Organization	0.62
Q17 PR1 <-- F4 Processes and Systems	0.32
Q18 PR2 <-- F4 Processes and Systems	0.65
Q19 PR3 <-- F4 Processes and Systems	0.65
Q20 PR4 <-- F4 Processes and Systems	0.69
Q21 PR5 <-- F4 Processes and Systems	0.33
Q22 PR6 <-- F4 Processes and Systems	0.70
Q23 PR7 <-- F4 Processes and Systems	0.58
Q24 ST1 <-- F5 Strategy	0.67
Q25 ST2 <-- F5 Strategy	0.60
Q26 S1 <-- F5 Strategy	0.62
Q27 S2 <-- F5 Strategy	0.65
Q28 S3 <-- F5 Strategy	0.56
Q29 S4 <-- F5 Strategy	0.79
Q30 S5 <-- F5 Strategy	0.52
Q31 S6 <-- F5 Strategy	0.43
Q32 S7 <-- F5 Strategy	0.59
Q33 T1 <-- F6 Technology	0.70
Q34 T2 <-- F6 Technology	0.64
Q35 T3 <-- F6 Technology	0.68

Appendix A.10 - Glossary and Abbreviations

Table 49: List of Abbreviations

Abbreviations	Definition	Explanation
DMI	Digital Maturity Index	An instrument to measure digital maturity level of the organizations.
C	Culture	Organization culture.
D	Data and Analytics	Data, machine learning, artificial intelligence, and data analytics related topics at the organization.
PE	People, Structure and Organization	Employees, organizational structure and organization itself.
PR	Processes and Systems	Processes and digital systems of the organizations.
S	Strategy	Organization's strategy covering digital strategy, data strategy, business strategy, and all organization related strategies.
T	Technology	Technology, digital technologies which are adopted at the organization.
IOT	Internet of Things	Internet of Things and connectivity.
ML/AI	Machine Learning and Artificial Intelligence	Machine Learning and Artificial Intelligence. Artificial Intelligence is a field of combining data and computer science to solve problems using techniques. Machine learning is the subfield and application side of Artificial Intelligence.
AR	Augmented Reality	Augmented Reality
RPA	Robotic Process Automation	Robotic Process Automation is a automation process which is based on virtual robots who substitute as an employee.
ERP	Enterprise Resource Planning	Enterprise Resource Planning.
DMS	Dealer Management System	Dealer Management System.
MVP	Minimum Viable Product	Minimum Viable Product is the minimum working product.
PO	Technical Product Owner	Technical employee role who deals with the technical and digital product implementations.

BO	Business Owner	Business employee role who deals with the digital product implementations.
OEM	Original Equipment Manufacturer	Manufacturer.
E2E	End to End	End to end systematic solutions.
DX	Digital Business Transformation	Digital Business Transformation.
ICE	Internal Combustion Engine	Internal Combustion Engine.
CFA	Confirmatory Factor Analysis	Confirmatory Factor Analysis.
EFA	Exploratory Factor Analysis	Exploratory Factor Analysis.
CR	Composite Reliability	Composite Reliability.
AVE	Average Variance Extracted	Average Variance Extracted.
RQ	Research Question	Research Question
IQ	Interview Question	Interview Question
ICT	Information and Communication Technology	Information and Communication Technology (ICT) Experts

BIBLIOGRAPHY

- [1] G.A. Churchill, “A Paradigm for Developing Better Measures of Marketing Constructs”. *Journal of Marketing Research*, vol. 16, no. 1, pp. 64-73, Feb 1979.
- [2] R.C. Santos and J.L. Martinho, “An Industry 4.0 maturity model proposal,” *Journal of Manufacturing Technology Management*, vol. 31, no. 5, pp. 1023-1043, Nov 2020. Available: <https://doi-org.offcampus.ozyegin.edu.tr/10.1108/JMTM-09-2018-0284>
- [3] BCG, M. Rüssman, M. Lorenz, P. Gerbert, M. Waldner, M. Harnisch and J. Justus, “Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries,” 09 April 2015, [Online]. Available: https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries [Accessed 25 March 2023]
- [4] E. Gökalp and V. Martinez, “Digital transformation capability maturity model enabling the assessment of industrial manufacturers,” *Computers in Industry*, vol. 132, no 103522, pp. 1-23., Nov 2021. Available: <https://doi.org/10.1016/j.compind.2021.103522> [Accessed 13 Apr 2023]
- [5] iscoop. “What is digital business transformation? The essential guide to DX,” 2022, [Online]. Available: <https://www.i-scoop.eu/digital-transformation/> [Accessed December 2022]
- [6] Gartner. IT Glossary. 2022 [cited 2023 Apr 16]; Available: <https://www.gartner.com/en/information-technology/glossary>
- [7] A. Amaral and P. Peças. “A Framework for Assessing Manufacturing SMEs Industry 4.0 Maturity,” *Applied Sciences*, vol. 11, no. 6127, Jul 2021. Available: <https://doi.org/10.3390/app11136127>
- [8] K. Smaje and R. Zimmel. “Digital transformation on the CEO agenda”, 12 May, 2022, *McKinsey Podcast*, [Online]. Available: <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/digital-transformation-on-the-ceo-agenda>. [Accessed 29 December 2022]
- [9] I. Mutlu, E. den Hartigh and C. Ucler, “Digital Technology and the Stages of Digital Business Transformation,” 2022 *IEEE 28th International Conference on Engineering, Technology and Innovation (ICE/ITMC) & 31st International Association For Management of Technology (IAMOT) Joint Conference, Engineering, Technology and Innovation (ICE/ITMC)*, pp. 1–8, (2022). <https://doi-org.offcampus.ozyegin.edu.tr/10.1109/ICE/ITMC-IAMOT55089.2022.10033256>
- [10] IBM Institute for Business Value, “Digital Reinvention in Action”, *IBM*, 2016. [Online]. Available: <https://www.ibm.com/downloads/cas/7MK5LPON>. [Accessed 24 August 2019]

- [11] D. Tilson, K. Lyytinen, C. Sørensen, "Digital infrastructures: The missing IS research agenda," *Information Systems Research*, vol. 17, no. 4, pp. 748-759, 2010.
- [12] A. Bharadwaj, O. A. El Sawy, P. A. Pavlou, N. Venkatraman, "Digital Business Strategy: Toward A Next Generation of Insights," *MIS Quarterly*, Vol. 37, no. 2, pp. 471-482, Jun 2013.
- [13] D. Savić, "From Digitization Through Digitalization, to Digital Transformation," *Online Researcher*, pp. 36-39, Jan/Feb 2019, [Online]. Available: <https://search-ebscohost-com.offcampus.ozyegin.edu.tr/login.aspx?direct=true&db=f6h&AN=133970782&site=eds-live&scope=site> [Accessed 14Apr 2023].
- [14] G. Vial, "Understanding digital transformation: A review and a research agenda", *The Journal of Strategic Information Systems*, Vol. 28, no. 2, pp. 118-144, June 2019. Available: <https://doi.org/10.1016/j.jsis.2019.01.003>
- [15] I. Mergel, N. Edelmann and N. Haug, "Defining digital transformation: Results from expert interviews," *Government Information Quarterly*, vol. 36, no. 4, 101385, pp. 1-16, Oct 2019. Available: <https://doi-org.offcampus.ozyegin.edu.tr/10.1016/j.giq.2019.06.002>
- [16] T. Saarikko, U. H. Westergren and T. Blomquist, "Digital transformation: Five recommendations for the digitally conscious firm," *Business Horizons*, vol. 63, no. 6, pp. 825-839, Nov 2020. Available: <https://doi.org/10.1016/j.bushor.2020.07.005>
- [17] P. C. Verhoef, T. Broekhuizen, Y. Bart, A. Bhattacharya, J. Qi Dong, N. Fabian and M. Haenlein. "Digital transformation: A multidisciplinary reflection and research agenda," *Journal of Business Research*, vol. 122, pp. 889-901, Jan 2021. Available: <https://doi.org/10.1016/j.jbusres.2019.09.022>
- [18] R. N. Chawla and P. Goyal. "Emerging trends in digital transformation: a bibliometric analysis," *Benchmarking: An International Journal*, vol. 29, no. 4, pp. 1069-1112, Mar 2022. Available: <https://doi.org/10.1108/BIJ-01-2021-0009>
- [19] C. Gong, V. Ribiere, "Developing a unified definition of digital transformation," *Technovation*, Vol 102, no. 102217, Apr 2021. Available: <https://doi.org/10.1016/j.technovation.2020.102217>
- [20] X. Zhu, S. Ge, N. Wang, "Digital transformation: A systematic literature review," *Computers & Industrial Engineering*, vol. 162, no: 107774, Dec 2021. Available: <https://doi.org/10.1016/j.cie.2021.107774>
- [21] S. Kraus, S. Durst, J. J. Ferreira, P. Veiga, N. Kailer and A. Weinmann. "Digital transformation in business and management research: An overview of the current status quo," *International Journal of Information Management*, vol. 63, no. 102466, Apr 2022. Available: <https://doi.org/10.1016/j.ijinfomgt.2021.102466>
- [22] S. Berghaus and A. Back, "Stages in Digital Business Transformation: Results of an Empirical Maturity Study," *Mediterranean Conference on Information Systems (MCIS) Proceedings*, pp. 1-17, 2016. Available: <http://aisel.aisnet.org/mcis2016/22>

- [23] O. Valdez-De-Leon, “A Digital Maturity Model for Telecommunications Service Providers,” *Technology Innovation Management Review*, vol. 6, no. 8, 2016. Available: www.timreview.ca
- [24] E. A. Isaev, N. L. Korovkina, M. S. Tabakova, “Evaluation of the readiness of a company’s IT department for digital business transformation”, *Business Informatics*, vol. 2, no. 44, pp. 55–64, Jun 2018. Available: <https://doi-org.offcampus.ozyegin.edu.tr/10.17323/1998-0663.2018.2.55.64>
- [25] A. Garzoni, I. De Turi, G. Secundo and P. Del Vecchio, “Fostering digital transformation of SMEs: a four levels approach,” *Management Decision*, vol. 58, no. 8, pp. 1543–1562, Dec 2020 4.
- [26] J. Sandberg, J. Holmström and K. Lyytinen, “Digitization and phase transitions in platform organizing logics: Evidence from the process automation industry,” *MIS Quarterly*, vol. 44, no. 1, pp. 129–153, Mar 2020. Available: <https://doi-org.offcampus.ozyegin.edu.tr/10.25300/MISQ/2020/14520>
- [27] E. Gökalp and V. Martinez, “Digital transformation maturity assessment: development of the digital transformation capability maturity model,” *International Journal of Production Research*, vol. 60, no. 20, pp. 6282-6302, October 2021. Available: DOI: 10.1080/00207543.2021.1991020
- [28] S. Brennen and D. Kreiss. “Digitalization and Digitization,” 2014, [Online]. Available: <http://culturedigitally.org/2014/09/digitalization-and-digitization/>
- [29] MA. M. Gobble, “Digitalization, Digitization, and Innovation,” *Research Technology Management*, vol. 61, no. 4, pp. 56–59, Jul 2018. Available: <https://doi.org/10.1080/08956308.2018.1471280>
- [30] A. Tiwana, B. Konsynski, A. A. Bush, “Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics,” *Information Systems Research*, vol. 21, no. 4, pp. 675–687, 2010.
- [31] J. Ross, “Don’t Confuse Digital With Digitization,” 2017, [Online]. Available: <https://sloanreview.mit.edu/article/dont-confuse-digital-with-digitization/>
- [32] B. Brown, J. Sikes and P. Willmott, “Bullish on digital: McKinsey Global Survey results,” *McKinsey & Company*, 2013, [Online]. Available: <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/bullish-on-digital-mckinsey-global-survey-results> [Accessed 14 Apr 2023]
- [33] J. Bughin, T. Catlin, M. Hirt and P. Willmott, “Why digital strategies fail,” *McKinsey Quarterly*. 15p, Jan 2018, [Online]. Available: <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/why-digital-strategies-fail>
- [34] N. Van Zeebroeck, T. Kretschmer and J. Bughin, “Digital “is” Strategy: The Role of Digital Technology Adoption in Strategy Renewal”. *IEEE Transactions on Engineering Management*, 2021. Available: <https://doi-org.offcampus.ozyegin.edu.tr/10.1109/TEM.2021.3079347>
- [35] iScoop. “Digitization, digitalization and digital transformation: the differences”, 2016 [Online]. Available: <https://www.i-scoop.eu/digitization-digitalization-digital-transformation-disruption/> [Accessed 14 Apr 2023]

- [36] A. Irniger, "Difference between Digitization, Digitalization and Digital Transformation", 2017 [Online]. Available: <https://www.coresystems.net/blog/difference-between-digitization-digitalization-and-digital-transformation> [Accessed 24 Aug 2019]
- [37] J. Bloomberg, "Digitization, Digitalization, And Digital Transformation: Confuse Them At Your Peril I write and consult on digital transformation in the enterprise," *Forbes*, 2018, [Online]. Available: <https://www.forbes.com/sites/jasonbloomberg/2018/04/29/digitization-digitalization-and-digital-transformation-confuse-them-at-your-peril/#78e677fd2f2c>
- [38] T. F. Bresnahan and M. Trajtenberg, "General purpose technologies: Engines of growth?", *Journal of Econometrics*, vol.65, pp.83-108, 1995.
- [39] E. Brynjolfsson and A. McAfee, "Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy," *Lexington, Mass: Digital Frontier Press*, 2012.
- [40] D. J. Teece, "Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world," *Research Policy*, vol. 47, no. 8, pp. 1367–1387, Oct 2018.
- [41] R. L. Baskerville, M. D. Myers and Y. Yoo, "Digital First: The Ontological Reversal and New Challenges For Information Systems Research," *MIS Quarterly*, vol. 44, no. 2, pp. 509–523, Jun 2020.
- [42] Y. Benkler, "The wealth of networks: how social production transforms markets and freedom," *Yale University Press*; pp. 515, 2006.
- [43] P. Guenzi and J. Habel, "Mastering the Digital Transformation of Sales," *California Management Review*, vol. 62, no. 4, pp. 57–85, (2020). Available: <https://doi.org/10.1177/0008125620931857>
- [44] I. Iyamu, A. X. T. Xu, O. Gómez-Ramírez, A. Ablona, H. J Chang, G. Mckee and M. Gilbert, "Defining digital public health and the role of digitization, digitalization, and digital transformation: Scoping review," *JMIR Public Health and Surveillance*, vol. 7, no. 11, pp. 1–14, 2021. Available: <https://doi.org/10.2196/30399>
- [45] K. Buntak, M. Kovačić and M. Mutavdžija, "Measuring Digital Transformation Maturity of Supply Chain," *Tehnički Glasnik*, vol. 15, no. 2, pp. 199–204, 2021. Available: <https://doi.org/10.31803/tg-20200414191933>
- [46] P. Mugge, H. Abbu, T. L. Michaelis, A. Kwiatkowski, G. Gudergan, "Patterns of Digitization: A Practical Guide to Digital Transformation," *Research Technology Management*, vol. 63, no. 2, pp. 27–35, Mar 2020. Available: <https://doi.org/10.1080/08956308.2020.1707003>
- [47] C. Ogorean and M. Herciu, "Digital Transformation as Strategic Shift – A Bibliometric Analysis," *Studies in Business and Economics*, vol. 16, no. 3, pp. 136-151, 2021. Available: <https://doi.org/10.2478/sbe-2021-0050>
- [48] D. Schallmo, C.A. Williams and L. Boardman, "Digital transformation of business models-best practice, enablers, and roadmap," *International Journal of*

Innovation Management, vol. 21, no. 8, 2017. World Scientific Publishing Co. Pte Ltd. Available: <https://doi.org/10.1142/S136391961740014X>

[49] Z. Tekic and D. Koroteev, "From disruptively digital to proudly analog: A holistic typology of digital transformation strategies," *Business Horizons*, vol. 62, no. 6, pp. 683–93, Nov-Dec 2019. Available: <https://doi.org/10.1016/j.bushor.2019.07.002>

[50] C. van Tonder, C. Schachtebeck, C. Nieuwenhuizen and B. Bossink, "A Framework for Digital Transformation and Business Model Innovation," *Journal of Contemporary Management Issues*, vol. 25, no. 2, 2020 Available: <https://doi.org/10.30924/mjcmi.25.2.6>

[51] Z. Van Veldhoven and J. Vanthienen, "Digital transformation as an interaction-driven perspective between business, society, and technology", *Electronic Markets*, 32(2), 629–644. <https://doi.org/10.1007/s12525-021-00464-5>

[52] B. Wernicke, L. Stehn, A. A. Sezer and M. Thunberg, "Introduction of a digital maturity assessment framework for construction site operations," *International Journal of Construction Management*, vol. 23, no. 5, 2021. Available: <https://doi.org/10.1080/15623599.2021.1943629>

[53] L. Wessel, A. Baiyere, R. Ologeanu-Taddei, J. Cha and T. Blegind Jensen, "Unpacking the Difference Between Digital Transformation and IT-Enabled Organizational Transformation," *Journal of the Association for Information Systems*, vol. 22, no. 1, article 6, 2021. Available: <https://doi.org/10.17705/1jais.00655>

[54] A. Raghavan, E. Ritsema, S. Allema, I. Vaganov, A. Allen, O. Choudhry and M. Olstowski, "It's Time for TICC Companies to Catch Up on Digital," *BCG, Rotschild & Co*, May 2021. Available: <https://web-assets.bcg.com/af/01/d2563e504897bfff6a85bacc69c22/bcg-its-time-for-ticc-companies-to-catch-up-on-digital-may-2021.pdf> [Accessed 03 Jun 2023]

[55] IBM Institute for Business Value (GBS), 2019, MGMT 781: Digital Business and Transformation, week 3, session 6 notes [IBM Digital Reinvention in Action – What to do and how to make it happen Course Presentation]. Available: <https://lms.ozyegin.edu.tr/course/view.php?id=4089>

[56] B. Marr, "The Secret to Successful Digital Transformation: It's All About the People," *Forbes*, 24 March 2023. Available: <https://www.forbes.com/sites/bernardmarr/2023/03/24/the-secret-to-successful-digital-transformation-its-all-about-the-people/?sh=7c0667757383>

[57] B. Tabrizi, E. Lam, K. Girar and V. Irvin, "Digital Transformation Is Not About Technology," *HBR*, 13 March 2019. Available: <https://hbr.org/2019/03/digital-transformation-is-not-about-technology> [Accessed 01 Aug 2020]

[58] A. Aagaard, M. Presser, T. Collins, M. Beliatas, A. K. Skou, E. M. Jakobsen, "The Role of Digital Maturity Assessment in Technology Interventions with Industrial Internet Playground," *Electronics*, vol. 10, no. 1134, pp. 1-14, May 2021. Available: <https://doi.org/10.3390/electronics10101134>

[59] T. von Leipzig, M. Gamp, D. Manz, K. Schöttle, P. Ohlhausen, G. Oosthuizen, D. Palm, K. Von Leipzig, "Initialising Customer-orientated Digital

Transformation in Enterprises,” *Procedia Manufacturing*, vol. 8, pp. 517–524, 2017. Available: <https://doi-org.offcampus.ozyegin.edu.tr/10.1016/j.promfg.2017.02.066>

[60] M. K. Borštnar and A. Pucihar, “Multi-Attribute Assessment of Digital Maturity of SMEs,” *Electronics*, vol. 10, no. 885, 2021. Available: <https://doi.org/10.3390/electronics>

[61] M. Fischer, F. Imgrund, C. Janiesch and A. Winkelmann, “Strategy archetypes for digital transformation: Defining meta objectives using business process management,” *Information and Management*, vol. 57, no. 5, Jul 2020. Available: <https://doi.org/10.1016/j.im.2019.103262>

[62] R. Teichert, “Digital transformation maturity: A systematic review of literature,” *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 67, no. 6, pp. 1673–87, 2019. Available: <https://doi.org/10.11118/actaun201967061673>

[63] M. Lassnig, J. M. Müller, K. Klieber, A. Zeisler and M. A Schirl, “Digital readiness check for the evaluation of supply chain aspects and company size for Industry 4.0,” *Journal of Manufacturing Technology Management*, vol. 33, no. 9, pp. 1–18, 2021. Available: <https://doi-org.offcampus.ozyegin.edu.tr/10.1108/JMTM-10-2020-0382>

[64] C. Williams, D. Schallmo, K. Lang, L. Boardman, “Digital Maturity Models for Small and Medium-sized Enterprises: A Systematic Literature Review,” *ISPIM Innovation Conference*, pp. 1-15, 2019. Available: www.ispim.org

[65] T. Gollhardt, S. Halsbenning, A. Hermann, A. Karsakova, J. Becker, “Development of a Digital Transformation Maturity Model for IT Companies,” *Proceedings - 2020 IEEE 22nd Conference on Business Informatics, CBI 2020*, 1, 94–103, 2020. <https://doi.org/10.1109/CBI49978.2020.00018>

[66] BCG, “BCG ’ s Digital Acceleration Index (DAI) Study Finds That Digitally Mature Companies Saw Valuations of 23 %, on Average , Above Precrisis Levels Within Six Months of the Pandemic’s Start,” *Boston Consulting Group*, pp. 21–24. Press Release. (2022). Available: <https://www.bcg.com/press/21june2021-bcgs-digital-acceleration-index-dai-study-finds-that-digitally-mature-companies-saw-valuations-of-23-on-average-above-precrisis-levels-within-six-months-of-the-pandemics-start> [Accessed 14 Nov 2022]

[67] J. Azevedo, “Digital acceleration index: the relationship between firms’ digital maturity and human capital,” NOVA School of Business and Economics, 2021. [Online] Available: https://run.unl.pt/bitstream/10362/138109/1/dai_scale_thesis_joao_-final.pdf

[68] KPMG Digital Readiness, [Online]. Available: <https://atlas.kpmg.com/de/en/business-analytics/details/digital-readiness#tab1> [Accessed 6 Dec 2022]

[69] Deloitte, “Digital Maturity Model Achieving digital maturity to drive growth,” Feb 2018. [Online]. Available: <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology->

[Media-Telecommunications/deloitte-digital-maturity-model.pdf](#) [Accessed 14 Nov 2022]

[70] G. Gudergan, P. Mugge, A. Kwiatkowski, H. Abbu, G. Hoeborn and R. Conrad, “Digital Leadership - Which leadership dimensions contribute to digital transformation success?”, *2021 IEEE International Conference on Engineering, Technology and Innovation, ICE/ITMC 2021 – Proceedings*, Jun 2021. Available: <https://doi.org/10.1109/ICE/ITMC52061.2021.9570231>

[71] McKinsey Quarterly, “Enduring Ideas: The 7-S Framework,” *McKinsey*, 1 March 2008. Available: <https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/enduring-ideas-the-7-s-framework#>

[72] K. Osmundsen, J. Iden and B. Bygstad, “Digital Transformation: Drivers, Success Factors, and Implications” *MCIS 2018 Proceedings*, Vol. 37, 2018. Available: <https://aisel.aisnet.org/mcis2018/37>

[73] B. Hortense, M. Alberto and R. Angelika, “Unlocking success in digital transformations,” *McKinsey & Company*, pp. 1–14, October 2018. Available: <https://www.mckinsey.com/business-functions/organization/our-insights/unlocking-success-in-digital-transformations>

[74] C. Ebert and C. D. C. Henrique, “Digital Transformation”. *IEEE Software*, vol. 35, no. 4, pp. 16–21, 2018. Available: <https://doi.org/10.1109/MS.2018.2801537>

[75] G. Lanzolla, A. Lorenz, E. Miron-Spektor, M. Schilling, G. Solinas, C. L. Tucci, “Digital transformation: What is new if anything? Emerging patterns and management research,” *Academy of Management Discoveries*, vol. 6, no. 3, pp. 341–350, 29 Oct 2020. Available: <https://doi.org/10.5465/amd.2020.0144>

[76] E. Solberg, L. E. M. Traavik, S. I. Wong, “Digital Mindsets: Recognizing and Leveraging Individual Beliefs for Digital Transformation,” *California Management Review*, vol. 62, no. 4, pp. 105–24, Aug 2020. Available: <https://doi.org/10.1177/0008125620931839>

[77] Z. Dobrovic, “The Role of Business Processes in Digital Transformation of the Organization,” *44th International Convention on Information, Communication and Electronic Technology, MIPRO 2021 – Proceedings*, p. 1329–1334, 2021. Available: <https://doi.org/10.23919/MIPRO52101.2021.9596754>

[78] Y. Yoo, O. Hendfridsson, and K. Lyytinen, “The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research,” *Information Systems Research*, vol. 21, no. 4, pp. 724–735, 2010.

[79] A. Correani, A. De Massis, F. Frattini, A. M. Petruzzelli, A. Natalicchio, “Implementing a Digital Strategy: Learning from the Experience of Three Digital Transformation Projects,” *California Management Review*, vol. 62, no. 4, pp. 37–56, Aug 2020.

[80] L. Massa and C. L. Tucci, “Business model innovation,” In M. Dodgson, D. M. Gann & N. Philips (Eds.), *The Oxford handbook of innovation management*, Vol. 20, pp. 420–441, 2013. Oxford, UK: University of Oxford.

- [81] K. Pousttchi, A. Gleiss, B. Buzzi and M. Kohlhagen, “Technology impact types for digital transformation”. *21st IEEE Conference on Business Informatics, CBI 2019 -Proceedings*, pp. 487–94, 2019.
- [82] A. Sestino, M. I. Prete, L. Piper and G. Guido, “Internet of Things and Big Data as enablers for business digitalization strategies,” *Technovation*, vol. 98, Elsevier Ltd, 2020. Available: <https://doi.org/10.1016/j.technovation.2020.102173>
- [83] T. Kretschmer and P. Khashabi, “Digital Transformation and Organization Design: An Integrated Approach,” *California Management Review*, vol. 62, no. 4, pp. 86–104, Aug 2020 1. Available: <https://doi.org/10.1177/0008125620940296>
- [84] Y. Yoo, R. J. Boland Jr., K. Lyytinen and A. Majchrzak, “Organizing for Innovation in the Digitized World,” *Organization Science*, vol. 23, no. 5, pp.1398–1408, 2012. Available: <https://www.jstor.org/stable/23252314>
- [85] S.J. Berman, “Digital transformation: opportunities to create new business models,” *Strategy & Leadership*, vol. 40, no. 2, pp.16–24, 2012. Available: <https://doi.org/10.1108/10878571211209314>
- [86] C. Matt, T. Hess and A. Benlian, “Digital Transformation Strategies,” *Business & Information Systems Engineering*, vol. 57, no. 5, pp.339–343, 2015. Available: <https://doi.org/10.1007/s12599-015-0401-5>
- [87] TDWI, Data Management Maturity Model, [Online]. Available: <https://tdwi.org/Pages/Assessments/DIQ-ALL-Data-Management-Maturity-Model-Assessment.aspx>
- [88] Org CMF, Overview of the Digital Maturity Index (DMI), 2022, [Online]. Available: [https://orgcmf.com/en-gb/pages/digital/dmiooverview/#:~:text=The%20Digital%20Maturity%20Index%20\(DMI\)%20is%20a%20Reference%20Model%20that,Systems%20Maturity%20Theory%20\(DSMT\)](https://orgcmf.com/en-gb/pages/digital/dmiooverview/#:~:text=The%20Digital%20Maturity%20Index%20(DMI)%20is%20a%20Reference%20Model%20that,Systems%20Maturity%20Theory%20(DSMT)) [Accessed 14 Nov 2022]
- [89] G. C. Kane, D. Palmer, N., A. Philips, D. Kiron and N. Buckley, “Strategy, Not Technology, Drives Digital Transformation,” *MIT Sloan Management Review and Deloitte University Press*, Jul 2015. [Online]. Available: <https://sloanreview.mit.edu/projects/strategy-drives-digital-transformation/>
- [90] G. C. Kane, D. Palmer, A. N. Phillips, D. Kiron and N. Buckley, “Achieving Digital Maturity Adapting Your Company to a Changing World Summer 2017 Research Report,” *MIT Sloan Management Review and Deloitte University Press*, July 2017. [Online]. Available: https://www2.deloitte.com/content/dam/insights/us/articles/3678_achieving-digital-maturity/DUP_Achieving-digital-maturity.pdf [Accessed 14 Nov 2022]
- [91] Deloitte, “Digital Maturity Index Survey. Digital Value Creation in an Unsettled Environment,” *Deloitte*, 2022. [Online]. Available: <https://www2.deloitte.com/content/dam/Deloitte/de/Documents/Deloitte%20Digital%20Maturity%20Index-Survey%202022.pdf>
- [92] C. Anderson and E. William, “Digital Maturity Model: Achieving digital maturity to drive growth,” *Deloitte*, pp. 1–24, 2018. [Online]. Available: <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/deloitte-digital-maturity-model.pdf>

- [93] D. Küpper, “Embracing Industry 4.0 and Rediscovering Growth,” *BCG*, 2019. [Online]. Available: <https://www.bcg.com/capabilities/operations/embracing-industry-4.0-rediscovering-growth> [Accessed 02 Aug 2020]
- [94] C. Karalee, A. Gourevitch, M. Schuurin, M. Sterman, L. Quarta and A. Sawadogo, “Digital Acceleration Is Just A Dream Without A New Approach To Tech,” *BCG*, 2020. [Online]. Available: <https://www.bcg.com/publications/2020/how-to-successfully-accelerate-digital-transformation> [Accessed 10 Nov 2022]
- [95] BCG, “Digital Maturity”, 2022. [Online]. Available: <https://www.bcg.com/capabilities/digital-technology-data/digital-maturity>
- [96] S. Ranking and D. Rosmann, “The Playbook for Successful Digital Transformation,” *KPMG*, [Online]. Available: <https://www.kpmg.us/insights/transforming-transformation.html>
- [97] A. R. Dhaini, “KPMG Digital Transformation Playbook,” *KPMG*, 2020. [Online]. Available: <https://assets.kpmg/content/dam/kpmg/sa/pdf/2020/digital-transformation-playbook.pdf> [Accessed 6 Dec 2022]
- [98] B. Brunsman and B. Sonni, “Global Tech Report 2022 Global technology leaders share their digital transformation progress and explore how to strengthen ongoing digital maturity,” *KPMG*, Sept 2022. [Online]. Available: <https://assets.kpmg/content/dam/kpmg/xx/pdf/2022/09/kpmg-global-tech-report-2022.pdf>
- [99] R. Koets, E. Rüdisüli, “Data Management for Data & Analytics”, *KPMG*, [Online]. Available: <https://assets.kpmg.com/content/dam/kpmg/ch/pdf/data-management-for-data-analytics.pdf>
- [100] KPMG, “Digital Transformation, How advanced technologies are impacting financial reporting and auditing,” *KPMG & Forbes Insight*, 2017. Available: <https://assets.kpmg/content/dam/kpmg/us/pdf/2017/08/kpmg-forbes-digital-transformation-report.pdf> [Accessed 14 Nov 2022]
- [101] A. Dawson, M. Hirt and J. Scanlan, “The economic essentials of digital strategy”. *McKinsey Quarterly*, vol. 2, pp. 30–44, 2016.
- [102] H. Broeders and S. Khanna (2015). “Strategic choices for banks in the digital age”. *McKinsey Quarterly*, 2018(1), 7. [Online] Available: <https://www.mckinsey.com/industries/financial-services/our-insights/strategic-choices-for-banks-in-the-digital-age>
- [103] McKinsey, “Twenty-five years of digitization: Ten insights into how to play it right,” *McKinsey Global Institute*, pp. 1–12, 2019. [Online]. Available: <https://www.mckinsey.com/~media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Twenty-five%20years%20of%20digitization%20Ten%20insights%20into%20how%20to%20play%20it%20right/MGI-Briefing-Note-Twenty-five-years-of-digitization-May-2019.ashx>
- [104] Website – Automotive Company’s Website, 2019
- [105] Website – Technology Company’s Website, 2019

- [106] Website -Automotive Dealer's Website, 2021
- [107] J. A. Marin-Garcia, J. P. Garcia-Sabater and J. Maheut, "Case report papers guidelines: Recommendations for the reporting of case studies or action research in Business Management," *WPOM-Working Papers on Operations Management*, vol. 13, no. 2, pp. 108–37, Jul 2022. [Online]. Available from: <https://doi.org/10.4995/wpom.16244>
- [108] C. Selltiz, L. S. Wrightsman and S.W. Cook. "Research Methods in Social Relations", 3rd ed. New York: Holt, Rinehart, and Winston, 1976.
- [109] J. C. Nunnally. "Psychometric Theory". New York: McGraw-Hill Book Company. 1967.
- [110] J. F. Hair, W. C. Black, B. J. Babin and R.E. Anderson, "Multivariate Data Analysis", 7th Edition, Pearson Hall International, New York, 2010.
- [111] Y. Terzi, "Anket güvenilirlik geçerlilik analizi". Ondokuz Mayıs Üniversitesi Fen-Edebiyat Fakültesi İstatistik Bölümü, Samsun, 2019.
- [112] A. J. Onwuegbuzie, A. E. Witcher, M. T. Kathleen, , J. D. Collins Filer, C. D. Wiedmaier and C. W. Moore, "Students' Perceptions of Characteristics of Effective College Teachers: A Validity Study of a Teaching Evaluation Form Using a Mixed-Methods Analysis", *American Educational Research Journal*, vol. 44, no. 1, pp. 113-160, Mar 2007. Available: <http://www.jstor.org/stable/30069473>
- [113] C. Werner and K. Schermelleh-Engel, "Deciding Between Competing Models: Chi-Square Difference Tests", *Introduction to Structural Equation Modeling with LISREL*, 2010. [Online]. Available: http://www.psychologie.uzh.ch/fachrichtungen/methoden/team/christinawerner/semin/chisquare_diff_en.pdf
- [114] M. Kırımı and B. Kocaoglu, "Digital transformation maturity model development framework based on design science: case studies in manufacturing industry," *Journal of Manufacturing Technology Management*, vol. 33, no. 7, pp. 1319–1346, Sep 2022. Available: <https://doi.org/10.1108/JMTM-11-2021-0476>
- [115] T. Burns and G. M. Stalker. Chapter 15 Mechanistic and Organic Systems from *The Management of Innovation*. London: Tavistock Publications, 1961, 119-125.
- [116] P. R. Lawrence and J. W. Lorsch, "Differentiation and integration in complex organizations," *Administrative Science Quarterly*, vol. 12, no. 1, pp. 1-46, Jun 1967.
- [117] P. R. Lawrence and J. W. Lorsch, Chapter 19 Organization-Environment interface from *Developing Organizations: Diagnosis and Action*. Reading, Massachusetts: Addison-Wesley Publishing, 1969, 23-30., from *Developing organizations: diagnosis and action*.

VITA

Irmak Mutlu received her Bachelor of Science (BSc.) degree in Industrial Engineering (2010) from Koç University, Istanbul, Turkey. She completed her dual Master of Science (MSc.) degree in International Management (MIM) at Koç University, Istanbul, Turkey in 2012 and Global Alliance in Management Education - Community of European Management Schools (CEMS) in 2013. During her university years, she studied abroad in Boston MA, USA, Vancouver, BC, Canada, and London, ON, Canada: Harvard University, University of British Columbia, and Richard Ivey School of Business, respectively. Following her master's degree studies, she started work in Germany in 2012. After working for Volkswagen Group companies (MAN Financial Services GmbH and Volkswagen Financial Services AG) in Germany for seven years, she returned to Turkey and joined Doğu Otomotiv, VW Group distributor in Turkey, and has been working as Digital Transformation and New Business Development Manager since 2018. At the same time, she continues her Ph.D. studies in the field of management, with a specialization in Digital Transformation under the supervision of Assistant Professor Erik den Hartigh, Faculty of Business Administration, Özyeğin University. Particularly, she is interested in the digital maturity measurement based on the stages of digital business transformation.