

**ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF ARTS AND
SOCIAL SCIENCES**

**IMPACT FACTORS AND CURRENT ISSUES ON TECHNOLOGY
DEVELOPMENT FOR INDUSTRY 4.0 TRANSFORMATION IN
TECHNOPARK COMPANIES: THE CASE OF TURKEY**



MBA THESIS

Gizem ATAĞ

Department of Management

Management MBA Programme

JUNE 2018

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Thesis Advisor: Prof. Dr. Ferhan ÇEBİ

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ SOSYAL BİLİMLER ENSTİTÜSÜ

**TEKNOPARK FİRMALARINDA ENDÜSTRİ 4.0 DÖNÜŞÜMÜNE YÖNELİK
TEKNOLOJİ GELİŞTİRMEDE GÜNCEL SORUNLAR VE ETKİ
FAKTÖRLERİ: TÜRKİYE ÖRNEĞİ**

YÜKSEK LİSANS TEZİ

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İşletme Anabilim Dalı

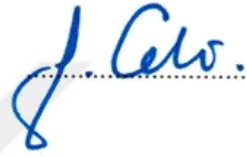
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HAZİRAN 2018

Gizem Atak, a MBA student of ITU Graduate School of Arts and Social Sciences student ID 403161036, successfully defended the thesis entitled “IMPACT FACTORS AND CURRENT ISSUES ON TECHNOLOGY DEVELOPMENT FOR INDUSTRY 4.0 TRANSFORMATION IN TECHNOPARK COMPANIES: THE CASE OF TURKEY”, which she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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Date of Submission : 04 May 2018
Date of Defense : 06 June 2018





To my mom and dad,



FOREWORD

I aimed to reveal impact factors and current issues of technopark companies which are in the center of technology production, on the technology development for Industry 4.0 transformation in our country.

First of all, I would like to thank my great advisor, Prof. Dr. Ferhan Çebi for her patience, understanding and precious support. She has always willing to help and support me even when she has not enough time. Ferhan Çebi is more than an advisor and I am very fortunate that I am her student.

I would like to convey my thanks to all my teachers especially, Prof Dr. Şule Önsel Ekici, Prof. Dr. Mehmet Mutlu Yenisey, Assoc. Prof. Gül Temur and Asst. Assoc. Prof. Alper Camcı for all continual and precious support.

I owe to dear Dr. Onur Tolga Okan from Trabzon Technopark Technology Transfer Office and my graduate friends, Deniz Aydemir, Kübra Şimşek and Tuba Öztepe a debt of gratitude for cooperating on the issue of sending my survey study to technopark companies. I would like to thank also both technopark directors and respondent firms which are in technopark, for their contribution and cooperation to my graduate study.

I would like to thank firstly, Erhan Musaoğlu, Neşe Arın Kuter, Muammer Akgün, İhsan Yaprak and all my administrators and colleagues from LA Software Group who have always supported me during my graduate studies.

Lastly, and above all, I would like to express my sincere gratitude to my parents who have never left me alone with their material and moral support throughout my studies, for their contributions.

May 2018

Gizem ATAK



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ABBREVIATIONS

AI	: Artificial Intelligence
CNC	: Computer Numerical Controller
CPPS	: Cyber-Physical Production Systems
ERP	: Enterprise Resource Planning
IASP	: International Association of Science Parks
IoT	: Internet of Things
M2M	: Machine-to-machine Communication
OSB	: Organized Industrial Zone (Turkish: Organize Sanayi Bölgesi)
R&D	: Research and Development
STK	: Civil Society Organization (Turkish: Sivil Toplum Kuruluşu)
TOBB	: Turkish Union Of Chambers And Commodity Exchanges (Turkish: Türkiye Odalar ve Borsalar Birliği)
TTO	: Technology Transfer Office
TUBITAK	: The Scientific and Technological Research Council of Turkey (Turkish: Türkiye Bilimsel ve Teknolojik Araştırma Kurumu)
TUSIAD	: Turkish Industry and Business Association (Turkish: Türk Sanayicileri ve İşadamları Derneği)
UK	: United Kingdom



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IMPACT FACTORS AND CURRENT ISSUES ON TECHNOLOGY DEVELOPMENT FOR INDUSTRY 4.0 TRANSFORMATION IN TECHNOPARK COMPANIES: THE CASE OF TURKEY

SUMMARY

With the advances in technology, today's world is in the fourth industrial revolution, which plays an important role in the economies and industries of the countries. With this transformation, it is expected that all the tools and devices used in the Industry will be smart, self-learning and more efficient hardware and software products will be produced. For this way, industrial production speed, volume and productivity will increase, and economic and social life will develop. Efforts and impacts on digital transformation have also begun to appear in all parts of the world, from the private sector to public sector and the manufacturing environment to the academic environment.

Technoparks have an undeniable role on technology production and development. For this reason, technopark company's current issues and impact factors on the new technology development, their awareness levels, problems encountered and opportunities that they benefit, have a critical importance in terms of providing and improving the effective utilization of digital transformation. In the study, a questionnaire study was carried out to reveal the issues that lived in the source of technology production, and factors such as the factors that encourage the development of Industry 4.0 technologies, the difficulties encountered, strategies followed, organizational structure and workforce competencies were examined.

In addition, in this thesis, firstly literature search on the fourth industrial revolution was carried out. The current literature includes models and practices for measuring the level of Industry 4.0 maturity of manufacturing companies, but there are no studies to obtain the competencies of technopark companies that we can identify as technology producers and developers, and their role and impact of the development of the new industrial revolution or the models in which these relationships are analyzed. In this respect, the study aims to contribute to the national and international literature with an original value.

The survey prepared considering the opinions and sights who are expert in the field of Industry 4.0 such as BOSCH Industry 4.0 Director Mustafa Ayhan, Bahçeşehir University, Department of Management Engineering, Assist. Assoc. Prof. Alper Camci and Assoc. Prof. Gül T. Temur, Arçelik Manufacturing Technology Specialist İzlem Tekin Bayrak, and information gathered in the light of literature. After that, questionnaire was sent to 50 technopark in Turkey. A total of 231 technology development centered companies participated in the survey.

The data obtained from survey were tested with hypothesis and the models were developed by performing analyzes such as descriptive statistics, exploratory factor analysis, reliability analysis, t-test, ANOVA, Mann-Whitney U test, Kruskal-Wallis test, regression analysis by using the SPSS 25.0 statistical software program.



TEKNOPARK FİRMALARINDA ENDÜSTRİ 4.0 DÖNÜŞÜMÜNE YÖNELİK TEKNOLOJİ GELİŞTİRMEDE GÜNCEL SORUNLAR VE ETKİ FAKTÖRLERİ: TÜRKİYE ÖRNEĞİ

ÖZET

Teknolojideki ilerlemelerle birlikte günümüz dünyası; ülkelerin ekonomilerinde ve endüstrilerinde önemli bir rol oynayan Endüstri 4.0 devriminin içinde bulunmakta, dijital dönüşüm olarak da isimlendirilen bu dönüşümle birlikte sanayide kullanılan tüm araçların, cihazların akıllı olması, kendi kendine öğrenebilmesi, daha verimli donanım ve yazılım ürünlerinin üretilmesi ile endüstriyel üretim hızını, hacmini ve verimliliği artırarak ekonomik ve sosyal yaşamların geliştirilmesi beklenmektedir. Dijital dönüşümle ilişkin çabalar, gayretler ve etkiler ülkemizde de kamudan özel sektöre, akademik ortamdaki imalat ortamına kadar tüm sektörlerde görülmeye başlamaktadır.

Teknolojik ilerlemelerin kaynağı olarak nitelendirebileceğimiz teknoloji üretimi ve geliştirmesinde yadsınamaz bir rolü bulunan Teknopark işletmelerinin, ülkemiz için kritik bir öneme sahip olan dijital dönüşümün sağlanması ve gelişimindeki rolünün, yerinin, farkındalık düzeylerinin, karşılaştığı sorunların ve yararlandıkları fırsatların belirlenmesi; dönüşümün etkin bir şekilde yönlendirilmesi ve gelişmesi açısından kritik bir önem taşımaktadır. Çalışmada, teknoloji üretiminin kaynağında yaşanan bu konuları ortaya çıkarmaya yönelik bir anket çalışması yapılmış, ayrıca Endüstri 4.0 teknolojilerinin geliştirilmesini teşvik eden faktörler, karşılaşılan zorluklar, izlenen stratejiler, örgüt yapısı ve iş gücü yetkinlikleri gibi unsurlar incelenmiştir.

Çalışmada öncelikle dördüncü sanayi devrimine ilişkin literatür taraması yapılmıştır. Mevcut literatür imalat şirketlerinin Endüstri 4.0 olgunluk seviyesini ölçmeye yönelik modeller ve uygulamaları içermesine karşın teknoloji üreticileri ve geliştiricileri olarak tanımlayabileceğimiz Teknopark şirketlerinin Endüstri 4.0 projelerindeki yetkinlikleri ve yeni sanayi devriminin gelişimindeki durumunu, rolünü ve etkilerini ortaya koymaya veya bu ilişkilerin analiz edildiği modelleri geliştirmeye yönelik çalışmalar bulundurmamaktadır. Bu yönüyle çalışma özgün bir nitelik taşımakta, ulusal ve uluslararası literatüre katkıda bulunmayı amaçlamaktadır.

Literatür ışığında derlenen bilgiler ve konuyla ilgili uzmanlık alanları olan; BOSCH Endüstri 4.0 Direktörü Mustafa Ayhan, Bahçeşehir Üniversitesi İşletme Mühendisliği Bölümünden Yard. Doç. Dr. Alper Camcı, Doç. Dr. Gül Temur ve Arçelik Üretim Teknolojileri Uzmanı İzlem Tekin Bayrak'ın değerli görüşleri alınarak hazırlanan anket çalışması, Türkiye'de faaliyette bulunan 50 teknoloji geliştirme bölgesindeki teknoloji geliştirme odaklı işletmeye gönderilmiş ve ankete 231 firmadan katılım sağlanmıştır.

Elde edilen veriler ile, SPSS 25.0 istatistiksel yazılım programı kullanılarak betimleyici istatistikler, açıklayıcı faktör analizi, güvenilirlik analizi, normalite testi, t-testi, ANOVA, Mann-Whitney U test, Kruskal-Wallis testi, regresyon analizi gibi analizler gerçekleştirilerek hipotezler test edilmiş ve modeller geliştirilmiştir.

İlk bölümde şirketlerin farkındalık düzeylerini ölçmeye yönelik sorular sorulmuştur. Bu bölümdeki sorular dört faktörde toplanmıştır. Bunlar, Endüstri 4.0'ın organizasyona etkisi üzerine farkındalık, rekabetçilik etkisi üzerine farkındalık, Teknoparkların rolü ve destek farkındalığı ve çevresel etkisi üzerine farkındalıktır.

İkinci bölümdeki sorular ise şirketlerin Endüstri 4.0 stratejileri ve organizasyon yapıları hakkında sorular içermektedir. Buradaki sorular üç faktörde toplanmıştır. Bunlar, strateji ve politika, ürünler, hizmetler ve iş gücü alt yapısı ve dijitalleşme için altyapıdır. Buna ek olarak, şirketlerin Endüstri 4.0 kapsamında hangi teknolojileri geliştirdikleri, gelecekte hangi Endüstri 4.0 teknolojilerinde çalışmayı hedefledikleri hakkında sorular yer almaktadır. Şirketlerin mevcut durumda üzerinde çalıştıkları ve ileride çalışmayı hedefledikleri Endüstri 4.0 teknolojileri ise dijital üretim sistemleri teknolojileri, veri yönetimi teknolojileri ve sanal teknolojiler olarak üç grupta toplanmıştır. Yine bu bölümde şirketlerin Endüstri 4.0 teknolojisi geliştirirken gerçekleştirdikleri iş birlikleri ve bunların derecesini ölçen sorular da yer almaktadır. Bu bölümdeki sorular iç ve dış paydaşlar olarak iki faktörde toplanmıştır. Bu bölümdeki şirket çalışan becerileri, yetkinlikleri ve ürünlerin sunulduğu uygulama alanları ayrı ayrı tek bir faktörde toplanmıştır.

Üçüncü bölümde ise şirketlerin Endüstri 4.0 teknolojileri geliştirirken karşılaştıkları zorluklar, yararlandıkları fırsatlar, Endüstri 4.0 teknolojisi geliştirme kapsamında kendi ve müşteri beklentileri ve bu beklentilerinden elde ettikleri başarı derecesini ölçen sorular yer almaktadır. Bu bölümde şirketlerin karşılaştıkları zorluklar dört faktörde toplanmıştır. Bunlar; iş gücü problemleri, ticarileştirme sorunları, yetersiz destek ve teknolojik sorunlardır. Şirketlerin yararlandıkları fırsatlar ise doğrudan ve dolaylı ilişkiler olarak iki grupta toplanmıştır. Son olarak beklentilerden şirketin kendi beklentileri; pazar rekabetçiliği ve organizasyonel rekabetçilik olarak iki grupta toplanırken, müşteri beklentileri ise rekabet avantajı geliştirme, operasyonel performansı geliştirme, ürün ve hizmetleri geliştirme ve üretim etkinliğini geliştirme olarak dört faktörde toplanmıştır.

Araştırma anketinin son bölümünde ise şirket hakkında genel bilgiler sorgulanmaktadır. Bu bölümde şirket yaşı, hangi Teknoparkta yer aldığı, hedef pazarı, şirket yapısı, müşteri yapısı, çalışan ve müşteri sayısı, patent alımı, Endüstri 4.0'a ayrılan bütçe, şirket büyüklüğünü ölçmek amacıyla yıllık gelir bilgisi gibi belirleyici sorular yer almaktadır.

Betimleyici analizler dikkate alındığında, katılımcıların yarısından fazlasının şirket sahibi ya da yönetici olduğu bilgisi elde edilmiştir. Ayrıca katılımcıların yarısını 2010 yılından sonra kurulan şirketler oluşturmaktadır.

Çalışmada öncelikle betimleyici analizler ve faktör analizleri yapıldıktan sonra hipotezler kurulmuş ve test edilmiştir. Tüm değişkenler için Kolmogorov Smirnov ile normalite testi yapılmış ve her bir hipotez için uygun analiz yöntemi seçilmiştir. Hipotezlerde şirket genel özellikleri ile her bir faktör arasında hipotezler kurulmuş ve aralarında anlamlı farklılıkların olup olmadığı incelenmiştir. Ardından şirket beklentileri ve müşteri beklentilerinde elde edilen başarıyı açıklayıcı iki model oluşturulup regresyon analizi yapılmıştır.

Sonuçlara göre, şirketin kuruluş yılı ile yetersiz destek problemi ile karşılaşma, Endüstri 4.0 teknolojilerinden sanal teknolojiler grubunda toplanan teknolojileri geliştirmek ve Endüstri 4.0 kapsamında teknoloji geliştirirken dış paydaşlardan faydalanma arasında anlamlı farklılık bulunmuştur. 2010 yılından sonra kurulan şirketlerin yetersiz destek problemi ile karşılaşma ortalaması daha yüksektir. Bu

durum şirketlerin yeni olmasından kaynaklanabilir. Ayrıca diğer tüm farklılıklar, 2010 yılı sonrası kurulan şirketlerin lehinedir.

Şirketlerin sermaye yapısı ile Endüstri 4.0'ın organizasyona etkisi üzerine farkındalığı ve şirketlerin Endüstri 4.0 teknolojileri geliştirirken karşılaştıkları teknolojik problemler arasında anlamlı bir farklılık gözlemlenmiştir. Yerli sermaye yapısına sahip şirketlerin Endüstri 4.0'ın organizasyona etkisi üzerine farkındalığı ve teknolojik problemlerle karşılaşma ortalamaları diğer şirketlere göre daha yüksektir.

Şirket yapısı ile şirketlerin Endüstri 4.0 kapsamında ürünleri, hizmetleri ve iş gücü alt yapıları ve Endüstri 4.0 teknolojileri geliştirirken iş gücü problemleri ile karşılaşmaları arasında anlamlı farklılık bulunmuştur. Her iki durumda da ulusal bir şirkete bağlı şirketlerin ortalamaları bağımsız şirketlere göre daha yüksektir.

Çalışan becerileri, şirketlerin Endüstri 4.0'ın organizasyona etkisi üzerine farkındalığı, şirketlerin kendi beklentilerinden elde ettikleri başarı ve Endüstri 4.0 strateji ve politikaları ile toplam müşteri sayısı arasında anlamlı bir fark bulunmuştur. Sonuçlara göre, 50 üzerinde müşteriye sahip firmaların beklentilerden elde ettikleri başarı ve çalışan becerileri ortalamalarının diğerlerine göre daha yüksek olduğu sonucu elde edilmiştir. 1 ile 10 müşteriye sahip grubun Endüstri 4.0'ın organizasyona etkisi üzerine olan farkındalık ortalaması daha yüksek bulunmuştur. Ayrıca 1 ile 10 adet müşteri sayısına sahip şirketlerin, müşteri sayısı 50'den fazla olanlara göre Endüstri 4.0 strateji ve politikası ortalamalarının daha yüksek olduğu sonucuna ulaşılmıştır.

Şirketlerin çalışan sayıları ile Endüstri 4.0 ürün, hizmet ve iş gücü yapıları ve müşteri beklentilerinden elde ettikleri başarı arasında anlamlı bir farklılık bulunmuştur. 50'den fazla çalışan sayısına sahip şirketlerin Endüstri 4.0 ürün, hizmet ve iş gücü yapıları ortalaması, 1-10 adet çalışana sahip şirketlere göre daha yüksektir. Ayrıca 10- 49 adet çalışana sahip şirketlerinde müşteri beklentilerinden elde ettikleri başarı ortalaması 1-10 adet çalışana sahip şirketlere göre daha yüksektir.

Şirketlerin yıllık gelirleri ile Endüstri 4.0'ın organizasyona olan etkisi üzerine farkındalığı ve karşılaşılan zorluklardan iş gücü problemleri ile karşılaşma arasında anlamlı bir farklılık bulunmuştur. Yıllık gelirleri 500 bin TL'den az olan şirketlerin farkındalık ortalamaları diğer şirketlere göre yüksektir. Aynı şekilde yıllık gelirleri 500 bin TL ile 1 milyon TL arasında olan şirketlerin iş gücü problemleri ile karşılaşma ortalaması diğer şirketlere göre yüksek bulunmuştur.

Endüstri 4.0'a ayrılan bütçe ile şirketlerin dijitalleşme için altyapıları, Endüstri 4.0 teknolojilerinden veri yönetimi teknolojileri geliştirmeye odaklanmaları, çalışan becerileri ve iç paydaşlardan yararlanmaları arasında anlamlı farklılık bulunmuştur. Endüstri 4.0'a %50'den fazla bütçe ayıran şirketlerin ortalamaları yukarıda sayılan faktörler açısından daha yüksektir.

Patent alımı ile şirketlerin iç paydaşlardan yararlanmaları, veri yönetimi teknolojileri geliştirmeleri ve Endüstri 4.0 kapsamında teknoloji geliştirirken doğrudan ilişkileri kullanmaları arasında anlamlı bir farklılık bulunmuştur. Şirketlerin iç paydaşlardan yararlanma ortalamaları, daha önce patent alımı olmuş şirketlerde diğerlerine göre daha yüksektir. Buna karşın, daha önce hiç patent alımı olmamış şirketlerin Endüstri 4.0 teknolojilerinden veri yönetimi teknolojisi geliştirme ortalamaları ve bu teknolojileri geliştirirken doğrudan ilişkileri kullanma ortalamaları daha yüksektir.

Şirketlerin Endüstri 4.0 algısı ile Teknopark şirketlerinin teknoloji gelişimindeki rolü ve etkisi üzerine farkındalığı, çalışan yetkinlikleri, Endüstri 4.0 strateji ve politikası, ürün, hizmet ve iş gücü alt yapısı, Endüstri 4.0 teknolojilerinden dijital üretim

sistemleri teknolojisi geliştirme ve bu teknolojileri geliştirirken iç paydaşlardan yararlanmaları arasında anlamlı bir farklılık bulunmuştur. Endüstri 4.0 algısını lider ve takipçi olarak belirten şirketlerin, algılarını ilgili ve ilgisiz olarak belirten şirketlere göre yukarıda belirtilen faktör ortalamalarının daha yüksek olduğu gözlemlenmiştir.

Diğer bir yandan şirketin hedef pazarı ile diğer tüm faktörler arasında anlamlı bir farklılık bulunamamıştır. Ayrıca Endüstri 4.0'ın doğduğu yerin Almanya olması sebebiyle, alman müşteriye sahip şirketler ve alman müşteriye sahip olmayan şirketler için hiçbir faktör grubunda anlamlı bir farklılık gözlenememiştir. Buna ek olarak, şirketlerin Teknopark bünyesinde bulunma süresi ile de hiçbir faktör arasında anlamlı bir ilişki bulunamamıştır.

Çalışmada ayrıca katılımcı şirketlerin beklentilerinden elde ettikleri başarıyı açıklayıcı bir model kurulmuştur. Bu modele regresyon analizi yapılmıştır. Analiz sonuçlarına göre, şirketlerin kendi beklentilerinden elde ettikleri başarı, altı değişkenle açıklanmıştır. Bu değişkenler, çalışan becerileri, ürün, hizmet ve iş gücü alt yapısı, Endüstri 4.0 teknolojisi geliştirirken iç ve dış paydaşlardan yararlanma ve doğrudan ve dolaylı ilişkileri kullanmalarıdır. Bu değişkenlerden çalışan becerileri ve şirket ürün, hizmet ve iş gücü alt yapısının, şirketin beklentilerinden elde ettiği başarıya pozitif etkisi olduğu sonucuna ulaşılmıştır.

1. INTRODUCTION

More than two centuries old Industry concept is in our lives. Today we are in a new industrial revolution or, in other words, a period of digital transformation. With the first industrial revolution which was started in the late 18th century, only the industrial period did not begin. Together with the revolution, lots of major changes, that directly affect our lives, have also brought about such as improvement of living standards, new branches of Industry-economic activities, cultural changes etc. [1].

The fourth industrial revolution is quite different from the other three revolutions. The New Industrial Revolution (Industry 4.0) is a digital transformation of production systems, as developed by information and communication technologies, as TUBITAK defines. Digitization of every stage of the production chain is the development of 'Intelligent Manufacturing Systems' through the provision of machine-human-infrastructure interaction [2]. With this revolution, all machines and technological devices used in the Industry will produce data and will have meaningful intelligence from these data. In this way factories will be smart and able to manage themselves.

If we are not ready for this revolution as a country, we will have to face significant devastating effects besides the benefits of the revolution, just as it is in every industrial revolution. To be able to transform the new industrial revolution into an opportunity for our country, there is a need for measures to be taken in this direction and studies to shed light on what needs to be done.

Industry 4.0 is referred to as the period in which machines, equipment, computers, and other computer aided systems exchange information with each other and with internet platforms in manufacturing systems, and computers can manage production places themselves instead of expert decision makers [3].

The subject of this thesis study is to obtain Industry 4.0 awareness level and technological development intentions of technopark entrepreneurs that are thought will have a major impact on the development and diffusion of Industry 4.0 and determine its role and state on achieving digital transformation in our country. The results of this

thesis study will shed light on the road map to be established for digital conversion in our country. In addition to all these, the scope of this thesis is all technology manufacturers that are located in technopark in Turkey.

In the literature, several models have been developed and studies have been implemented to measure the maturity levels of the companies involved in the manufacturing sector under Industry 4.0. On the other hand, technopark companies, which have an undeniable importance in technology development and production, have played a significant role in the development and diffusion of technologies in a sense; there is no work yet to determine its place in the fourth industrial revolution and its impact on the development of Industry 4.0 technologies. In this respect, this thesis study is the first in both national and international literature. The intensive literature research shows that this study will fill an important gap in the literature.

On the other hand, the study is a preliminary study to determine which of the technologies within the scope of Industry 4.0 is prioritized in our country and it is also important to shed light on the determination of the necessary infrastructure (workforce, labor union, organizational structure, etc.) for the development of digitalization. This thesis study aims to contribute for obtaining obstacles of technopark and technocentric companies that have faced in the way of providing digital transformation in our country, also to ensure allocating resources to the required areas and use them effectively and thus transforming into a competitive industrial structure by carrying out high added value production. In addition, it is expected that companies with technology users will lead to the identification of benefit expectations in this area and thus the determination of success performance indicators.

Additionally, it is considered that the study will fill a significant gap in the literature by contributing to the development of models that will be used in the technological parks in determining the location of the digital conversion path and its role, by developing and analyzing hypotheses related to the factors such as level of awareness, strategy and roadmap, organizational structure, digital transformation technologies, areas where these technologies are used, human resource qualities, difficulties encountered in developing technology, opportunities and expected benefits utilized, expectation of technology practitioners, company size, customer structure, capital structure etc. This model, which will be developed by examining the relations between the characteristics, reveals another original value of the study.

This thesis study consists of three main parts. First part involves literature survey regarding industrial revolutions, Industry 4.0, digital transformation and technopark in detail. In the second part methodology of thesis study have been presented. Characteristics of the participant companies, research methods and hypotheses that are tested are also located in this section. Finally; in the last part, conclusion, summary of findings, limitations and recommendations for the future research have been presented.





2. INDUSTRIAL REVOLUTIONS

The concept of “revolution” evokes the sudden and radical change. Revolutions have taken place every time that new technologies and new perceptions of the world have brought about profound changes in economic systems and social structures during the history [4].

Just before the industrial revolution, people were engaged in agriculture and animal husbandry, and they lived in small villages and towns [1]. The first major change in our way of life has come to the fore in the transitional phase of hunting. With the tame of animals, the agrarian revolution has combined animal labor with human labor. Thus, food production improved and supported the increase of population. This situation has also revealed urbanization. This period is called the agrarian revolution, and it has followed by series of industrial revolutions since the second half of the 18th century [4].

As seen in Figure 2.1, three major industrial revolutions have taken place in the world up to now. Nowadays, we are in a fourth industrial revolution which is called Industry 4.0. Revolutions and their features are described in this section.

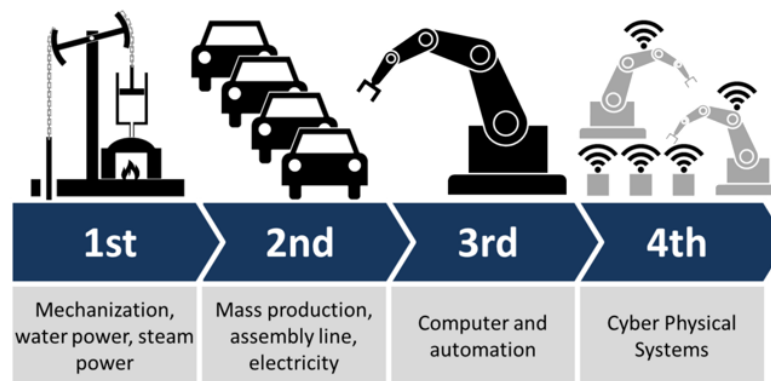


Figure 2. 1 : Industrial revolutions [5].

2.1 The First Industrial Revolution

The first industrial revolution began with the use of steam and water power for the first time on handloom [6]. The revolution which is continued from 1760 to around 1840,

led to mechanical production with the construction of railways and the steam engine [4].

The concept of the first industrial revolution passes on a letter written by Louis-Guillaume Otto on 6 July 1799. In this letter, it is mentioned that France entered an industrial race. Nevertheless, at the beginning of the 1800s, the UK became the pioneer of revolution with the speed brought by new technologies. It is stated that with this revolution, the production capacity of a worker with new technologies used especially in the textile Industry has increased about 40 times. In other words, with this revolution, there has been a serious increase in production capacity and speed [1].

In addition to all these, according to many authors, steam engines have not only affected steam and textile industries, but also affected the other industries such as transportation, communication and banking etc. With this revolution, more and more products are being produced and the improved the standards of living, while at the same time there has also emerged a poor and hard-working employee. Therefore, this revolution not only affected production, but also affected people's lives from a social and psychological point of view.

2.2 The Second Industrial Revolution

The second industrial revolution, thanks to electric technology and chemical techniques, soon spread to Europe, the United States and Japan. It has become possible to achieve mass production with the production band technique used by Ford, resulting in an increase in productivity [6].

The second industrial revolution, which accelerated in the late 19th and early 20th centuries, made mass production possible with the support provided by the electricity and assembly line [4].

The production methods continued to change until the second industrial revolution, which took place in 1870, specialization in workers began, and workers were separated according to their expertise. Organizations have transformed, and all these developments have spread to the world. [1].

The most important feature that distinguishes the second revolution from the first is production capacities and new machines used to increase these capacities. In this

period of technological production, it is not only the production elements that are affected as in the first revolution but the entire life of people [1].

2.3 The Third Industrial Revolution

In the third industrial revolution, automation-based manufacturing processes, in which electronic and information technologies were used, were introduced [6].

The third industrial revolution, which started in the 1960s; is often referred to as a computer or digital revolution. This is because, this period was developed by the catalyzes of host computers (1960s), personal computers (1970s-1980s) and the internet (1990s) [4].

In this period; transistors, ERP (Enterprise Resource Planning) systems, CNC machines (Computer Numerical Controller) were produced for the first time thanks to the programming language of computers and machines. In this period, all kinds of data stored on paper became stored in the computer environment and thus the Industry had the production speed and capacity that it had never reached before. Besides, administrative costs and difficulties have been eliminated and automation needs have been met in this term. The technology that has progressed in this industrial revolution has been used to structure of companies' strategies, designing the new business forms and increasing of the production channels [1].

In the third industrial revolution, which started in 1940 and ended in 2010, there are computers, digital products and solutions and internet. In this revolution, the recordings were digitized, and major innovations emerged in the field of information science, especially after 1950. Additively, the increase in the new technology and production capacities also produced new markets [1].

After the third industrial revolution, Industry 4.0, which is made up of the highest level of technology use and the cyber-physical systems that internet and information technologies combine, has been reached [6].

2.4 The Fourth Industrial Revolution (Industry 4.0)

The world face to face the threshold of a new technological era, that will initiate the fourth industrial revolution (Industry 4.0) [7]. Industry 4.0 is a development process called "the fourth industrial revolution", which has been planned for the future and is

now under way. [6] According to this concept, web-based network will give support to the smart factories at every level of the production such as design, servicing and recycling etc. [7].

2.4.1 Industry 4.0 concept

Industry 4.0 which is a concept that is arise from Germany in 2011, is focused on improving smart chains based on communicating with each other elements of production such as products, components, factory, people etc. [7]. Industry 4.0 is regarded as the “Fourth Industrial Revolution” and is expected to lead to significant changes in many sectors [8].

Industry 4.0 concept; is based on the communication of all the actors involved in the industrial production process, all the data can be accessed in real time and the acquiring the highest possible value added thanks to this data. Also, this concept in general, at every stage of the entire supply chain such as starting from the purchase of raw materials, producing the products, delivering them to the consumer and recycling processes are improved by taking advantage of emerging technologies [8].

It is a term which propagates the combination of the big data, sensors, internet of things, cloud computing, robotics, artificial intelligence, and the application of these technologies to the production, use and distribution of physical goods [5].

Industry 4.0 refers to the way in which a product is produced, delivered, used, repaired and recycled entirely automatically via the Internet without human intervention. The Federal Ministry of Education and Research in Germany supports this. According to them, with Industry 4.0, equipment and machines will constantly exchange information and be ensured that many processes in the future will be controlled and coordinated in real time at large distances. In this way, smart products and factories will be formed [5].

2.4.2 Benefits and risks of Industry 4.0

There are lots of advantages of fourth industrial revolution. For instance, this revolution may increase the level of global income and develop the quality of people life all around the world. For example, thanks to new Industry 4.0 technologies, consumers will reach to the digital world easily and they will benefit from new technological services and products with a higher economic efficiency. On the other

hand, from supplier's perspective, productivity and efficiency will increase on long term and global supply chains will be more effective because of the decreasing of the cost of trade activities such as transportation, communication etc. and, due to accessing to world markets easily [9].

Each development arises because of a need. Given the other Industry revolutions examined above, the emergence of Industry 4.0 has also influenced specific needs. Countries with industrial and technological advancement under the leadership of Germany have launched the Fourth Industrial Revolution to provide competitive advantage and further reduce their costs. It is expected that this revolution will reduce the need for shifting to the far east due to low labor cost, dependence on qualified workforce and labor cost in many sectors. Today, thanks to the developing technology and communication network, transportation to the raw materials and markets has become easier [8].

In addition, according to the TUSIAD 2016 Industry 4.0 reports, Industry 4.0 offers a great opportunity to launch a high value-added investment cycle. Increased global competitive power, higher cost efficiency, higher production speed and flexibility, higher quality and lower waste rate, increased share of high added value products from the global value chain, emerging productivity and competencies and protect and strength companies' global competitive position, improving the conditions of employees by making ergonomic improvements and improve labor force profile will be provided by the fourth industrial revolution [10].

There are disadvantages as well as the advantages of this development. According to some authors, there are also some disadvantages or potential risks in terms of the social impact. Author like Schwab who published book which is called "the fourth industrial revolution" about this topic. According to the Schwab, the fourth industrial revolution will create the same great benefits and great threats. A significant source of risk is the intensified inequalities. It is difficult to determine the threats that will increase the likelihood of increased inequality. This is because, most of us are consumers as much as the manufacturer. That is why innovations and distortions will affect our standards of living in both positive and negative ways according to the Schwab [4].

As a result, the start point of Industry 4.0 is ensuring competitive advantage, reducing dependency on the workforce, enabling products to move quickly and faultlessly,

increasing flexibility and reducing costs. In addition, the depletion of resources, the declining life expectancy of the world, and growing concern about this situation have created a driving force for the development of Industry 4.0. Thanks to the technology and innovations that Industry 4.0 will bring, it is expected to make a major contribution to sustainability [8].

Globalization provides the sustainable development of human beings in their social, environmental and economic dimensions. On the other hand, globalization is also facing the challenge of meeting the ever increasing demand for capital and consumption goods worldwide. In order to be able to overcome this difficulty, industrial value creation must be sustainable. The value creation of industrialized countries is shaped by Industry 4.0, towards the fourth stage of industrialization. This development offers tremendous opportunities for sustainable production [11].

2.4.3 The triggers of Industry 4.0

The traditional manufacturing Industry is trying to integrate itself by experiencing the difficulties of the Industrial Revolution, a digital transformation that is accelerated by technology. The triggers for this digital transformation are shown in Figure 2.1 [12]

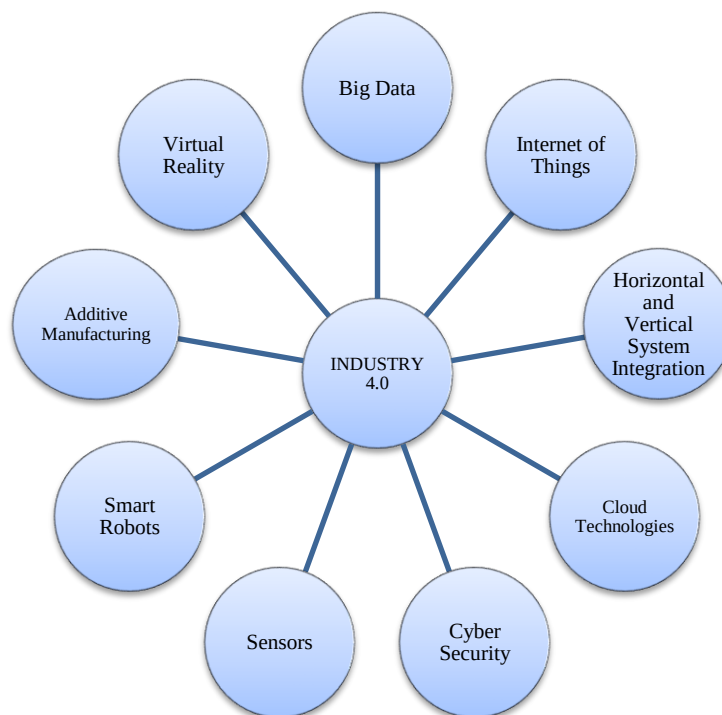


Figure 2.2 : The triggers for this digital transformation [12].

The Trigger Components and Features of Industry 4.0 are described in detail in Chapter 3, technologies of Industry 4.0.





3. TECHNOLOGIES OF INDUSTRY 4.0

The concept of Industry 4.0 gets more and more global recognizability day by day. The expanding of market globalization, rapidly rising global competition and more complex products and services lead to the application of new technologies, business models and methods. A rapidly changing market environment and fluctuating customer demands require to operate logistics processes efficiently [13].

Industry 4.0 is a notion which includes the integration of technologies and factor for the common aim of developing the performance and efficiency of a production system [14].

Industry 4.0, a term which is developed in Europe to support perfect manufacturing productivity. It provides smarter and more competitive enterprises by gathering data from devices in real-time and transforming it into information which can be used gaining much more market share and rising profits [15].

Recent research show that, the fourth industrial revolution will affect the corporate world in terms of three main areas such as digitalization and integration of vertical and horizontal value chains, the formation of customer relationships and digital business models and digitalization of services and products [13]. For this reason, production needs new technologies. Thanks to these new technologies, the whole production process will flexibly adapt to unique customer demands, the activities of each ring of the supply chain, and the rapidly changing economic environment [13].

Among the new technologies produced in this context that mentioned above, are such as The Cyber-Physical Production Systems (CPPS), Machine-to-machine Communication (M2M), Artificial Intelligence (AI), Horizontal and vertical system integration, Internet of Things (IoT), Big Data, Cloud Services, Cyber Security, Virtual Reality, Simulation, Additive Manufacturing. These technologies and their features are explained in detail in the next section.

3.1 The Cyber-Physical Production Systems

Cyber-physical systems (CPPS) are defined generally as a connection between embedded systems [16]. In other words, cyber-physical production systems are equipment which are able to communicate on a network. It creates a link between IT technology and electronic or mechanic items [13].

With cyber physical systems, the entire process of the system can automatically perform itself without any intervention or additional effort, with a program to be done at the beginning of the system. Here, "automation" concept comes first. Many machines which including learning robots, are involved in the production process. Nowadays, it is known that robots and vehicles learning in the automobile Industry are already present in some production processes [8].

With a help of this connection, cyber-physical systems can act and react between the digital and the physical world. For example, to integrate the employee into the system, the cyber-physical systems provide an interface that is enable a human machine interaction [16].

Sensors provide the machines keeping contact with the other production elements such as factories, networks and people [13].

Intelligent production robots are the parts of the whole system that are able to communicate with the production control system and the element to be processed. In this way, they are able to optimize the entire process and obtain system-wide optimization of resources [13].

CPPS are also consolidate statistics and real time data which are received from physical systems, to model the response of a system under various cases to make decisions in real time. The eventual aim is to develop the performance, at overall levels of system [14].

3.1.1 Machine to machine communication

Machine-to-machine communication is a crucial need for cyber-physical systems. This is because, M2M allows that the devices connected to the network activate the communication without human interference. For instance, robots that work on a production line are able to provide needs of each other or stop the entire production systems where necessary cases [13].

The machine-to-machine communication provide a horizontal integration. Machines which are in the same location as well as different enterprises can then be communicate via internet. The machine's and enterprises' connectivity and communication design an overall system along the entire network. Thus, one enterprises can be seen as a sub-system of the overall system [16].

Machine Learning is also defined as a computer techniques group which center on getting beneficial information and make proper decisions from big data, both structured or unstructured, which can be acquired from a business or factory at any given time [14].

3.1.2 Artificial intelligence

Perhaps one of the most important technologies included in the concept of Industry 4.0 is artificial intelligence and machine learning [1].

Artificial Intelligence is a machine ability that provide machines to learn and think logically. Thanks to artificial intelligence, machines are able to fulfill complex tasks [13].

3.1.3 Augmented reality technology

The technology of increasing images with information such as sound, graphics, animation is a long-standing technology on the agenda [17]. Systems that benefit from augmented reality support a variety of services, such as selecting parts in the depot and sending repair instructions to mobile devices. Although these systems are still in beginning, companies will benefit from enriched reality in the future in order to improve the decision-making and operational processes of the companies and to provide real-time information to their employees [10].

3.1.4 Horizontal and vertical system integration

Products communicate with the other workpieces and the machines as well to work own manufacturing. Besides, that communication is occurred not only within the factory, but also in an entire chain such as suppliers, producers etc. [13].

Most of today's information technology systems have not fully integrated each other. Firms, customers and suppliers are rarely connected to each other from end to end. A similar situation exists in engineering, design, production and service functions. But

as universal data integration networks improved on a company-wide basis, companies, units and competencies will become more and more compatible with each other [10].

3.1.5 Internet of things

The internet is helping people communicate with each other despite the distance between them. The internet, the fundamental building block of globalization, causes the structure of existing markets and business strategies to change. It is inevitable that this communication, now carried to the size of the objects, will affect the market structure and the production and marketing strategies of the enterprises [8].

The internet of things (IoT) is one of the principal technologies in the era of Industry 4.0 [14]. IoT means that objects have a distinctive function and communicate with each other over the Internet. In other words, objects are connected to each other by internet, for data production and sharing. The Internet of objects is considered to be one of the most important of the technology fields of the future [18].

The Internet of things is a network connection and data exchange of incorporated electronic items [13]. To put a fingerprint on it, the Internet of objects is the transfer of information from any object, i.e. the device or from a human being, to other systems via a network [1]. For this reason, for the machine to machine communication, IoT is a crucial need. With the help of IoT, the items realize not only their environment. They are also able to regulate it. In this way, the devices can be used more and more efficiently [13].

Today, leading technology and software firms in many fields are bringing out products related to internet of things. Companies such as Siemens and Koç Sistem in Turkey and in the world of international foreign firms such as IBM and Oracle are making significant investments in the field of the internet of things [8].

3.1.6 Big data

Nowadays it is possible to bring together many data through internet. However, due to the fact that the data is too large and due to the increasing information pollution, the use of this information and the selection of correct information from it are difficult. Today, this information is decomposed by big data applications. For example, Koç System is working on large data, one of the Industry 4.0 tools. This system, called the IQ Plus system that is intended to simplify mixed and too large data [8].

The traditional data processing techniques are often found inefficient when the data set becomes big and complex. To overcome it, computer engineers and data scientists have improved a set of techniques to collect, hold and analyze data easily in the scope of Industry 4.0 [19].

Big data plays a major role in the evolution of the Industry 4.0 [1]. It is thought that the size of the data in existing networks will be much larger in the coming years [8]. The world is generating massive amounts of data every passing second. In addition, not only the volume of the data, but also the variety and speed of the data generated are increasing day by day [1]. Therefore, large data will play an important role for Industry 4.0. According to the German government, it is predicted that the fuel of Industry 4.0 will be the biggest data [8].

Systems that are operating as intelligent network needs huge and almost unmanageable amount of information which is called as "big data". This enormous and unmanageable data set requires excess work in terms of collection, holding and analysis [13]. In addition to collection, hold and analyze that data set is very costly. Here is the big data technology is an Industry 4.0 technology, that makes these activities easy such as collect, hold and analyze economically.

3.1.7 Cloud services and cyber security

The purpose of cloud-based services is to hold software data on a remote device (cloud) instead of storing data locally. These data can be accessed from any location or devices via internet connection [13]. The most important feature of cloud computing is the rapid use of the desired service. In addition, cloud computing services have high sustainability rates and short turnaround times in case of a possible disaster [1].

Today, firms are already using cloud-based software for some enterprise and some analytical applications. But with the fourth industrial revolution, more data on products had to be shared between plants and firms. At the same time, the number of machines belonging to cloud platforms will increase day by day and provide more service to production systems based on the database. Moreover, even systems that monitor and control processes are likely to move into the cloud in the Industry 4.0 era [10].

On the other hand, this access also raises concerns about the security of stored data [13]. Many companies still use management and production systems that are not integrated with each other. But with increased integration, critical industrial systems

and production lines will need to be protected against cyber security threats. For this purpose, secure communication based on identification of machines and management of access to machines will gain importance [10].

3.1.8 Smart robots

Manufacturers operating in some sectors benefit from robots in their operations. In the world, robot technology is now becoming more flexible, autonomous and collaborative by developing its abilities and reducing the cost. With the fourth industrial revolution, robots will interact with each other, work side by side with people more securely and develop their learning abilities [10].

3.1.9 Virtual reality and simulation

Today, products' design phase, 3D simulation of materials and production processes are using but, in the future, it is stated that simulations will become more widespread in factory operations. The virtual reality of the physical world will be created together with machines, products and people prepared by using real-time data thanks to the simulation models. Thus, for a product on the production line, the machine parameters will be tested in the virtual world before it is actually set. This will shorten the set-up time of the machines and increase the quality [10].

With the digital transformation, the actual and virtual reality merge together during the production. Virtuality have a significant role in design and production. The simulation of processes also has an important role for production to obtain and measure the unexpected cases and their effects [13].

3.1.10 Additive manufacturing

Additive manufacturing is defined as an innovative manufacturing technology in the recent years. The main characteristics of this technology is its support to design of manufacturing quickly. It is an effective manufacturing technique for today's world [20].

With Industry 4.0, companies began adopting additive manufacturing techniques, such as three-dimensional printing, to prototype and manufacture product parts. This method will be used more widely in the future, especially in areas such as complex and light designs, in order to produce a small number of special products. As a result,

high performance and decentralized additive production systems will reduce logistics costs and stock levels [10].

Raw materials are transformed to final parts by digital dataflow of the additive manufacturing process. Firstly, the process starts with a digital 3D sample of the piece which is to be produced. Secondly, support pieces are added if it is necessary. After that, digital model is sliced or otherwise discretized to compose directives for the machine. Finally, the additive manufacturing machine receive these directives to produce the physical material [14].

3.2 Fields of Application

With the fourth industrial revolution, many sectors will undergo change. It is expected that this revolution will be influential in the world of production and everyday life. The reason for the development of this approach; flexibility in production, productivity, speed and quality. Therefore, Industry 4.0 is expected to show itself in the most effective sense, the field of production and manufacturing [8].

Machines and robots which communicate with each other will enable the production of large production lines in a practical manner and will lead to the creation of flexible and smart factories. The use of production lines which have not any human effort, data and simulation techniques will provide higher production speed and low stock needed, thereby increasing productivity. The sensors will provide instant follow-up of the production process and possible errors, so that there will be an increase in quality. On the other hand, it is expected that the demand for low-quality workforce will decrease, whereas demand for workforce with different competencies will increase [8]. Especially Ogan Özdoğan stated these capabilities that must-have in 2020, in his book Industry 4.0 [1]. According to the book, the competencies are stated below:

- Complex problem solving
- Critical thinking
- Creativity
- People management
- Coordination with others
- Emotional intelligence

- Decision making
- Service orientation
- Cognitive flexibility

On the other hand, according to TUSIAD's Industrial 4.0 report published in 2016, these technologies are used in many industrial fields [10].

For example, in a company that produces semiconductor materials, product errors were reduced, and quality improved with the data from a single chip during the test phase at the end of the manufacturing process and the data obtained in the previous steps of the process by big data analysis from Industry 4.0 technologies [10].

Another example is about smart robots. In a company that operates in Europe and produces autonomous robots that interact with each other, the robots can work together and adjust their behavior to be ready for the next product assembly on the production line. Thanks to its advanced technology sensors and control units, robots can work closely with people [10].

As regards horizontal and vertical system integration, a collaborative platform for the European defense and aviation Industry has been established, for creating a common working area for cooperation in design and production issues and presenting this service as a cloud-based service [10].

In the internet of objects, a control system is used in a production center. Thanks to this technology, each product knows which production levels it should go through and moves according to its necessity [10].

In addition, according to a study that investigated the use of the increased reality technologies in 2017, these technologies have many uses such as human sciences, science, education, natural disaster and nuclear accident protection, education, engineering and traffic [17].

The additive production example belongs to aviation companies. These companies use joint manufacturing techniques when designing new products to reduce the cost of raw materials such as titanium and to reduce the weight of the aircraft [10].

In addition to all these, Industry 4.0 technology is not only used in production. These technologies will also affect our daily life.

In fact, we have the Industry 4.0 technology that we are using today. For example, with some applications that can be downloaded to our smartphones, televisions can be controlled without the need for any additional tools. Or, the fact that the information on our smartphones is being used on a computer or tablet at the same time is regarded as the first step in implementing the internet of things [8].

As a more sophisticated system, it is now possible to use some household appliances remotely thanks to telephone applications. For example, a variety of programs are used to control the temperature of the house without having to enter the house. In addition, thanks to cloud technologies, the data we want to store can be stored on our computer without space and can be accessed, downloaded and used by another device. However, these are only micro-effects, and it is expected that macro-effects will be encountered in the future [8].



4. TECHNOPARK

Technoparks are very different from each other in terms of their organization, purpose, way of working or administrative structures. For this reason, it is very difficult to define a single and a whole scope for technopark [21]. Some different definitions are given below:

According to the International Association of Science Parks (IASP):

A science park is an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities. [22]

According to the Technology Development Zone Law No. 4691:

The Technology Development Zone is a region where technology / software developed by companies using high / advanced technology or new technology, utilizing the facilities of a specific university or high technology institute, R&D center or institute. Firms in this region operate to transform a technological invention into a commercial product, method or service, thereby contributing to the development of the region. In addition, the technology development zone also refers to the site with or integrated with the academic, economic and social structure within or near the same university, high technology institute or R&D headquarters or institute area. [23]

According to the Association of Technology Development Zones:

Technopark; It is an organized research and business development ecosystem in which universities / research institutions and industrial organizations carry out research, development and innovation work in the same environment, carry out information and technology transfer among each other, and integrate academic, economic and social structure. [24]

Technology development areas are given different names in different countries and regions such as Technology Park / Technopark, Teknopolis / Teknopol, Science Park, Research Park, Technology Development Zone, Technology Development Center, Technology Corridor and Innovation Center. In our country, it is referred to as

"Technology Development Regions" in Law no. 4691. However, the concept of technopark is more widely used.

According to the Ministry of Science, Industry and technology the purpose of technopark is defined as follows:

In Technology Development Regions the development of technological knowledge, the commercialization of the produced information, the improvement of product quality and standard in product and production methods, the development of innovations that will increase the productivity and reduce the production costs, the adaptation of small and medium sized enterprises to new and advanced technologies, the provision of business opportunities for researchers and the investment of foreign capital are aimed to increase the competitive power of the Industry by accelerating the entry into the country. [21]

Technoparks are the important structures of the innovation system that brings together the technology and science infrastructure of the university with the Industry [25]. They are established to induce the formation and improvement of the new technology-based firms [26].

Technopark create an environment that helps companies to establish relationships with other companies and universities, thanks to the structures that keep their companies in close proximity to each other and to the university. These relationships help to spread knowledge and it leads to entrepreneurial and innovative cultures. [25].

4.1 Technopark in the World

The most profitable contribution to the industrial and economic areas of our century has been achieved after the establishment of technopark. For this reason, societies are now turning from capital and manpower production to knowledge and technology production. This change has led people to research, investigate, and explore [27].

In various sources, it is stated that the world's technopark activities begin with the Silicon Valley-Stanford Research Park in 1951 [28]. Today, hundreds of global companies such as Google, Intel, Adobe Systems, Yahoo and VeriSign are involved in this technopark. Then, in 1959, Research Triangle Park was established in North Carolina [29].

The rapid development of science and technology parks emerged in the 1970s [30]. The reason for this is that the world economic balances have changed since the 1970s. Since the 1970s, declining Industry-based production has led to firms increasing their

resources allocated to R&D to increase production and stimulate the industrial sector. The most effective mechanism developed in this respect was technopark [28].

The second country where technoparks are established is England. In 1972, Heriot-Watt University Technopark in Edinburgh and Cambridge Technopark were the first technopark established in England. The number of technopark in technology producing countries is more than other countries. Also, in addition to contributing to additional employment, such structures have also shown significant potential for implementing technological innovations through small businesses. This situation has led to spread of technopark in Europe rapidly. [29].

Technoparks are spreading rapidly due to the increase of international competitiveness and a new direction in world economy and trade [27]. Today, there are close to 1000 technopark in the world and it is stated that this number reached to 4000 with incubation centers [28].

Some of the major technopark in the world are listed below [27]:

- In the United States:
Silicon Valley, Massachusetts Institute of Technology, Research Triangle Park
- In the UK:
Herriot Watt Research Park, Science Park (Cambridge), Science Park (Merseyside), Science Park (Oxford)
- In France:
Sophia Antipolus, Grenoble (Meylan), Taulose
- In Finland:
Oulu Teknolip
- In the Czech Republic:
Brno Technology Park

4.2 Technopark in Turkey

Technopark in Turkey initiative has started quite late relative to the World [29]. However, the increase in technopark in the world has also increased the importance given to this area in our country [31].

Turkey's technology-driven initiative began by establishing TUBITAK to coordinate, organize and support research in basic and applied sciences them in 1963 [29].

Since the 1960s, the basic policy to strengthen small industrial enterprises in Turkey, has been to increase the number of small industrial sites. The main purpose of this is to consolidate these institutions in specific centers and thus to improve the production and market potential [30].

The idea of establishing technopark in Turkey has emerged in 1990 with four universities and KOSGEB. However, it was originally legalized by the 'Technology Development Zones Law' in 2001 [31].

Within the scope of Technology Development Zones Law, which aims to develop new products and production methods aimed at technology intensive production by bringing the private sector together with researchers and universities, support and exemption is provided for encouraging and ensuring sustainability of University-Industry cooperation. These exemptions and supports within the scope of the Law on Technology Development Regulations No. 6170 which entered into force on 12 March 2011 are as follows [32]:

- Institutions and income tax exemption
- VAT exemption
- Insurance premium support
- Advantage of tax exemption of R&D personnel fee
- Advantage of tax exemption of support staff fee
- Proportional support of out-of-district workers
- R&D investment support

These incentives and exemptions lead techno park companies to focus on technology development and research.

There are 77 pieces Technology Development Zone in Turkey. Of these, 56 are still in operation [21].

Technopark which are active in Turkey are given in Table 4.1, and ongoing infrastructure work technoparks are given in Table 4.2.

Table 4.1 : Active technopark in Turkey [21].

Technopark	University	City	Year of Foundation
Middle East Technical University	Middle East Technical University	Ankara	2001
TUBITAK Marmara Research Center	TUBİTAK-TTGV	Kocaeli	2001
Ankara	Bilkent University	Ankara	2002
İzmir	İzmir Institute of Technology	İzmir	2002
GOSB Technopark	Sabancı University	Kocaeli	2002
Hacettepe University	Hacettepe University	Ankara	2003
Istanbul Technical University ARI	Istanbul Technical University	İstanbul	2003
Eskisehir	Anadolu University	Eskişehir	2003
Selçuk University	Selçuk University	Konya	2003
Kocaeli University	Kocaeli University	Kocaeli	2003
Yıldız Technical University	Yıldız Technical University	İstanbul	2003
İstanbul University	İstanbul University	İstanbul	2003
West Mediterranean	Akdeniz University	Antalya	2004
Erciyes University	Erciyes University	Kayseri	2004
Trabzon	Karadeniz Technical University	Trabzon	2004
Çukurova University	Çukurova University	Adana	2004
Mersin University	Mersin University	Mersin	2005
Lakes Region	Süleyman Demirel University	Isparta	2005
Ulutek	Uludağ University	Bursa	2005
Erzurum Ata	Atatürk University	Erzurum	2005
Gaziantep University	Gaziantep University	Gaziantep	2006
Ankara University	Ankara University	Ankara	2006
Gazi University	Gazi University	Ankara	2007
Fırat University	Fırat University	Elazığ	2007
Pamukkale University	Pamukkale University	Denizli	2007
Cumhuriyet University	Cumhuriyet University	Sivas	2007
Dicle University	Dicle University	Diyarbakır	2007
Trakya University	Trakya University	Edirne	2008
Sakarya University	Sakarya University	Sakarya	2008
Tokat	Gaziosmanpasa University	Tokat	2008
Bogazici University	Bogazici University	İstanbul	2009
Bolu	Abant İzzet Baysal University	Bolu	2009
Malatya	İnönü University	Malatya	2009

Table 4.1 (continued) : Active technopark in Turkey [21].

Technopark	University	City	Year of Foundation
Kütahya Dumlupınar Design	Dumlupınar University	Kütahya	2009
Istanbul	İstanbul Ticaret University	İstanbul	2009
Samsun	On Dokuz Mayıs University	Samsun	2009
Düzce University	Düzce University	Düzce	2010
Harran University	Harran University	Urfa	2010
Kahramanmaraş	Sütcü İmam University	Kahramanmaraş	2011
Namık Kemal University	Namık Kemal University	Tekirdag	2011
Çanakkale	On Sekiz Mart University	Çanakkale	2011
İzmir Science and Technology Park	İzmir Economy University	İzmir	2012
Yüzüncü Yıl University	Yüzüncü Yıl University	Van	2012
Corum	Hitit University	Corum	2012
Dokuz Eylül University	Dokuz Eylül University	İzmir	2013
Bozok University	Bozok University	Yozgat	2013
Kırıkkale University	Kırıkkale University	Kırıkkale	2013
Marmara University	Marmara University	Istanbul	2014
Ege University	Ege University	İzmir	2014
Konya	Selçuk University	Konya	2015
Afyon-Uşak Zafer	Afyon Kocatepe-Uşak University	Afyon-Uşak	2015
Nigde University	Nigde University	Nigde	2013
Celal Bayar University	Celal Bayar University	Manisa	2012
Ankara Technopark	Yıldırım Beyazıt University	Ankara	2014
Muallimköy	Gebze Technical University	Kocaeli	2011
Adnan Menderes University	Adnan Menderes University	Aydın	2016

Table 4.2 : Ongoing infrastructure work technopark in Turkey [21].

Technopark	University	City	Year of Foundation
ASO Technopark	TOBB Economy and Technology University	Ankara	2008
Mehmet Akif Ersoy University	Mehmet Akif Ersoy University	Burdur	2013
Balıkesir University	Balıkesir University	Balıkesir	2014
OSTİM Ekopark	Ankara-Baskent-Atılım-Cankaya-Hacettepe- TOBB Economy and Technology University	Ankara	2014
Hatay	Mustafa Kemal University	Hatay	2014
Finans	Bogazici University	Istanbul	2014
Karaman	Karamanoglu Mehmet Bey University	Karaman	2014
Mugla	Sıtkı Kocman University	Mugla	2015

Table 4.2 (continued) : Ongoing infrastructure work technopark in Turkey [21].

Technopark	University	City	Year of Foundation
Batman University	Batman University	Batman	2017
Osmaniye	Osmaniye Korkut Ata University-Adana Science and Technology University	Osmaniye	2017
Zonguldak	Bulent Ecevit University	Zonguldak	2017
Karabuk University	Karabuk University	Karabuk	2017
Gaziantep OSB	Hasan Kalyoncu University	Gaziantep	2017
Antalya OSB	Akdeniz University-Antalya Science University	Antalya	2018
Kapadokya	Nevsehir Hacı Bektas Veli University	Nevsehir	2018
İstanbul Sebahattin Zaim	İstanbul Sebahattin Zaim University	Istanbul	2018
Gebze Technical University	Gebze Technical University	Kocaeli	2018
Medical Science University	Medical Science University	Istanbul	2018
İstanbul Medeniyet	İstanbul Medeniyet University	Istanbul	2018
Dudullu OSB	Bogazici University	Istanbul	2018
Bogazici University			
Mersin Agricultural Food Specialization	Mersin University	Mersin	2018

Sectoral distribution of Technopark firms is shown in Table 4.3. According to the data of Turkey's General Directorate of Science and Technology in 2017, Technopark firms as a percentage of the software Industry seems to be the most dominant sector with 37%.

Table 4.3 : The sectoral distribution of firms technopark in Turkey [21].

Industry	Percentage (%)
Software	37
Computer and Communication Technologies	17
Electronics	8
Manufacture of Machinery and Equipment	6
Energy	4
Medical	3
Health	3
Defense Industry	3
Chemistry	3
Food Industry	2

Table 4.3 (continued) : The sectoral distribution of firms technopark in Turkey [21].

Industry	Percentage (%)
Agriculture	2
Other	2
Construction	1
Telecommunications	1
Automotive	1
Aviation	1
Drug	1
Farming	1
Shipping	1
Manufacturing Industry	1
Recycling	1
Automotive Design Engineering	1

In addition, some general information such as total number of firm, total number of personnel etc. about the technopark firms in Turkey are given in Table 4.4.

Table 4.4 : Some general information about the technopark firms in Turkey [21].

Explanation	Amount
Total Number of Technopark Firm	4.846
Number of Foreign / Foreign Affiliated Companies	282
Academician Number of Affiliated Companies	1.017
Total Number of Personnel	47.333
Total Number of R&D Personnel	38.765
Total Number of Support Personnel	3.041
Total Number of Out of Scope Personnel	5.527
Number of Projects (Ongoing)	8.113
Number of Projects (Completed)	27.547
Total Sales (TL)	57,6 Billion
Total Exports (USD)	3,4 Billion

Today, one of the determining factors of the social welfare of country and the competitive power of the country is intellectual property rights. The situation regarding intellectual property rights of companies that are located in Turkey's technoparks are given in Table 4.5.

Table 4.5 : The situation of companies operating in technopark in Turkey in terms of intellectual property rights [21].

Explanation	Number
Number of Patent Registration (National /International)	997
Number of Patent Applications (Ongoing)	2179
Useful Model Registration Number	461
Utility Model Application Number (Ongoing)	174
Industrial Design Register Number	85
Number of Applications for Industrial Design (Ongoing)	56
Software Copyright (Accepted)	9

4.3 The Purpose and Benefits of Technopark

According to Cüneyt Çetin, the aim of the technopark is:

"The purpose of establishing technopark differs from country to country. But in general, the aim of technopark is increasing competition in international trade, accelerating technological development and technology production by enabling local governments to participate in economic development, and effectively using the potential of universities and other research institutions" [33].

Technoparks have many important goals. These; to mediate the business alliance between the university and Industry, to encourage firms in their own industries to develop new technologies in competitive market conditions, to inform and assist the state in investment support in the field of innovation [29].

Together with technopark, it is expected that firms that cannot allocate adequate resources for R & D investment are supported and technical information produced in universities is commercialized. With this, all stakeholders in the University-State-Industry triangle are targeted to gain [29].

For example, in 2012 Nuri Ömürbek and Yekta Halıcı's study showed that the company's competitive situation in the market developed after the they entered the technopark [34].

In addition to these, with the Technopark, it is expected that the Industry, the universities, the region and the country will have significant contributions to the national economy. In terms of Industry, it is aimed to reach the technical and

theoretical knowledge in universities and at the same time to find the application field of the technological knowledge developed in the universities through the Industry [29].

It is stated that technoparks have an indisputable function to realize regional development by being in cooperation with universities. Technopark is seen as a means of the government's regional policies in presenting new job opportunities and employment opportunities in underdeveloped regions [34].

The benefits of technopark in terms of country and local economy are explained as below [35]:

- They support employment in the region where they are established
- Technoparks are influencing the income level of the people living around, well
- It supports increasing the level of education of the region
- Where there are technopark, regional development will happen
- In regions where technoparks are established, industrialization occurs again
- They contribute to the industrial competition of the country
- The development of high institutional links supports the country's innovation and production capacity
- They reduce the rate of unemployment at the national level
- They increase the image and reputation of the country in the world
- They develop a specialized workforce
- They increase the country's level of science and technology
- They support the opening of the country's international market

Apart from these, it is stated that technoparks have a great influence on the acquisition of innovation culture within the national innovation system. In particular, there are also mentioned benefits such as cultural expansion, the development of social opportunities and the enhancement of the effectiveness of non-governmental organizations [29].

5. LITERATURE REVIEW

This part presents the literature review on the relationship between technopark and Industry 4.0. Although the intensive research has been conducted to reach the studies on this subject, any study directly analyzing the role and position of technoparks and impact factors and current issues on the development of the fourth industrial revolution have not been found. Likewise, there is no study to measure the work of technopark companies in Industry 4.0. This reveals the original value of the thesis. Meanwhile, the literature has some studies directly in technopark, some studies on Industry 4.0. These studies are summarized as follows.

According to the results of Nurten Sinem Pamuk and Mehmet Soysal's research in 2018, both the business world and the relevant literature show a growing interest in the concept of Industry 4.0. However, the results of the literature review show that the journals related to the business science do not show enough interest in this issue. It is also stated that Germany, which introduced the concept of Industry 4.0 to the world, is also leading in the articles published in this subject and that no work has been found in our country [8].

On the other hand, there are many studies on the contribution of technopark to technological development or research on R&D. The literature reviews related to the studies are given below:

Alberto Albahari et al. showed that higher involvement of a university in the technopark is positively related to number of patent appeals, but in the same time negatively related to technopark firm's innovation sales in their study that is published in 2017 [36].

Ranfeng et al. in their work in 2016, they obtained the result that technopark supported the innovative activities of their own companies. In addition, Ranfeng et al. have reached the conclusion that the R&D facilities located in the technoparks have directed firms to innovate at a high level both in the product market and in the technological field [37]. Likewise, the results of a study in Spain in 2014 show that technoparks have

strong and positive influence on their companies in terms of creating product innovation and increasing amount of it [38].

On the other hand, in a study by Mariagrazia Squicciarini in 2008, they compared technology companies in the technopark in terms of patent procurement and found that the companies in the technopark that have a patent, have a better performance in this respect [39].

The importance of technopark to the development of high technology Industry has been widely accepted. In a study conducted in 2006 at the Hsinchu Science Park in Taiwan, it is stated that the especially computer Industry and the semiconductor Industry are performed best and that these industries had a strategic goal in the high-tech development plan of Taiwan's government for the last two decades. [40].

Tuğba Gökdoğan Gül and Serhat Çakır made a research about technopark in 2014. According to the study; factors such as R & D cooperation at international level, R&D support, the number of academic staff working at the firm, and cooperation with the firms in the technoparks have an important role on increasing the probability of firms making patent and utility model applications which are an important indicator of developing new technology. Especially, the cooperation of companies at international level has been found to have a positive effect on innovation performances. Accordingly, with these collaborations, companies have a chance to closely monitor and implement technology and innovation activities at international level. In addition, the company has the opportunity to take advantage of customer potential, financing and technical support around the world, with the possibility of involving networks related to the workplace. On the other hand, according to study, the employment of firms by academic staff also had a positive effect on innovation performances. The level of knowledge that academic staff possesses is a potential for innovation and a crucial place for performance. And finally, another significant innovation performance indicator of firms is cooperation with other companies in the technopark. This cooperation has a positive impact on the innovation performance of firms. According to the study, as the level of cooperation increases, firm costs and risk are decreasing. In other words, the uncertainty underlying R&D and innovation activities are minimized [41].

Contribution to the Development of Science and Technology Capacity of Technopark was examined in 2014. Patents issued by R&D activities in the study; is defined as the rights to commercialize information, innovations and inventions, to increase competitiveness and profits in terms of companies and countries, and to provide legal protection. According to the study, the incentives provided to technopark in our country contribute to patent production and hence to information technology capacity. In addition, with the contribution of tax incentives provided to Technopark and R&D centers, increase in employment has been observed in R&D and innovation activities and it has been stated that this contribution has continued increasing since the establishment of technopark. In addition, according to the research, technopark increase the export rate in our country [42].

In a study that is analyzing the present situation of technopark in 2010, it is stated that technopark provide information and technology transfer through University-Industry cooperation. Academic information can be commercialized in technopark. It also encourages and supports entrepreneurship towards advanced technology. Thanks to the support given to technopark, the formation of new technologically based firms which are producing high technology and products with added value is ensured. On the other hand, thanks to the synergy created by technopark, technology transfer among companies that are operating in the technopark can be achieved. This is an opportunity to market technological innovations. For all these reasons, the economic activity of the region is primarily developing, regional development is ensured, value added is developing nationwide and economic efficiency is rising [43].

In a study conducted with technopark in 2016, technopark companies' performance on innovation processes was measured. The study examined firms at four levels. These are “Idea Generation”, “Beta Version Development”, “Full Version Development” and “Sale Stage”. According to the results, companies do not give importance to “Idea Production” and generally get new product ideas from their customers. However, they have reached the conclusion that the “Full Version Development” and “Beta Version Development” process is extremely important for businesses [44].

Another study conducted with technopark is a doctoral work that reveals the importance of technopark in regional development. According to the result of the work done in Konya technopolis, technopolis has positive effects on the growth of turnover, exports, employment, investment and market area of the companies. It is proposed to

increase the R&D support and encourage the cooperation of the firms with the other technopark companies, public institutions and universities [45].

Apart from the studies done in technopark, authors have conducted some studies measuring maturity level of manufacturing companies regarding Industry 4.0. For example, in 2016, Andreas Schrumacher, Selim Erol and Wilfried Shin developed a maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises [46]. In addition, Tonelli, Demartini, Loleo and Testa developed a methodology and the related mapping and analyze tool within the scope of Industry 4.0 [47].

Another research that measure contributions on accounting department of technological developments provided by Industry 4.0 was made by Ahmet Can and Merve Kıymaz in 2017. The aim of this research to determine the extent to which information technologies have been utilized and to determine the impact of the Industry 4.0 on business leaders in the accounting department, which operates in the retail sector and in Turkey [48].

At the end of a graduate study studying the status of Industry 4.0 implementation in enterprises affiliated to the Sakarya Machinery Manufacturers, it was learned that the concept of Industry 4.0 and its applications are not yet fully effective. therefore, an initial efficiency can be obtained from the applications of Industry 4.0. Moreover, the institutions and organizations participating in the research are not as close to the industrial revolutions and technological developments as they should be. It has been shown that the reasons for this include basic information and communication problems, and that companies have invested in such a way that they cannot support Industry 4.0 [49].

6. THE RELATIONSHIP BETWEEN TECHNOPARK AND INDUSTRY 4.0

As stated earlier, this thesis aims to measure the awareness of technopark companies on the Industry 4.0 and to determine the state and role of them on the development of the fourth industrial revolution in Turkey. In this pursuit, a survey using a questionnaire form has been conducted in 231 technopark companies, which can be called the source and the heart of technology development in our country.

In detail, the objectives of this study are as follows;

- To determine the level of awareness and position for the Industry 4.0 development of technopark companies regarding Industry 4.0,
- To measure the strategy level and organization structures of technopark companies to determine whether they are ready to perform the digital conversion in Turkey,
- To measure Industry 4.0 operates and degrees of technology intensive enterprises which will help to advance in the field of digital transformation of Turkey,
- For helping to create the road map for Turkey about Industry 4.0 technologies, to determine which and how much Industry 4.0 technologies have been used by technopark firms on their solutions for customers in the last 5 years,
- For determining the state and role of the technopark firms on Industry 4.0's development in Turkey, to determine which of Industry 4.0 technologies that they want to work on in the future and which Industry 4.0 technologies that they directly contribute to the development of it,
- To measure the collaboration degree of technopark companies and to determine that they prefer which institutions and organizations for collaboration within the scope of Industry 4.0 activities,
- To determine in which application areas (R&D, production, logistics, etc.) products are offered by technopark companies within the scope of Industry 4.0 activities,

- While developing the technology within the scope of digital transformation in our country, it is aimed to determine the internal and customer-related difficulties encountered,
- To measure the importance level and rate of utilization of opportunities that can be assessed within the scope of Industry 4.0,
- To determine how the technopark employees are organized and equipped with the skills and competencies while the project for the Industry 4.0 is being produced,
- To determine technopark companies' expectations and the level of success they have achieved when developing the Industry 4.0 technologies,
- To determine customer expectations from Industry 4.0 technologies and the degree of success that achieved by technopark companies,
- Identify the strategies and areas of improvement needed to further develop Industry 4.0 technologies that will take our country one step ahead,
- Finally, to determine whether there is a significant difference and correlations between the characteristics of technopark companies and the mentioned elements above.

6.1 The Methodology of Research

This study goals to focus on the Industry 4.0 activities of technology producer companies that are operating in technopark in Turkey.

First of all, the questionnaire was prepared for the technology producer companies, which operate in technopark in Turkey, in the light of information gathered from the literature survey. In addition, the questionnaire organized considering the opinions and sights who are expert in the field of Industry 4.0 such as Bosch Industry 4.0 Director Mustafa Ayhan, Bahçeşehir University, Department of Business Engineering, Assist. Assoc. Prof. Alper Camci and Assoc. Prof. Gül T. Temur, Arçelik Manufacturing Technology Specialist İzlem Tekin Bayrak, Arçelik Automation Engineer Osman Er and Arçelik Sales Development Manager Evren Aksoy. After that, questionnaire was sent to 50 techno-park in Turkey. A total of 231 technology development-focused companies participated in the research.

The prepared questionnaire study was conducted as a pilot study to several technology manufacturing companies located in Istanbul Technopark. Then 350 printed questionnaires were handed out to the technopark. The companies that cannot be reached by face to face were sent survey links online via ITU VETI. In total, 231 of 830 respondents were answered. Thus, questionnaire response rate is approximately 28%.

To analyze questionnaire responses of the technopark companies, 25.0 version of SPSS computer software was used. The statistical analysis methods which are used in the study are descriptive statistics, reliability analysis, factor analysis, correlation analysis and difference tests. Difference tests were analyzed using t-test with two variables, ANOVA with three variables, and Mann-Whitney U test and Kruskal-Wallis test in non-normal distributions.

6.2 The Structure of Survey Questions

The questionnaire contains 30 questions in total and consists of 4 sections these identified below:

- Overview of Industry 4.0
- Strategy and organization
- Requirements and expectations
- General information about the company

The first section generally contains questions to determine the level of awareness at different levels of the company, such as environmental level, technopark level, organization level, individual level, and competition level etc. The first question is suggestion question of a specialist in the field of Industry 4.0. In addition, the questions 1.2, 1.3, 1.4, 1.11, 1.12, 1.13, 1.14, 1.15, and 1.16 in the first section were taken from a survey conducted by TUSIAD with The Boston Consulting Group to determine Industry 4.0 awareness of manufacturing companies [10]. Moreover, 1.6, 1.7, 1.8, 1.17, 1.18 and 1.19 questions in this section were inspired from a graduated study that measure Industry 4.0 awareness level of manufacturing firms [49].

The questions in the second section mainly consist of questions about determining the strategy and organizational structure of the companies. This section attempted to

determine the status and strategies of the companies that have the necessary infrastructure for Industry 4.0. In particular, there are questions about the technologies of Industry 4.0 which they use in their solutions or contribute directly to their development, collaboration structure, employee structure and the areas in which they offer their Industry 4.0 solutions. In addition, 2.1 and 2.15 questions in the second section were taken from a graduate study that measuring Industry 4.0 activities and awareness in the manufacturing sector [49]. Also; 2.8, 2.10, 2.11, 2.13 taken from the book section of Alp Üstündağ and Emre Çevikcan about Industry 4.0 [50]. The technologies in question 3 and 4 in this section were taken from the questionnaire which measures the maturity level of Industry 4.0 in the manufacturing sector by IMPULS. Moreover, the questions 6, 7 and 8 in this section were again inspected by the IMPULS questionnaire and asked according to technopark companies [51]. Furthermore, the questions 9.19, 9.20, 9.21, 9.23 and 10.10 were taken from a graduated study done in the technopark before [52].

The questions in the third section include the difficulties, expectations, customer expectations and opportunities that companies have encountered when offering products under Industry 4.0. The questions 9.10, 9.11, 9.12, 9.14, and 9.15 were taken from the Sethi and King's study. [53]

The questions in the last section question general information about the company such as establishment year, activity area of company, target market, position of the respondent, capital structure, sector of company, number of customer and structure, time in technopark, number of employee and profile, number of patent, annual turnover etc. These questions (1, 2, 3, 4, 5, 6, 7, 8, 9, 11,13, 15, 16, 17, 18 questions) were inspired by the work done in the technopark before [50, 61].

The questions in all sections were prepared in the light of literature reviews and with recommendations from experts who are interested in Industry 4.0. The questions in the first three chapters consist of questions prepared on a total of five Likert scales. The questions in the fourth section consist of nominal and ordinal type questions.

7. FINDINGS

In this section statistical analyzes and their results are explained.

7.1 Descriptive Analysis

First of all, a descriptive analysis of all the questions that asked to the participants was made.

7.1.1 General characteristics of the participant companies

To show off responses given by participants as a short brief, general characteristics of the participant firms are given below.

7.1.1.1 Position of the participants in the company

Most of the participants consist of managers with 33.3% as seen in table 7.1. This is followed by company owner with 22.9%.

Table 7.1 : Position frequency of the participants

Position	Frequency	Percent
Company Owner	53	22,9
Software Specialist	31	13,4
Support Staff	10	4,3
Manager	77	33,3
Engineer	32	13,9
Other	13	5,6

A graphical representation of the participants' positions in the company is shown in Figure 7.1.

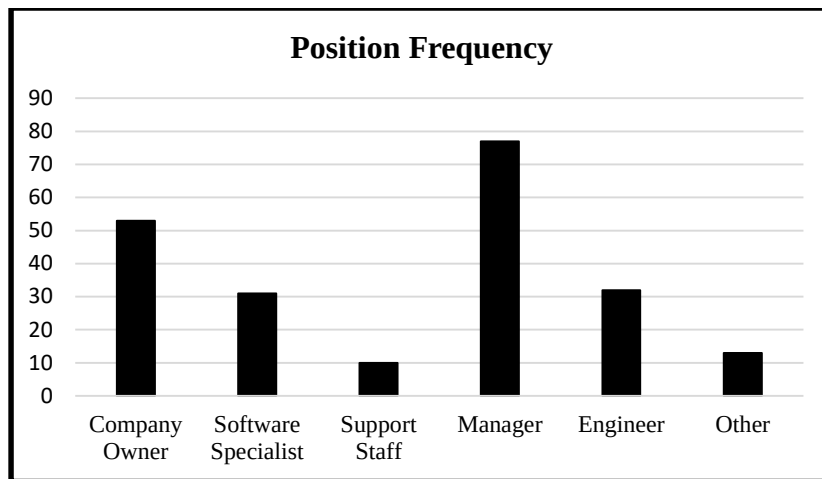


Figure 7.1 : Position frequency of participants.

7.1.1.2 Establishment year of companies

The years of establishment and percentage of the participating companies in the research are shown in Table 7.2.

Table 7.2 : Establishment year of participant companies.

Year	Frequency	Percent
Before 1990	7	3,0
1990-1994	8	3,5
1995-1999	11	4,8
2000-2004	25	10,8
2005-2009	37	16,0
2010-2018	119	51,5

A graphical representation of the years of establishment of participating companies is given in Figure 7.2. As can be seen from the graph, the majority of the companies were established after 2010.

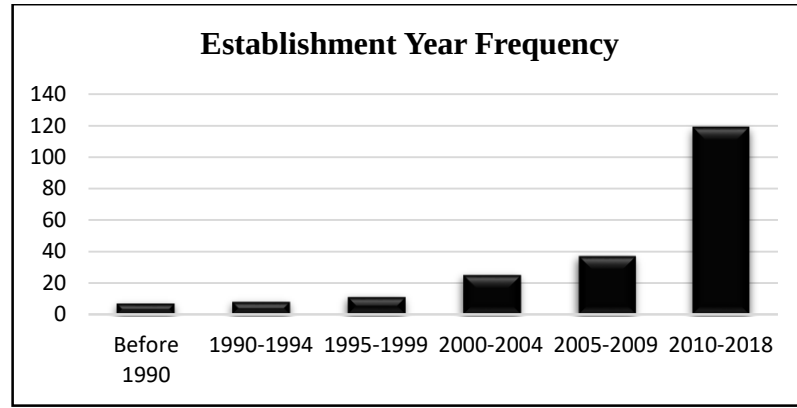


Figure 7.2 : Establishment year of participant firms.

7.1.1.3 Technopark of participant companies

As indicated before, the survey was sent to 50 technopark in Turkey. Unfortunately, some of them did not get a response. For this reason, technopark of participating companies are located are predominantly Istanbul and its surroundings. The technopark and the frequency of participants' participation are given in Table 7.3.

Table 7.3 : Technopark of participant firms.

Technopark	Frequency	Percent
Istanbul Technopark	82	35,5
Yıldız Technical University	47	20,3
Istanbul University Technopolis	25	10,8
TUBITAK Marmara Research	23	10,0
Muallimköy	15	6,5
ULUTEK	3	1,3
Middle East Technical University	3	1,3
Istanbul Technical University	2	0,9
Kocaeli University	2	0,9
Sakarya University	2	0,9
Eskişehir Technology Development Zone	1	0,4
Trabzon Technopark	1	0,4
Erciyes Technopark	1	0,4
Konya Technopolis	1	0,4
Trakya Technopark	1	0,4
Lakes Region	1	0,4
Gaziantep Technopark	1	0,4

The graphical representation of the technopark in which the participants are located is given in Figure 7.3. As it can be seen from the graph, Istanbul Technopark is the biggest one among participants.

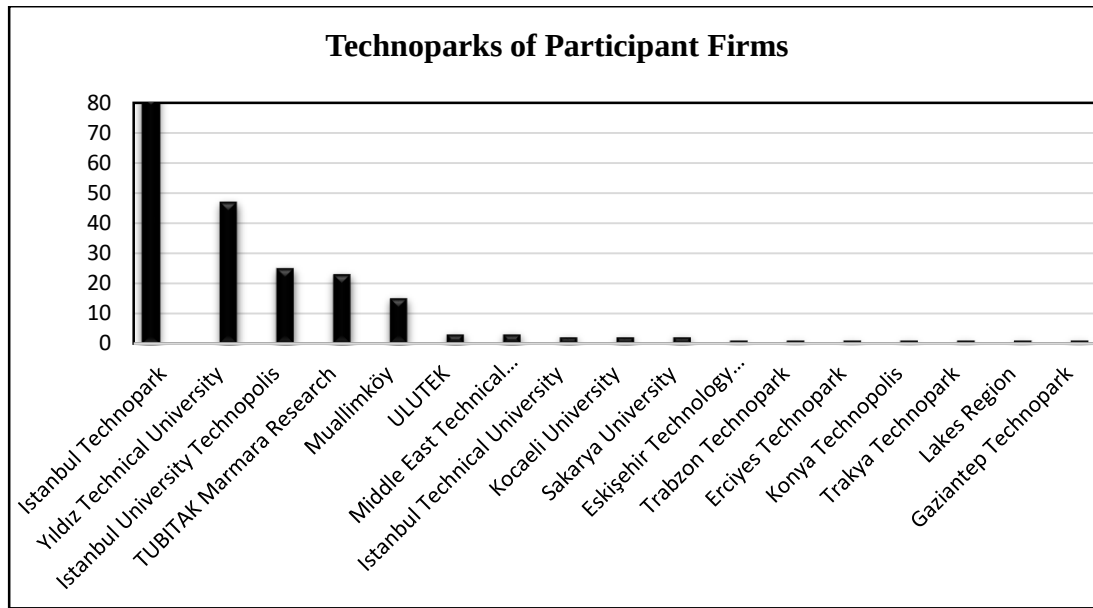


Figure 7.3 :Technopark of participant firms.

7.1.1.4 Categories of participant companies

This thesis goal is to obtain the role and state of technopark in developing Industry 4.0 technologies and to determine their role and state on the developing of the fourth industrial revolution in our country. Thus, as seen in the Table 7.4, participating companies consist of in the software and engineering category.

Table 7.4 : Categories of participant firms.

Category	Frequency	Percent
Software	161	69,7
Engineering	56	24,2

7.1.1.5 Target market of participant companies

Target market rates of participating firms are given in Table 7.5. As can be seen in the table, the majority of participating companies target both domestic and foreign markets with a rate of 78.4%

Table 7.5 : Target market of participant firms.

Market	Frequency	Percent
Domestic Market	30	13,0
Foreign Market	7	3,0
Both Domestic and Foreign Market	181	78,4

7.1.1.6 Capital structure of participant companies

The capital structures of the participating companies are shown in Table 7.6. As can be seen, most of the companies do not have foreign capital partnership.

Table 7.6 : Capital structure of participant companies.

Capital Structure	Frequency	Percent
Have Foreign Capital Partner	23	10,0
Domestic	190	82,3

7.1.1.7 Structure of participant companies

Table 7.7 shows that the majority of the participating companies are independent companies when they analyze it in terms of general structure.

Table 7.7 : Structure of participant companies.

Structure	Frequency	Percent
Dependent with an international Company	14	6,1
Dependent with a National Company	19	8,2
Independent Company	182	78,8

7.1.1.8 Total amount of customer

The number of customers of participating companies in the survey are given in Table7.8.

Table 7.8 : Number of customers of participants.

Number of Customer	Frequency	Percent
1-4	18	7,8
5-9	36	15,6
10-19	24	10,4
20-49	37	16,0
50-100	32	13,9
+100	63	27,3

Figure 7.4 shows a graphical representation of the participants' number of customers.

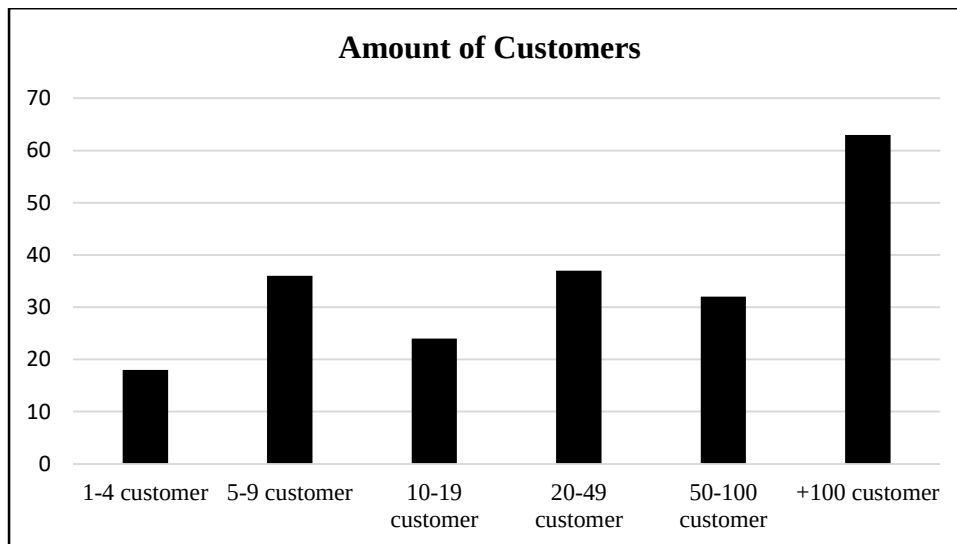


Figure 7.4 : Number of customers of participants.

7.1.1.9 Time spent in technopark of participant companies

Information on the duration of the participating companies in the technopark is given in Table 7.9.

Table 7.9 : Time spent in technopark.

Duration	Frequency	Percent
Less than 1 year	49	21,2
2 years	28	12,1
3 years	27	11,7
4 years	30	13,0
5-9 years	54	24,4
+10	21	9,1

In addition, Figure 7.5 gives a graphical representation of the participants' duration in the technopark.

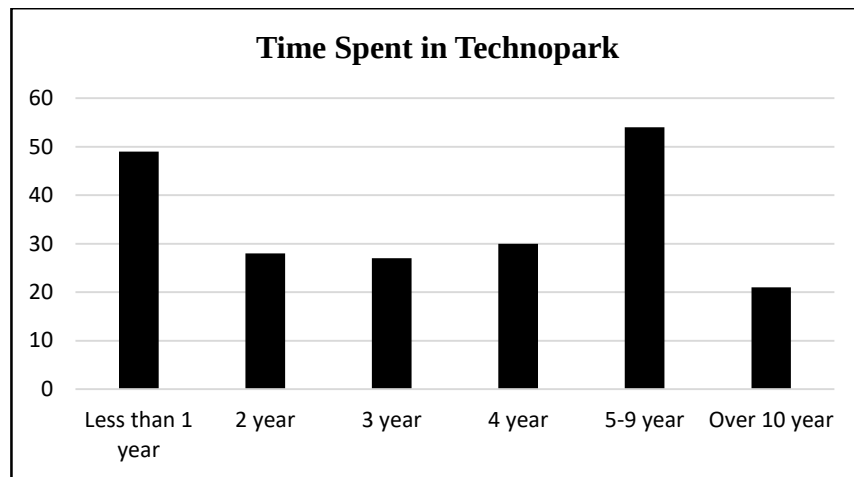


Figure 7.5 : Time spent in technopark.

7.1.1.10 Total amount of employee

Percentages of employee numbers of participants are given in Table 7.10.

Table 7.10 : Total amount of employee.

Number of Employee	Frequency	Percent
1-9	81	35,1
10-19	59	25,5
20-49	38	16,5
50-100	15	6,5
100-249	12	5,2
+250	9	3,9

As seen in the Figure 7.6, due to the participating companies are selected from technology-intensive but small companies operating in the technopark, the number of employees in most of firms is less than 250.

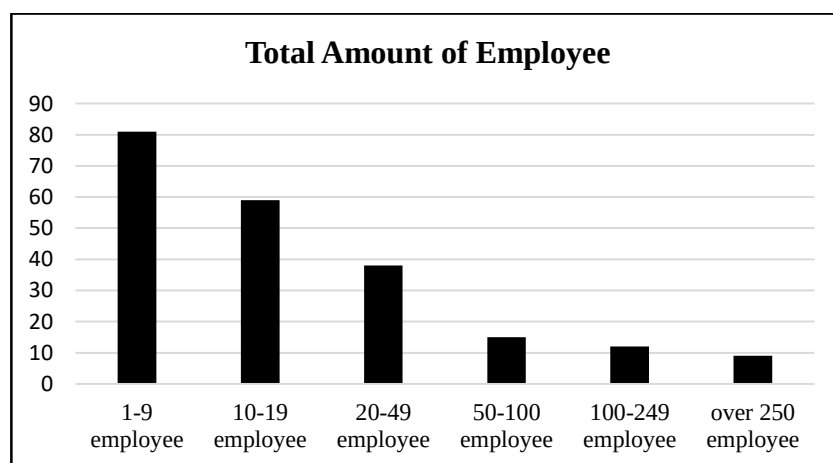


Figure 7.6 : Total amount of employee.

7.1.1.11 Annual revenues of the participating companies

Annual revenues of the participating companies are given in Table 7.11. According to the company's annual revenues, we can say that most of the participant companies are micro, small and medium-sized enterprises.

Table 7.11 : Annual revenues of the participating companies.

Annual revenues	Frequency	Percent
Less than 500 billion TL	35	15,2
500 billion TL- 1 million TL	38	16,5
1 million TL-8 million TL	48	20,8
8 million TL-25 million TL	17	7,4
25 million TL-40 million TL	6	2,6
More than 40 million TL	8	3,5

The figure of the annual revenue distribution of participating companies is given in Figure 7.7.

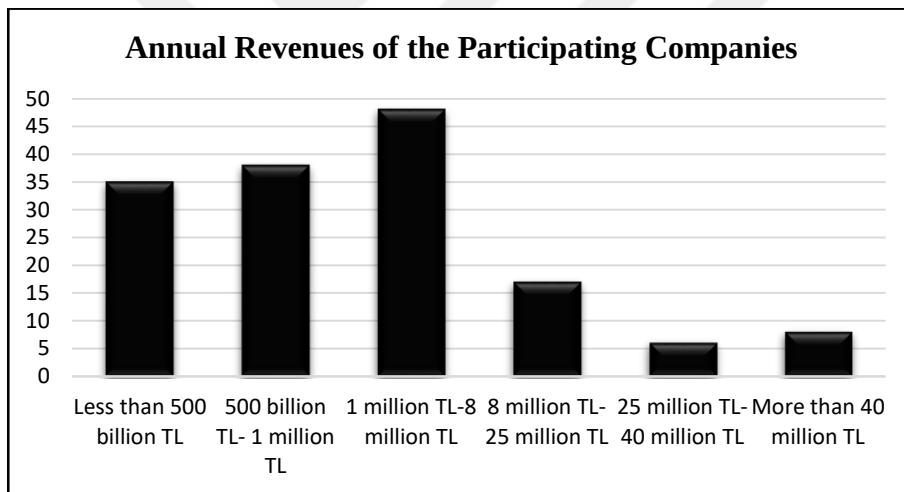


Figure 7.7 : Annual revenues of the participating companies.

7.1.1.12 Number of patent of the participating companies

Participating companies were asked whether they had received patents in their earlier studies and whether they also received patents within the scope of Industry 4.0 technologies. As can be seen in the Table 7.12, a small number of participating companies own patents from their past studies.

Table 7.12 : Company state in terms of patent.

Explanation	Frequency	Percent
Yes, we have patent	63	27,3
No, we have not got a patent yet	139	60,2
Yes, we have patent within the scope of Industry 4.0	18	7,8
No, we have not got a patent within the scope of Industry 4.0 yet	183	79,2

7.1.2 Overview of Industry 4.0

Averages and standard deviations of participants' responses to the questions in the "Overview to Industry 4.0" are given in Table 7.13. In this session questions were asked to respondents on 5-Likert Scale where 5 implies "strongly agree" and 1 implies "strongly disagree".

Table 7.13 : Participants' answers in the "Overview to Industry 4.0" section.

Explanation	N	Mean	Std. Deviation
I have information about Industry 4.0	227	3,81	1,12
I have information about Industry 4.0 technologies	227	3,72	1,09
Top management is aware of Industry 4.0	226	3,90	1,10
All our organization has information about Industry 4.0	227	3,31	1,19
Our company has information about the Industry 4.0 platform	225	3,58	1,16
Our company knows how much Industry 4.0 will affect the Industry we are in.	226	3,72	1,17
Our company understood the content of the Industry 4.0 concept much better than our competition	227	3,50	1,49
Developing products / services within the context of Industry 4.0 has great importance for the future of our business.	226	3,82	1,21
Digital transformation in the Industry will increase the competitiveness of companies	227	4,41	0,87
Digital transformation in the Industry will increase the international competitiveness of Turkey	227	4,35	0,98
Industry 4.0 will change the general market structure of the country.	229	4,18	0,93
Industry 4.0 will make it possible to gain more global market share	226	4,16	1,00
Industrial investment in 4.0 will provide the growth of Turkey's global market share in the long term.	229	4,25	0,92
Turkey's need to add more value to gain more share of the global market.	229	4,49	0,85
Industry 4.0 will provide employees with new jobs and increase employment	228	3,79	1,08
It is enough for companies to work on their own for the development of Industry 4.0.	227	2,53	1,25
Industry 4.0 concept in Turkey are discussed enough by the government.	226	2,35	1,09

Table 7.13 (continued) : Participants' answers in the "Overview to Industry 4.0" section.

Explanation	N	Mean	Std. Deviation
Industry 4.0 concept in Turkey are discussed enough by academics.	227	2,80	0,99
Industry 4.0 concept in Turkey are discussed enough by non-governmental organizations, trade unions and press.	226	2,41	1,09
Technopark has a vital role on the development and spread of Industry 4.0 in Turkey	229	3,78	1,01
Technoparks have a great importance in developing new products, services or technology.	229	4,75	0,98
Turkey supports to technopark companies which are aiming to develop technology, enough.	228	2,07	1,16
Turkey supports to technopark companies aiming to develop technology within the scope of Industry 4.0 enough.	226	2,75	1,16

As seen in Table 7.13, we can say that, technopark firms think that Industry 4.0 has an important role in achieving market share and technoparks are important to technology development. However, they find that their support is inadequate.

7.1.3 Strategy and organization

In this section, companies were asked about the strategies related to Industry 4.0 and they were asked whether they have the necessary infrastructure to realize the digital transformation.

The responses of the participants are given in Table 7.14. In this session questions were asked to respondents on 5-Likert Scale where 5 implies "strongly agree" and 1 implies "strongly disagree".

Table 7.14 : Participants' answers in the "Strategy and Organization" section.

Explanation	N	Mean	Std. Deviation
Within the scope of Industry 4.0, we have goals and objectives as a company.	227	3,53	1,19
As a company, we have our roadmap and strategies under the scope of Industry 4.0.	226	3,20	1,20
Our company uses indicators to monitor the implementation status of our Industry 4.0 strategy.	225	2,81	1,19
Our company plans to work on Industry 4.0 technologies in the long run.	225	3,60	1,25
While our company fulfills its processes, it benefits from technologies within the scope of Industry 4.0.	227	3,34	1,27

Table 7.14 (continued) : Participants' answers in the "Strategy and Organization" section.

Explanation	N	Mean	Std. Deviation
Our company is receiving guidance and consulting services for Industry 4.0 technologies.	225	2,30	1,34
We have employees who are receiving / studying graduate / doctorate degree in the field of Industry 4.0 in our company.	220	2,61	1,52
Technologies within Industry 4.0 are among the solutions / products we offer to our customers.	226	3,41	1,27
Our services / products are adaptable to customer preferences.	223	4,13	1,00
We have employees with digital skills in our company	225	4,25	0,95
We have employees with analytical skills in our company	223	4,39	0,85
In our different departments, there are employees who produce innovative projects within the scope of Industry 4.0.	224	3,46	1,33
Our Company has a dedicated team that only produces innovative projects within the scope of Industry 4.0.	225	2,67	1,48
Our company has an organizational structure based on data.	226	3,11	1,39
Our company allocates resources to digital business models.	225	3,52	1,17
Our existing products / services are compatible with innovative digital business models.	223	3,72	1,27
Our company has the knowledge to unite Industry 4.0 initiatives in a common framework.	227	3,42	1,22
Our company provides guidance / consulting services for Industry 4.0 technologies.	227	2,49	1,47
Our company is pursuing technological developments at the national and international level regarding Industry 4.0.	226	3,59	1,20
Our company provides training on digital transformation.	225	2,38	1,40
Our company participates in events such as seminars, conferences organized in relation to digital transformation.	226	3,23	1,36

As can be seen in Table 7.14, technopark companies have a low average in terms of training or organizing under Industry 4.0. However, it also has a high average in terms of the adaptability of its products and their employee skills.

7.1.4 Industry 4.0 technologies

Participants were asked which of the technologies in Industry 4.0 were offered to their customers. These technologies are; sensor technology, big data, robot and automation, horizontal / vertical system integration, cyber security, cloud computing, augmented reality technology, additive manufacturing, internet of things, machine learning and

artificial intelligence, simulation and virtual reality. From the answers given by the participants;

- 1 represents "0-4" project
- 2 represents "5-9" projects
- 3 represents "10-14" projects
- 4 represents "+15" projects

Participants' response to sensor technology is given in Table 7.15.

Table 7.15 : Responses for sensor technology.

Number of Project	Frequency	Percent
0-4	91	39,4
5-9	29	12,6
10-14	11	4,8
+15	4	1,7

Participants' response to robot and automation is given in Table 7.16.

Table 7.16 : Responses for robot and automation.

Number of Project	Frequency	Percent
0-4	65	28,1
5-9	17	7,4
10-14	10	4,3
+15	9	3,9

Participants' response to big data is given in Table 7.17.

Table 7.17 : Responses for big data.

Number of Project	Frequency	Percent
0-4	93	40,3
5-9	37	16,0
10-14	15	6,5
+15	5	2,2

Participants' response to cyber security is given in Table 7.18.

Table 7.18 : Responses for cyber security.

Number of Project	Frequency	Percent
0-4	71	30,7
5-9	21	9,1
10-14	12	5,2
+15	4	1,7

Participants' response to horizontal / vertical system integration is given in Table 7.19.

Table 7.19 : Responses for horizontal / vertical system integration.

Number of Project	Frequency	Percent
0-4	61	26,4
5-9	22	9,5
10-14	10	4,3
+15	4	1,7

Participants' response to cloud computing is given in Table 7.20.

Table 7.20 : Responses for cloud computing.

Number of Project	Frequency	Percent
0-4	74	32,0
5-9	28	12,1
10-14	20	8,7
+15	12	5,2

Participants' response to augmented reality technology is given in Table 7.21.

Table 7.21 : Responses for augmented reality technology.

Number of Project	Frequency	Percent
0-4	71	30,7
5-9	17	7,4
10-14	8	3,5
+15	2	0,9

Participants' response to additive manufacturing is given in Table 7.22.

Table 7.22 : Responses for additive manufacturing.

Number of Project	Frequency	Percent
0-4	66	28,6
5-9	7	3,0
10-14	5	2,2
+15	4	1,7

Participants' response to internet of things is given in Table 7.23.

Table 7.23 : Responses for internet of things.

Number of Project	Frequency	Percent
0-4	79	34,2
5-9	21	9,1
10-14	12	5,2
+15	9	3,9

Participants' response to machine learning and artificial intelligence is given in Table 7.23.

Table 7.24 : Responses for machine learning and artificial intelligence.

Number of Project	Frequency	Percent
0-4	82	35,5
5-9	21	9,1
10-14	5	2,2
+15	3	1,3

Participants' response simulation is given in Table 7.25.

Table 7.25 : Responses for simulation.

Number of Project	Frequency	Percent
0-4	74	32,0
5-9	11	4,8
10-14	7	3,0
+15	4	1,7

Participants' response virtual reality is given in Table 7.26.

Table 7.26 : Responses for virtual reality.

Number of Project	Frequency	Percent
0-4	75	32,5
5-9	13	5,6
10-14	4	1,7
+15	3	1,3

It appears that most of the participants who answered this question, offered their solutions which are related to these technologies is in the range of 0-4 predominantly.

Participants were also asked whether they directly contributed to the development of these technologies. The answers are given in Table 7.27. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very intense”

Table 7.27 : Participants' answers about contribution.

Technology	N	Mean	Std. Deviation
Sensor Technology	163	2,34	1,37
Big Data	171	2,77	1,33
Robot and Automation	140	2,23	1,42
Horizontal / Vertical System Integration	132	2,11	1,28
Cyber Security	142	2,18	1,36
Cloud Computing	164	2,84	1,44
Augmented Reality Technology	144	2,00	1,31
Additive Manufacturing	130	1,75	1,22
Internet of Things	158	2,45	1,43
Machine Learning and Artificial Intelligence	154	2,33	1,39
Simulation	135	1,82	1,26
Virtual Reality	141	1,83	1,27

As shown in Table 7.27, it belongs to additive manufacturing technology had least average with 1.75. However, cloud computing had the most average with 2.84. In addition to this, participants have also been asked about Industry 4.0 technologies that they are planning to contribute in the future. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very intense”. The answers are given in Table 7.28.

Table 7.28 : Participants' answers about contribution in the future.

Technology	N	Mean	Std. Deviation
Sensor Technology	154	3,27	1,60
Big Data	172	3,86	1,37
Robot and Automation	137	3,13	1,62
Horizontal / Vertical System Integration	124	2,83	1,60
Cyber Security	135	3,14	1,64
Cloud Computing	166	3,85	1,42
Augmented Reality Technology	131	2,85	1,67
Additive Manufacturing	115	2,34	1,57
Internet of Things	157	3,48	1,57
Machine Learning and Artificial Intelligence	154	3,64	1,53
Simulation	126	2,57	1,64
Virtual Reality	132	2,68	1,64

As seen in Table 7.28, the technology is “big data”, which had the highest average of the technologies with 3,86 that the participants plan to work on in the future. On the other hand, “simulation” had the least average with the value of 2,57.

7.1.5 Collaboration

In this part, participants were asked which institutions and organizations they are working within the scope of Industry 4.0 activities. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very often”. The answers are given in Table 7.29.

Table 7.29 : Participants' answers about collaboration.

Technology	N	Mean	Std. Deviation
Universities	211	2,77	1,44
Other academic institutions	191	2,33	1,37
Technology transfer offices	196	2,60	1,42
Economic development institutions	199	2,81	1,43
Other companies in technopark	203	2,68	1,35
Suppliers	198	2,73	1,41
Customers	210	3,50	1,38
Employee	204	3,32	1,37
Competitors	191	2,13	1,26
Consulting companies	192	2,21	1,34

As seen in Table 7.29, “customers” had the highest average with the value of 3,50 from the institutions that the participating companies cooperate with. At least average was owned by “competitors” with the value of 2,13.

7.1.6 Application area

In this section participants were asked which application area that they would like to present their solution and its degree, within the scope of Industry 4.0. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very intense”. The answers are given in Table 7.30.

Table 7.30 : Participants' answers about application area.

Application Area	N	Mean	Std. Deviation
Production	176	2,52	1,50
Purchase	163	2,07	1,33
Logistics	169	2,04	1,37
Sales	169	2,43	1,49
Finance/Accounting	169	2,13	1,44
Service	179	2,66	1,53
Information technologies	192	3,41	1,52
After sales service	172	2,63	1,55
Human resources	166	1,98	1,34
R&D	190	3,28	1,46

As seen in Table 7.30, according to the participants, “information technology” had the highest average mean of the areas in which they offer Industry 4.0 products with the value of 3,41. In addition, according to the participants “human resources” had the least average mean of the areas in which they offered Industry 4.0 products with the value of 1,98

7.1.7 Employee skills

Participants were asked how their employees assessed their skills when they considered Industry 4.0 requirements. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “very weak” and 5 represents “very strong”. The answers are given in Table 7.31.

Table 7.31 : Participants' answers about employee skills.

Skills	N	Mean	Std. Deviation
In terms of infrastructures of information technologies	216	3,94	1,10
In terms of automation technology	206	3,29	1,33
In terms of data analysis	214	3,58	1,22
In terms of data security / communication	213	3,49	1,23
In terms of developing or implementation of auxiliary systems	208	3,73	1,13
In terms of software development	216	4,22	1,11
In terms of systematic thinking and process understanding	214	4,07	1,09

As shown in Table 7.31, the highest average of employee skills was “software development” with the value of 4,22. Besides, automation technology had the lowest average means with the value of 3,29.

7.1.8 Employee competence

Participants were asked how their employees assessed their competence when they considered Industry 4.0 requirements. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “very weak” and 5 represents “very strong”. The answers are given in Table 7.32.

Table 7.32 : Participants' answers about employee competence.

Skills	N	Mean	Std. Deviation
Problem solving	218	4,22	0,84
Critical thinking	218	4,04	0,86
Creativity	217	4,06	0,89
Coordination with others	221	4,14	0,91
Emotional intelligence	219	3,71	0,98
Decision making	219	3,96	0,88
Service-oriented	218	4,14	0,84
Cognitive flexibility	216	3,93	0,96
Resource management competence	216	3,90	0,96

As shown in Table 7.32, the highest average of employee competence was “problem solving” with the value of 4,22. Besides, “emotional intelligence” had the lowest average means with the value of 3,71.

7.1.9 Challenges

Participants in this section were asked about the difficulties that they encountered while developing technologies related to Industry 4.0. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very often”. The answers are given in Table 7.33.

Table 7.33 : Participants' answers about challenges.

Challenges	N	Mean	Std. Deviation
High employee turnover rate	208	2,87	1,25
Reluctance to share information between employees	212	2,22	1,14
Inability to work with current workforce	209	2,54	1,16
Resistance of employees to change and innovation	209	2,32	1,11
Difficulty finding workforce in accordance with requirements	208	3,12	1,26
Lack of information about digital technologies	211	2,75	1,13
Data security risks	206	2,88	1,17
Difficulty and inadequacy in finding advanced technology buyers	210	3,12	1,17
Unable to provide up-to-date and reliable data from horizontal integration customers and suppliers	206	2,81	1,09
Risk of not working developed technology as planned	209	2,66	0,99
Risk of unforeseen costs	211	3,10	1,02
Risks of management approaching negatively developed technology	209	2,41	1,22
Risk of customers find technology investment costs very high	211	3,27	1,15
Risk of customers and users not finding or accepting the system profitable	210	3,02	1,10
The risk that systems cannot integrate with existing technologies and systems	206	2,65	1,13
Standardization problem among all other industries	208	2,93	1,17
Difficulties in the commercialization of products	207	3,15	1,15
Inadequate financial support and funds for technopark companies	209	3,15	1,27
Failure to benefit from the academic environment	209	2,94	1,25
Inadequate financial support and funding sources	207	3,30	1,21
Weakness of the support services given to technopark (technical support, administrative support, training support, etc.)	206	2,95	1,23
Lack of the companies that are working on the Industry 4.0 in the technopark	206	3,07	1,19
Ineffective technopark management	205	2,76	1,26
The complexity of the intellectual property rights, the fear of infringement	203	2,77	1,19
Lack of the companies that are working on the Industry 4.0 in the technopark	206	3,07	1,19
Inadequate financial support and funds for technopark companies	209	3,15	1,27
Failure to benefit from the academic environment	209	2,94	1,25
Inadequate financial support and funding sources	207	3,30	1,21
Weakness of the support services given to technopark (technical support, administrative support, training support, etc.)	206	2,95	1,23
Lack of the companies that are working on the Industry 4.0 in the technopark	206	3,07	1,19
Ineffective technopark management	205	2,76	1,26
The complexity of the intellectual property rights, the fear of infringement	203	2,77	1,19

As seen in Table 7.33, according to the participants the highest average mean of the difficulties that they faced when developing Industry 4.0 technologies was “inadequate financial support and funding sources” with the value of 3,30. However, “lack of information sharing among employees” had the least average mean with the value of 2,22.

7.1.10 Opportunities

In this part, participants were asked about the importance of opportunities when developing Industry 4.0 technology. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “unimportant” and 5 represents “very important”. The answers are given in Table 7.34.

Table 7.34 : Participants' answers about opportunities (importance level).

Opportunities	N	Mean	Std. Deviation
International business association	204	3,97	1,16
University-Industry business association	205	4,10	1,15
Support of national development agencies	205	4,03	1,11
Support of non-governmental organizations such as TÜSİAD	200	3,85	1,09
Meetings, meeting tea, fair events	204	3,61	1,17
Scientific activities like symposium, conference	203	3,93	1,03
Technology transfer offices	202	3,85	1,17
Advantages of technopark	205	4,16	0,95
Business association with companies in technopark	202	3,98	1,04
Technopark's physical facilities such as library, computer laboratories etc.	203	3,48	1,33
The university, academic consulting, information accumulation facilities provided by technopark	205	3,84	1,12

As seen in Table 7.34, according to the participants' responses the highest average mean of the opportunity's importance level when developing Industry 4.0 technologies was the “advantages offered by the technopark” with the value of 4,16.

Participants in this section were also asked about the opportunities that they benefit while developing technologies related to Industry 4.0. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very intense”. The answers are given in Table 7.35.

Table 7.35 : Participants' answers about opportunities (benefit level).

Opportunities	N	Mean	Std. Deviation
International business association	203	2,60	1,35
University-Industry business association	205	2,72	1,33
Support of national development agencies	202	2,49	1,25
Support of non-governmental organizations such as TUSIAD	201	2,21	1,27
Meetings, meeting tea, fair events	202	2,88	1,26
Scientific activities like symposium, conference	204	2,98	1,21
Technology transfer offices	202	2,61	1,35
Advantages of technopark	207	3,26	1,23
Business association with companies in technopark	200	2,71	1,32
Technopark's physical facilities such as library, computer laboratories etc.	201	2,22	1,40
The university, academic consulting, information accumulation facilities provided by technopark	201	2,43	1,35

As seen in Table 7.34, according to the participants' responses the highest average mean of the opportunity that they benefit when developing Industry 4.0 technologies was the "advantages offered by the technopark" with the value of 3,26.

7.1.11 Expectations of customers

In this part, participants were asked about the customer expectations regarding Industry 4.0 technology. In this session questions were asked to respondents on 5-Likert Scale where 1 represent "unimportant" and 5 represents "very important". The answers are given in Table 7.36.

Table 7.36 : Participants' answers about customer expectations.

Expectations	N	Mean	Std. Deviation
To reduce costs	197	4,14	1,00
To provide flexibility in production and increase it	195	3,97	1,05
To increase productivity in production	195	4,11	1,10
To increase resource efficiency	194	4,17	0,94
To shorten the period of product / service development and market presentation	194	4,01	1,13
To develop new products / services	195	4,03	1,13
To improve the quality of the products / services offered	193	4,24	0,95
To increase the effectiveness of processes	194	4,15	0,95
To raise the quality of life of employees	197	3,60	1,29
To increase the competitive advantage	195	4,15	1,02
To develop the customer base	194	4,13	1,04
To increase sales	195	4,16	1,12
To increase profitability	194	4,28	0,99
To increase market share	190	4,20	0,97
To create and develop company image	191	4,08	1,02

As seen in Table 7.36, according to the participants' responses the highest average mean of the customer expectation regarding Industry 4.0 technologies was the “to increase profitability” with the value of 4,20.

In this section, the achievements of participants' customer expectations were also asked. In this session, questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very intense”. The answers are given in Table 7.37.

Table 7.37 : Participants' answers about customer expectations (success level).

Expectations	N	Mean	Std. Deviation
To reduce costs	193	3,36	1,07
To provide flexibility in production and increase it	188	3,38	1,14
To increase productivity in production	188	3,51	1,16
To increase resource efficiency	184	3,61	1,12
To shorten the period of product / service development and market presentation	190	3,33	1,18
To develop new products / services	191	3,50	1,09
To improve the quality of the products / services offered	186	3,77	1,09
To increase the effectiveness of processes	187	3,69	1,10
To raise the quality of life of employees	187	3,25	1,22
To increase the competitive advantage	188	3,60	1,08
To develop the customer base	187	3,55	1,16
To increase sales	190	3,53	1,17
To increase profitability	190	3,60	1,12
To increase market share	186	3,50	1,12
To create and develop company image	188	3,65	1,12

As seen in Table 7.37, according to the participants' responses from the customer expectations, the highest success level average mean regarding Industry 4.0 technologies was “to improve the quality of the products / services offered” with the value of 3,77.

7.1.12 Expectations of technopark companies

In this part, participants were asked about the expectations when developing Industry 4.0 technology. In this session questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very intense”. The answers are given in Table 7.38.

Table 7.38 : Participants' answers about expectations

Expectations	N	Mean	Std. Deviation
To increase the competitive advantage	203	4,20	0,88
To develop the customer base	203	4,33	0,84
To increase profitability	202	4,43	0,80
Increase sales	202	4,39	0,86
Increase market share	202	4,44	0,79
Creating and developing company image	201	4,38	0,82
To create and develop innovation	204	4,43	0,85
Establish new partnerships	203	3,61	1,31
Creating new business opportunities	203	4,14	0,97
To gain funds from support organizations	200	3,76	1,24

As seen in Table 7.38, according to the participants' responses the highest average mean of the expectation when developing Industry 4.0 technologies was the “to increase market share” with the value of 4,44.

In this section, the achievements of participants' expectations were asked. In this session, questions were asked to respondents on 5-Likert Scale where 1 represent “never” and 5 represents “very intense”. The answers are given in Table 7.39.

Table 7.39 : Participants' answers about expectations (success level).

Expectations	N	Mean	Std. Deviation
To increase the competitive advantage	206	3,37	1,06
To develop the customer base	204	3,29	1,06
To increase profitability	205	3,26	1,12
Increase sales	203	3,22	1,11
Increase market share	204	3,21	1,11
Creating and developing company image	205	3,44	1,12
To create and develop innovation	206	3,50	1,06
Establish new partnerships	204	2,63	1,30
Creating new business opportunities	203	3,15	1,12
To gain funds from support organizations	200	2,73	1,27

As seen in Table 7.39, according to the participants' responses from the expectations that had the highest success level average mean when developing Industry 4.0 technologies was “creating and developing company image” with the value of 3,26.

7.2 Factor Analysis, Reliability Test and Correlation

Factor analysis is the most important analysis to reveal the quality and validity of measurement in social sciences. The main objective of factor analysis is dimension reduction [54]. Factor analysis can be defined as a highly variable statistic aiming to find fewer, more conceptually meaningful new variables (factors, dimensions) by putting together a multitude of correlated variables [55].

In factor analysis, firstly data should be tested for suitability for factor analysis. One of these tests is the measurement of Kaiser-Meyer-Olkin Sampling Adequacy and the other is the Bartlett test.

Kaiser-Meyer-Olkin (KMO) and Bartlett's Test are tests that measure the power of the relationship between variables [56]. Bartlett's test tests H_0 . Bartlett's test should be $\text{sig} < 0.05$. If sig. below the 0.5, H_0 is rejected, that means that the correlation matrix is not an identical matrix.

In Kaiser-Meyer-Olkin test the KMO value should be minimum 0,6 [57]. The interpretation guide proposed by Kaiser, Meyer and Olkin is given in Table 7.40 [58].

Table 7.40 : The interpretation guide for KMO values [58].

KMO Value	Explanation
0,90 to 1,00	Marvelous
0,80 to 0,89	Meritorious
0,70 to 0,79	Middling
0,60 to 0,69	Mediocre
0,00 to 0,49	Don't Factor

In factor analysis factor loading of each element should be greater than 0,32 [59]. In addition, communalities for each element should have value greater than 0,30. This is a sign of satisfactory quality of the evaluation.

In this section, factor analysis had performed on all questions. Kaiser-Meyer-Olkin (KMO) and Bartlett's Test were applied, and variables were reduced in a single factor. Cronbach's alpha coefficient method was also used for reliability. This method is used for measurement reliability estimation [56]. For this value 0,7 is acceptable reliability coefficient [60].

Apart from these, in this part the correlation between all factors also had analyzed. Correlation is a statistical method that explains the degree of relationship and whether

the relationship between equal and more than two variables is negative or positive. The correlation coefficient varies between 1.00 and -1.00. Table 7.41 represents an interpretation guideline about correlation coefficients [61].

Table 7.41 : The interpretation guide for correlation coefficient values [61].

Correlation Coefficient	Explanation
0,90 to 1,00 (-0,90 to -1,00)	Very high positive (negative)
0,70 to 0,90 (-0,70 to -0,90)	High positive (negative) correlation
0,50 to 0,70 (-0,50 to -0,70)	Moderate positive (negative) correlation
0,30 to 0,50 (-0,30 to -0,50)	Low positive (negative) correlation
0,00 to 0,30 (-0,00 to -0,30)	Negligible correlation

7.2.1 Analysis for the part of overview of Industry 4.0

Participants were asked 23 questions in this section. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett's tests was given Table 7.42. If KMO value is high, each of the variables can be predicted by others in the scale. Scale's KMO value is 0,878.

In addition, Bartlett's Test of Sphericity is significant ($p < 0.0005$). Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50. These are enough to use the factor analysis. Also, the sample size is sufficient for analysis.

Table 7.42 : Results of KMO and Bartlett's Test of overview of Industry 4.0 part.

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	,878
Bartlett's Test of Sphericity	Approx. Chi-Square
	3583,792
	Df
	231
	Sig
	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0,878 and $0,878 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 3583,792 and degree of freedom is 231. So, it is significant ($p = 0,000$, $p < 0.05$).

The results of the factor analysis are given in Table 7.43.

Table 7.43 : Components and factor loadings of overview of Industry 4.0 part.

Factors	Factor Loading	Communality
Factor 1: Awareness about organizational impact		
I have information about Industry 4.0	0,851	0,813
I have information about Industry 4.0 technologies	0,842	0,761
Top management is aware of Industry 4.0	0,820	0,730
All our organization has information about Industry 4.0	0,863	0,773
Our company has information about the Industry 4.0 platform	0,889	0,823
Our company knows how much Industry 4.0 will affect the Industry we are in.	0,840	0,781
Our company understood the content of the Industry 4.0 concept much better than our competition	0,825	0,732
Developing products / services within the context of Industry 4.0 has great importance for the future of our business.	0,707	0,580
Factor 2: Awareness about competitiveness impact		
Digital transformation in the Industry will increase the competitiveness of companies	0,756	0,662
Digital transformation in the Industry will increase the international competitiveness of Turkey	0,773	0,630
Industry 4.0 will change the general market structure of the country.	0,779	0,707
Industry 4.0 will make it possible to gain more global market share	0,826	0,715
Industrial investment in 4.0 will provide the growth of Turkey's global market share in the long term.	0,833	0,736
Turkey's need to add more value to gain more share of the global market.	0,698	0,565
Industry 4.0 will provide employees with new jobs and increase employment	0,517	0,395
Factor 3: Awareness about environmental impact		
Industry 4.0 concept in Turkey are discussed enough by the government.	0,806	0,746
Industry 4.0 concept in Turkey are discussed enough by academics.	0,802	0,701
Industry 4.0 concept in Turkey are discussed enough by non-governmental organizations, trade unions and press.	0,854	0,772
Factor 4: Awareness about role of technopark and support		
Technopark has a vital role on the development and spread of Industry 4.0 in Turkey	0,728	0,663
Technoparks have a great importance in developing new products, services or technology.	0,719	0,674
Turkey supports to technopark companies which are aiming to develop technology, enough.	0,747	0,733
Turkey supports to technopark companies aiming to develop technology within the scope of Industry 4.0 enough.	0,733	0,741

As seen in Table 7.43, communalities for each item have value greater than 0,30. Also the variables were collected in 4 groups. First factor has eigenvalue 8,063, which explains 36,649 % of total dispersion and factor 1 represents awareness about organizational impact.

The second factor has eigenvalue 3,584, which explains 16,291 % of total dispersion and factor 2 represents awareness about competitiveness impact.

The third factor has eigenvalue 2,709, which explains 12,313 % of total dispersion and factor 3 represents awareness about environmental impact.

Finally, fourth factor has eigenvalue 1,076, which explains 4,893 % of total dispersion and factor 4 represents awareness about role of technopark and support. Also, the total percentage of explanation is 70,146.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.44 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.44 : Cronbach's alpha coefficients of overview of Industry 4.0 factors.

Factors	N	Cronbach's Alpha
Awareness about organizational impact	8	0,948
Awareness about competitiveness impact	7	0,883
Awareness about role of technopark and support	3	0,835
Awareness about environmental impact	4	0,792

As seen in Table 7.44, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.45 represents descriptive statistics of factors. The range of factors' mean varies between 3,33 and 4,33. Here, 5 implies "strongly agree" and 1 implies "strongly disagree".

Table 7.45 : Descriptive statistics of overview of Industry 4.0 factors.

Factors	N	Mean	Std. Deviation
Awareness about organizational impact	219	3,66	0,99
Awareness about competitiveness impact	224	4,23	0,72
Awareness about role of technopark and support	223	2,51	0,91
Awareness about environmental impact	226	3,33	0,85

As seen in Table 7.45, awareness about competitive impact has the highest mean however, awareness about role of technopark and support has the lowest mean.

The relationship between the factors is given in Table 7.46.

Table 7.46 : Correlation of overview of Industry 4.0 factors.

		Correlations			
		F1	F2	F3	F4
F1	Pearson Correlation	1	,462**	,216**	,269**
	Sig. (2-tailed)		0,000	0,001	0,000
	N	219	217	215	217
F2	Pearson Correlation	,462**	1	-0,043	,279**
	Sig. (2-tailed)	0,000		0,523	0,000
	N	217	224	220	222
F3	Pearson Correlation	,216**	-0,043	1	,481**
	Sig. (2-tailed)	0,001	0,523		0,000
	N	215	220	223	222
F4	Pearson Correlation	,269**	,279**	,481**	1
	Sig. (2-tailed)	0,000	0,000	0,000	
	N	217	222	222	226

** . Correlation is significant at the 0.01 level (2-tailed).

As seen in Table 7.46, there is a low positive correlation between awareness about organizational impact and awareness about competitiveness impact. Also, there is again low positive correlation between awareness about organizational impact and awareness about environmental impact. In addition, there is a low positive correlation between awareness about competitiveness impact and awareness about environmental impact. Finally, there is a low positive correlation between awareness about role of technopark and support and awareness about environmental impact.

7.2.2 Analysis for the part of strategy and organization

Participants were asked 21 questions in this section. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett's tests was given Table 7.47.

Table 7.47 : Results of KMO and Bartlett's Test of strategy and organization part.

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	,931
Bartlett's Test of Sphericity	Approx. Chi-Square
	3633,865
	Df
	210
	Sig
	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0, 931 and $0, 931 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 3633,865 and degree of freedom is 210. So, it is significant ($p=0,000$, $p<0.05$).

The results of the factor analysis are given in Table 7.48. Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50. These are enough to use the factor analysis. Also, the sample size is sufficient for analysis.

Table 7.48 : Components and factor loadings of strategy and organization part.

Factors	Factor Loading	Communality
Factor 1: Strategy and policy		
Within the scope of Industry 4.0, we have goals and objectives as a company.	0,834	0,804
As a company, we have our roadmap and strategies under the scope of Industry 4.0.	0,818	0,823
Our company uses indicators to monitor the implementation status of our Industry 4.0 strategy.	0,721	0,709
Our company plans to work on Industry 4.0 technologies in the long run.	0,734	0,716
While our company fulfills its processes, it benefits from technologies within the scope of Industry 4.0.	0,748	0,728
Technologies within Industry 4.0 are among the solutions / products we offer to our customers.	0,733	0,735
In our different departments, there are employees who produce innovative projects within the scope of Industry 4.0.	0,708	0,694
Our Company has a dedicated team that only produces innovative projects within the scope of Industry 4.0.	0,637	0,637
Our company is pursuing technological developments at the national and international level regarding Industry 4.0.	0,637	0,677
Factor 2: Product, services and workforce infrastructure		
Our company has an organizational structure based on data.	0,779	0,677
Our company allocates resources to digital business models.	0,629	0,748
Our existing products / services are compatible with innovative digital business models.	0,456	0,762
Our company has the knowledge to unite Industry 4.0 initiatives in a common framework.	0,546	0,666
Our company provides guidance / consulting services for Industry 4.0 technologies.	0,681	0,631
Our company provides training on digital transformation.	0,756	0,659
Our company participates in events such as seminars, conferences organized in relation to digital transformation.	0,548	0,628
Our company is receiving guidance and consulting services for Industry 4.0 technologies.	0,673	0,599
We have employees who are receiving / studying graduate / doctorate degree in the field of Industry 4.0 in our company.	0,602	0,577
Factor 3: Infrastructure for digitalization		
Our services / products are adaptable to customer preferences.	0,705	0,602
We have employees with digital skills in our company	0,890	0,828
We have employees with analytical skills in our company	0,839	0,763

As seen in Table 7.48, communalities for each item have value greater than 0,30. Also the variables were collected in 3 groups. First factor has eigenvalue 10,815, which explains 51,501 % of total dispersion and factor 1 represents strategy and policy.

The second factor has eigenvalue 2,573, which explains 12,250 % of total dispersion and factor 2 represents product, services and workforce infrastructure.

The third factor has eigenvalue 1,275, which explains 6,070 % of total dispersion and factor 3 represents infrastructure for digitalization. Also, the total percentage of explanation is 69,822.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.49 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.49 : Cronbach's alpha coefficients of strategy and organization.

Factors	N	Cronbach's Alpha
Strategy and policy	9	0,949
Product, services and workforce infrastructure	9	0,900
Infrastructure for digitalization	3	0,868

As seen in Table 7.49, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.50 represents descriptive statistics of factors. The range of factors' mean varies between 3,28 and 4,26. Here, 5 implies "strongly agree" and 1 implies "strongly disagree".

Table 7.50 : Descriptive statistics of strategy and organization.

Factors	N	Mean	Std. Deviation
Strategy and policy	219	3,28	1,07
Product, services and workforce infrastructure	221	3,57	0,57
Infrastructure for digitalization	220	4,26	0,83

As seen in Table 7.50, infrastructure for digitalization has the highest mean however, strategy and policy have the lowest mean.

The relationship between the factors is given in Table 7.51.

Table 7.51 : Correlation of overview of strategy and organization.

		Correlations		
		F1	F2	F3
F1	Pearson Correlation	1	,483**	,455**
	Sig. (2-tailed)		0,000	0,000
	N	219	212	215
F2	Pearson Correlation	,483**	1	,374**
	Sig. (2-tailed)	0,000		0,000
	N	212	221	214
F3	Pearson Correlation	,455**	,374**	1
	Sig. (2-tailed)	0,000	0,000	

** . Correlation is significant at the 0.01 level (2-tailed).

As seen in Table 7.51, there is a low positive correlation between strategy and policy and product, services and workforce infrastructure. Also, there is again low positive correlation between strategy and policy and infrastructure for digitalization. In addition, there is a low positive correlation between infrastructure for digitalization and product, services and workforce infrastructure.

7.2.3 Analysis for the technologies of Industry 4.0

In this section, participants were asked about the level of Industry 4.0 technologies that they were working on. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett's tests was given Table 7.52.

Table 7.52 : Results of KMO and Bartlett's test of technologies of Industry 4.0.

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	,858
Bartlett's Test of Sphericity	Approx. Chi-Square
	610,751
	Df
	66
	Sig
	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0, 858 and $0, 858 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 610,751 and degree of freedom is 66. So, it is significant ($p=0,000$, $p<0.05$).

The results of the factor analysis are given in Table 7.53. Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50. These are enough to use the factor analysis. Also, the sample size is sufficient for analysis.

Table 7.53 : Components and factor loadings of technologies of Industry 4.0.

Factors	Factor Loading	Communality
Factor 1: Digital manufacturing systems technologies		
Sensor Technology	0,618	0,804
Robot and Automation	0,822	0,724
Horizontal / Vertical System Integration	0,731	0,680
Additive Manufacturing	0,601	0,681
Internet of Things	0,616	0,539
Factor 2: Virtualization technologies		
Augmented Reality Technology	0,790	0,803
Simulation	0,784	0,739
Virtual Reality	0,843	0,807
Factor 3: Data management technologies		
Big Data	0,758	0,643
Cyber Security	0,639	0,710
Cloud Computing	0,734	0,575
Machine Learning and Artificial Intelligence	0,598	0,539

As seen in Table 7.53, communalities for each item have value greater than 0,30. Also the variables were collected in 3 groups. First factor has eigenvalue 4,420, which explains 45,166 % of total dispersion and factor 1 represents digital manufacturing systems technologies. The second factor has eigenvalue 1,455, which explains 12,123 % of total dispersion and factor 2 represents virtualization technologies. The third factor has eigenvalue 1,174, which explains 9,780 % of total dispersion and factor 3 represents data management technologies. Also, the total percentage of explanation is 67,069.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.54 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.54 : Cronbach's alpha coefficients of technologies of Industry 4.0.

Factors	N	Cronbach's Alpha
Digital manufacturing systems technologies	5	0,814
Virtualization technologies	3	0,886
Data management technologies	4	0,767

As seen in Table 7.54, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.55 represents descriptive statistics of factors. The range of factors' mean varies between 1,91 and 2,32. Here, 5 implies "very intense" and 1 implies "never".

Table 7.55 : Descriptive statistics of technologies of Industry 4.0.

Factors	N	Mean	Std. Deviation
Digital manufacturing systems technologies	117	1,91	0,93
Virtualization technologies	124	1,79	1,09
Data management technologies	122	2,32	1,05

The relationship between the factors is given in Table 7.56.

Table 7.56 : Correlation of overview of technologies of Industry 4.0.

		Correlations		
		F1	F2	F3
F1	Pearson Correlation	1	,621**	,535**
	Sig. (2-tailed)		0,000	0,000
	N	117	111	113
F2	Pearson Correlation	,621**	1	,523**
	Sig. (2-tailed)	0,000		0,000
	N	111	124	112
F3	Pearson Correlation	,535**	,523**	1
	Sig. (2-tailed)	0,000	0,000	

** . Correlation is significant at the 0.01 level (2-tailed).

As seen in Table 7.56, there is a moderate positive correlation between digital manufacturing systems technologies and virtualization technologies. Also, there is again moderate positive correlation between first and third group technologies. In addition, there is a moderate positive correlation between digital manufacturing systems technologies and data management technologies.

7.2.4 Analysis for the collaboration

In this section, participants were asked about the collaboration. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett's tests was given Table 7.57.

Table 7.57 : Results of KMO and Bartlett's test of collaboration.

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	,855
Bartlett's Test of Sphericity	Approx. Chi-Square
	1054,028
	Df
	45
	Sig
	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0, 855 and $0, 855 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 1054,028 and degree of freedom is 45. So, it is significant ($p=0,000$, $p<0.05$).

The results of the factor analysis are given in Table 7.58. Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50. These are enough to use the factor analysis. Also, the sample size is sufficient for analysis.

Table 7.58 : Components, factor loadings and alpha coefficients of collaboration.

Factors	Factor Loading	Communality
Factor 1: External shareholders		
Universities	0,745	0,628
Other academic institutions	0,860	0,762
Technology transfer offices	0,844	0,737
Economic development institutions	0,776	0,638
Other companies in technopark	0,685	0,617
Competitors	0,650	0,629
Consulting companies	0,644	0,579
Factor 2: Internal shareholders		
Suppliers	0,666	0,631
Customers	0,891	0,817
Employee	0,878	0,819

As seen in Table 7.58, communalities for each item have value greater than 0,30. Also the variables were collected in 2 groups. First factor has eigenvalue 5,606, which explains 56,062 % of total dispersion and factor 1 represents external shareholders.

The second factor has eigenvalue 1,250, which explains 12,503 % of total dispersion and factor 2 represents internal shareholders. Also, the total percentage of explanation is 68,566.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.58 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.58 (continued) : Components, factor loadings and alpha coefficients of collaboration.

Factors	N	Cronbach's Alpha
External shareholders	7	0,904
Internal shareholders	3	0,833

As seen in Table 7.58, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.59 represents descriptive statistics of factors. Here, 5 implies "very intense" and 1 implies "never".

Table 7.59 : Descriptive statistics of collaboration.

Factors	N	Mean	Std. Deviation
External shareholders	189	3,14	1,21
Internal shareholders	174	2,42	1,09

The relationship between the factors is given in Table 7.60.

Table 7.60 : Correlation of collaboration.

		Correlations	
		F1	F2
F1	Pearson Correlation	1	,609**
	Sig. (2-tailed)		0,000
	N	189	171
F2	Pearson Correlation	,609**	1
	Sig. (2-tailed)	0,000	
	**. Correlation is significant at the 0.01 level (2-tailed).		

As seen in Table 7.60, there is a moderate positive correlation between external and internal shareholders.

7.2.5 Analysis for the challenges

In this section, participants were asked about challenges. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett's tests was given Table 7.61.

Table 7.61 : Results of KMO and Bartlett's test of challenges.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,871
Bartlett's Test of Sphericity	Approx. Chi-Square	2240,646
	Df	210
	Sig.	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0, 871 and $0,871 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 2240,646 and degree of freedom is 210. So, it is significant ($p=0,000$, $p<0.05$).

The results of the factor analysis are given in Table 7.62. Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50. These are enough to use the factor analysis. Also, the sample size is sufficient for analysis.

Table 7.62 : Components and factor loadings of challenges.

Factors	Factor Loading	Communality
Factor 1: Workforce challenges		
High employee turnover rate	0,581	0,426
Reluctance to share information between employees	0,822	0,729
Inability to work with current workforce	0,767	0,689
Resistance of employees to change and innovation	0,741	0,637
Difficulty finding workforce in accordance with requirements	0,620	0,715
Lack of information about digital technologies	0,705	0,616
Data security risks	0,667	0,536
Factor 2: Inadequate support		
Inadequate financial support and funds for technopark companies	0,672	0,593
Failure to benefit from the academic environment	0,645	0,771
Inadequate financial support and funding sources	0,747	0,718
Weakness of the support services given to technopark (technical support, administrative support, training support, etc.)	0,780	0,619
Lack of the companies that are working on the Industry 4.0 in the technopark	0,680	0,702
Ineffective technopark management	0,761	0,616
Factor 3: Commercial problems		
Difficulty and inadequacy in finding advanced technology buyers	0,619	0,512
Risk of customers find technology investment costs very high	0,695	0,513
Risk of customers and users not finding or accepting the system profitable	0,698	0,735
Difficulties in the commercialization of products	0,709	0,685
Factor 4: Technology-oriented problems		
Risk of not working developed technology as planned	0,636	0,608
The risk that systems cannot integrate with existing technologies and systems	0,759	0,735
Standardization problem among all other industries	0,700	0,685

As seen in Table 7.62, communalities for each item have value greater than 0,30. Also the variables were collected in 4 groups. Since the factor loads of questions 9.1 and 9.12 in this section was low, the analysis had not included them. First factor has eigenvalue 8,405, which explains 40,025 % of total dispersion and factor 1 represents workforce challenges.

The second factor has eigenvalue 2,235, which explains 10,643 % of total dispersion and factor 2 represents inadequate support.

The third factor has eigenvalue 1,508, which explains 7,180 % of total dispersion and factor 2 represents commercial problems. The fourth factor has eigenvalue 1,552, which explains 5,483 % of total dispersion and factor 2 represents technology-oriented problems. Also, the total percentage of explanation is 63,332.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.63 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.63 : Cronbach's alpha coefficients of challenges.

Factors	N	Cronbach's Alpha
Workforce challenges	7	0,867
Commercial problems	4	0,817
Inadequate support	6	0,873
Technology-oriented problems	4	0,801

As seen in Table 7.63, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.64 represents descriptive statistics of factors. Here, 5 implies "very often" and 1 implies "never".

Table 7.64 : Descriptive statistics of challenges.

Factors	N	Mean	Std. Deviation
Workforce challenges	198	2,66	0,87
Commercial problems	205	3,13	0,92
Inadequate support	200	3,02	0,96
Technology-oriented problems	204	3,82	0,95

As seen in Table 7.64, technology-oriented problems have the highest mean however, workforce challenges have the lowest mean. The relationship between the factors is given in Table 7.65.

Table 7.65 : Correlation of overview of challenges.

		Correlations			
		F1	F2	F3	F4
F1	Pearson Correlation	1	,498**	,480**	,561**
	Sig. (2-tailed)		0,000	0,000	0,000
	N	198	194	189	194
F2	Pearson Correlation	,498**	1	,602**	,635**
	Sig. (2-tailed)	0,000		0,000	0,000
	N	194	205	198	203
F3	Pearson Correlation	,480**	,602**	1	,528**
	Sig. (2-tailed)	0,000	0,000		0,000
	N	189	198	200	198
F4	Pearson Correlation	,561**	,635**	,528**	1
	Sig. (2-tailed)	0,000	0,000	0,000	
	N	194	203	198	204

** . Correlation is significant at the 0.01 level (2-tailed).

As seen in Table 7.65, there is a low positive correlation between workforce challenges and commercial problems and Inadequate support. Also, there is moderate positive correlation between workforce challenges and technology-oriented problems. In addition, there is moderate correlation between commercial problems and inadequate support and technology-oriented problems. Finally, there is low correlation between inadequate support and technology-oriented problems.

7.2.6 Analysis for the opportunities

In this section, participants were asked about opportunities. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett's tests was given Table 7.66.

Table 7.66 : Results of KMO and Bartlett's test of opportunities.

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	,909
Bartlett's Test of Sphericity	Approx. Chi-Square
	1246,732
	Df
	55
	Sig
	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0, 909 and $0,909 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 1246,732 and degree of freedom is 55. So, it is significant ($p=0,000$, $p<0.05$).

The results of the factor analysis are given in Table 7.67. Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50. These are enough to use the factor analysis. Also, the sample size is sufficient for analysis.

Table 7.67 : Components and factor loadings of opportunities.

Factors	Factor Loading	Communality
Factor 1: Indirect relations		
Meetings, meeting tea, fair events	0,691	0,617
Scientific activities like symposium, conference	0,678	0,662
Technology transfer offices	0,629	0,645
Advantages of technopark	0,711	0,613
Business association with companies in technopark	0,671	0,563
Technopark's physical facilities such as library, computer laboratories etc.	0,862	0,746
The university, academic consulting, information accumulation facilities provided by technopark	0,593	0,554
Factor 2: Direct relations		
International business association	0,806	0,688
University-Industry business association	0,814	0,712
Support of national development agencies	0,769	0,752
Support of non-governmental organizations such as TÜSİAD	0,706	0,686

As seen in Table 7.67, communalities for each item have value greater than 0,30. Also the variables were collected in 2 groups. First factor has eigenvalue 6,224, which explains 56,579 % of total dispersion and factor 1 represents indirect relations.

The second factor has eigenvalue 1,014, which explains 9,222 % of total dispersion and factor 2 represents direct relations. Also the total percentage of explanation is 65,801.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.68 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.68 : Cronbach's alpha coefficients of opportunities.

Factors	N	Cronbach's Alpha
Direct relations	4	0,860
Indirect relations	7	0,885

As seen in Table 7.68, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.69 represents descriptive statistics of factors. Here, 5 implies “very importance” and 1 implies “unimportant”.

Table 7.69 : Descriptive statistics of opportunities.

Factors	N	Mean	Std. Deviation
Direct relations	198	4,01	0,93
Indirect relations	195	3,83	0,86

As seen in Table 7.69, direct relations have the highest mean however, indirect relations have the lowest mean. The relationship between the factors is given in Table 7.70.

Table 7.70 : Correlation of overview of opportunities.

Correlations			
		F1	F2
F1	Pearson Correlation	1	,729**
	Sig. (2-tailed)		0,000
	N	198	190
F2	Pearson Correlation	,729**	1
	Sig. (2-tailed)	0,000	
	N	190	195
**. Correlation is significant at the 0.01 level (2-tailed).			

As seen in Table 7.70, there is a high positive correlation between relations.

7.2.7 Analysis for the expectations

In this section, participants were asked about expectations. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett’s tests was given Table 7.71.

Table 7.71 : Results of KMO and Bartlett's test of expectations.

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	,911
Bartlett's Test of Sphericity	Approx. Chi-Square
	1274,812
	Df
	45
	Sig
	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0, 911 and $0, 911 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 1274,812 and degree of freedom is 45. So, it is significant ($p=0,000$, $p<0.05$).

The results of the factor analysis are given in Table 7.72. Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50. These are enough to use the factor analysis. Also, the sample size is sufficient for analysis.

Table 7.72 : Components and factor loadings of expectations.

Factors	Factor Loading	Communality
Factor 1: Market competitiveness		
To increase the competitive advantage	0,741	0,612
To develop the customer base	0,822	0,745
To increase profitability	0,859	0,815
Increase sales	0,887	0,823
Increase market share	0,814	0,776
Creating and developing company image	0,556	0,612
To create and develop innovation	0,570	0,637
Factor 2: Organizational competitiveness		
Establish new partnerships	0,820	0,696
Creating new business opportunities	0,712	0,666
To gain funds from support organizations	0,738	0,578

As seen in Table 7.72, communalities for each item have value greater than 0,30. Also the variables were collected in 2 groups. First factor has eigenvalue 5,862, which explains 58,621 % of total dispersion and factor 1 represents market competitiveness.

The second factor has eigenvalue 1,098, which explains 10,978 % of total dispersion and factor 2 represents organizational competitiveness. Also, the total percentage of explanation is 69,599.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.73 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.73 : Cronbach's alpha coefficients of expectations.

Factors	N	Cronbach's Alpha
Market competitiveness	7	0,922
Organizational competitiveness	3	0,731

As seen in Table 7.73, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.74 represents descriptive statistics of factors. Here, 5 implies “very importance” and 1 implies “unimportant”.

Table 7.74 : Descriptive statistics of expectations.

Factors	N	Mean	Std. Deviation
Market competitiveness	198	4,38	0,68
Organizational competitiveness	200	3,84	0,95

As seen in Table 7.74, market competitiveness has the highest mean however, organizational competitiveness has the lowest mean. The relationship between the factors is given in Table 7.75.

Table 7.75 : Correlation of overview of expectations.

Correlations			
		F1	F2
F1	Pearson Correlation	1	,636**
	Sig. (2-tailed)		0,000
	N	198	195
F2	Pearson Correlation	,636**	1
	Sig. (2-tailed)	0,000	
	N	195	200
**. Correlation is significant at the 0.01 level (2-tailed).			

As seen in Table 7.75, there is a moderate positive correlation between factors of expectations.

7.2.8 Analysis for the customer expectations

Participants were asked 15 questions in this section. All questions were 5-Likert Scale. Before the factor analysis results of KMO and Bartlett’s tests was given Table 7.76. Also, the anti-image correlation matrix was examined, and all diagonal values were found greater than 0.50.

Table 7.76 : Results of KMO and Bartlett’s test of customer expectations.

KMO and Bartlett’s Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,873
Bartlett’s Test of Sphericity	Approx.	
	Chi-Square	1819,173
	Df	105
	Sig	,000

The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0,873 and $0,873 > 0,6$ means that it is significant.

The value of Bartlett's test Chi-Square is 1819,173 and degree of freedom is 105. So, it is significant ($p=0,000$, $p<0.05$).

The results of the factor analysis are given in Table 7.77.

Table 7.77 : Components and factor loadings of customer expectations.

Factors	Factor Loading	Communality
Factor 1: Improvement of competitive advantage		
To develop the customer base	0,703	0,736
To increase sales	0,837	0,769
To increase profitability	0,807	0,834
To increase market share	0,778	0,830
To create and develop company image	0,656	0,804
Factor 2: Improvement of production efficiency		
To reduce costs	0,665	0,729
To provide flexibility in production and increase it	0,807	0,811
To increase productivity in production	0,772	0,801
To increase resource efficiency	0,698	0,779
To shorten the period of product / service development and market presentation	0,594	0,526
Factor 3: Improvement of operational performance		
To increase the effectiveness of processes	0,660	0,621
To raise the quality of life of employees	0,800	0,738
To increase the competitive advantage	0,734	0,736
Factor 4: Improvement of product and services		
To develop new products / services	0,818	0,822
To improve the quality of the products / services offered	0,675	0,719

As seen in Table 7.77, communalities for each item have value greater than 0,30. Also the variables were collected in 4 groups. First factor has eigenvalue 7,574, which explains 50,497 % of total dispersion and factor 1 represents improvement of competitive advantage.

The second factor has eigenvalue 1,413, which explains 9,421 % of total dispersion and factor 2 represents improvement of production efficiency.

The third factor has eigenvalue 1,187, which explains 7,910 % of total dispersion and factor 3 represents improvement of operational performance.

Finally, fourth factor has eigenvalue 1,033, which explains 6,885 % of total dispersion and factor 4 represents improvement of product and services. Also, the total percentage of explanation is 74,712.

After conducting factor analysis, the reliability of each factor has been calculated. Table 7.78 represents Cronbach's alpha internal consistency coefficients of the all factors.

Table 7.78 : Cronbach's alpha coefficients of customer expectations.

Factors	N	Cronbach's Alpha
Improvement of competitive advantage	5	0,910
Improvement of production efficiency	5	0,849
Improvement of operational performance	3	0,765
Improvement of product and services	2	0,827

As seen in Table 7.78, all factors have Cronbach's Alpha value greater than the 0,7.

Table 7.79 represents descriptive statistics of factors. The range of factors' mean varies between 3,96 and 4,19. Here, 5 implies "very important" and 1 implies "unimportant".

Table 7.79 : Descriptive statistics of customer expectations.

Factors	N	Mean	Std. Deviation
Improvement of competitive advantage	185	4,19	0,87
Improvement of production efficiency	188	4,09	0,82
Improvement of operational performance	192	3,96	0,91
Improvement of product and services	192	4,14	0,96

As seen in Table 7.79, improvement of competitive advantage has the highest mean however, improvement of operational performance has the lowest mean.

The relationship between the factors is given in Table 7.80.

Table 7.80 : Correlation of customer expectations.

		Correlations			
		F1	F2	F3	F4
F1	Pearson Correlation	1	,610**	,625**	,579**
	Sig. (2-tailed)		0,000	0,000	0,000
	N	185	179	183	182
F2	Pearson Correlation	,610**	1	,598**	,516**
	Sig. (2-tailed)	0,000		0,000	0,000
	N	179	188	185	185
F3	Pearson Correlation	,625**	,598**	1	,512**
	Sig. (2-tailed)	0,000	0,000		0,000
	N	183	185	192	189
F4	Pearson Correlation	,579**	,516**	,512**	1
	Sig. (2-tailed)	0,000	0,000	0,000	
	N	182	185	189	192

**. Correlation is significant at the 0.01 level (2-tailed).

As seen in Table 7.80, there is a moderate positive correlation between improvement of competitive advantage and the other three factors. Also, there is again moderate positive correlation between Improvement of production efficiency and improvement of operational performance and improvement of product and services. In addition, there is a low positive correlation between improvement of operational performance and improvement of product and services.

7.2.9 Analysis for the skills, competencies and application area

For these sections, all questions were 5-Likert Scale. In all of three questions, variables collected in a single factor within themselves. The results of KMO and Bartlett's tests was given Table 7.81.

Table 7.81 : Results of KMO and Bartlett's test of skills, competencies and application area.

KMO and Bartlett's Test		
Application Area		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,906
Bartlett's Test of Sphericity	Approx. Chi-Square	1045,072
	Df	45
	Sig	,000
Skills		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,871
Bartlett's Test of Sphericity	Approx. Chi-Square	845,513
	Df	21
	Sig	,000
Competencies		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,871
Bartlett's Test of Sphericity	Approx. Chi-Square	1377,811
	Df	36
	Sig	,000

All Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) are greater than 0,6 means that it is significant and for all value of Bartlett's test is significant ($p=0,000$, $p<0.05$). In addition, as seen in the Table 7.82, for skills, competencies and application areas the Cronbach's alpha coefficients greater than 0,7.

Table 7.82 : Cronbach's alpha coefficients of collaboration.

Factors	N	Cronbach's Alpha
Application area	10	0,926
Skills	7	0,896
Competencies	9	0,938

7.3 Hypothesis Test

First of all, the normality test is applied on the data to decide the appropriate method for testing. If the data is normally distributed, ANOVA and t-Test have been used. Than the otherwise, Mann-Whitney U Test and Kruskal-Wallis Test have been applied.

7.3.1 Establishment year of company

Participants in this section are divided into two groups in terms of establishment year as before 2010 and after 2010. Then, the normality test was applied to the variables, and the t test was used for those with normally distributed and the Mann Whitney U test for the not normally distributed. The reason for this is that, there are two groups as before and after the foundation year 2010.

H₁₀₁: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to age of the company.

H₁₀₂: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to age of the company.

H₁₀₃: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to age of the company.

H₁₀₄: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to age of the company.

H₁₀₅: There is a statistically significant difference in developing data management technologies with respect to age of the company.

H₁₀₆: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to age of the company.

H₁₀₇: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to age of the company.

H₁₀₈: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to age of the company.

H₁₀₉: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to age of the company.

H₁₁₀: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to age of the company.

H₁₁₁: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to age of the company.

H₁₁₂: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to age of the company.

H₁₁₃: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to age of the company.

H₁₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to age of the company.

According to t-Test results, hypotheses H₁₀₁, H₁₀₂, H₁₀₃, H₁₀₄, H₁₀₅, H₁₀₆, H₁₀₇, H₁₀₈, H₁₀₉, H₁₁₁, H₁₁₂, H₁₁₃, and H₁₁₄ have been rejected ($p > 0,05$). On the other hand, H₁₁₀ have been accepted ($p < 0,05$) So, there is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to age of the company. The average mean of companies facing insufficient support after 2010 is higher than the companies established before 2010. The results are given Table 7.83.

Table 7.83 : t-test results for the age of the company.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower		Upper
Awareness about organizational impact	Equal variances assumed	0,016	0,900	-1,600	189	0,111	-0,22839364	0,14270988	-0,50990245	0,05311517
	Equal variances not assumed			-1,604	176,194	0,110	-0,22839364	0,14235133	-0,50932675	0,05253946
Awareness about environmental impact	Equal variances assumed	0,361	0,549	-1,996	189	0,047	-0,28750444	0,14403815	-0,57163338	-0,00337550
	Equal variances not assumed			-1,976	167,778	0,050	-0,28750444	0,14547514	-0,57470206	-0,00030682
Awareness about role of technopark and support	Equal variances assumed	1,004	0,318	0,311	189	0,756	0,04630230	0,14897119	-0,24755753	0,34016213
	Equal variances not assumed			0,308	168,558	0,758	0,04630230	0,15029454	-0,25039982	0,34300442
Infrastructure for digitalization	Equal variances assumed	0,007	0,934	-0,616	183	0,538	-0,09283771	0,15062523	-0,39002309	0,20434767
	Equal variances not assumed			-0,610	163,318	0,543	-0,09283771	0,15215220	-0,39327682	0,20760139
Data management technologies	Equal variances assumed	1,087	0,300	0,555	98	0,580	0,11359482	0,20468121	-0,29258839	0,51977802
	Equal variances not assumed			0,562	97,282	0,575	0,11359482	0,20215165	-0,28760559	0,51479522
Internal shareholders	Equal variances assumed	0,029	0,864	0,492	156	0,623	0,07999709	0,16249062	-0,24096861	0,40096278
	Equal variances not assumed			0,494	142,001	0,622	0,07999709	0,16189547	-0,24003963	0,40003380
Skills	Equal variances assumed	0,078	0,780	-0,288	179	0,774	-0,04398332	0,15296071	-0,34582152	0,25785488
	Equal variances not assumed			-0,285	159,754	0,776	-0,04398332	0,15440840	-0,34892830	0,26096166

Table 7.83 (continued) : t-test results for the age of the company.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
										Lower Upper
Facing workforce challenges	Equal variances assumed	0,220	0,640	-0,648	172	0,518	-0,09911798	0,15302826	-0,40117314	0,20293717
	Equal variances not assumed			-0,646	155,820	0,519	-0,09911798	0,15345212	-0,40223277	0,20399681
Competencies	Equal variances assumed	0,198	0,657	-1,169	189	0,244	-0,17336587	0,14825406	-0,46581109	0,11907936
	Equal variances not assumed			-1,165	174,050	0,246	-0,17336587	0,14879955	-0,46704967	0,12031794
Inadequate support	Equal variances assumed	5,155	0,024	-0,406	172	0,685	-0,06282791	0,15474943	-0,36828042	0,24262459
	Equal variances not assumed			-0,390	131,473	0,697	-0,06282791	0,16101584	-0,38134497	0,25568915
Facing commercial problems	Equal variances assumed	0,019	0,890	0,742	172	0,459	0,11485308	0,15470566	-0,19051303	0,42021918
	Equal variances not assumed			0,743	158,210	0,458	0,11485308	0,15449807	-0,19029172	0,41999787
Facing technology-oriented problems	Equal variances assumed	0,171	0,679	0,450	172	0,654	0,06934543	0,15425723	-0,23513553	0,37382640
	Equal variances not assumed			0,450	158,236	0,653	0,06934543	0,15404328	-0,23490074	0,37359160
Company's own expectations	Equal variances assumed	0,286	0,593	-0,809	180	0,420	-0,12222374	0,15115610	-0,42048961	0,17604213
	Equal variances not assumed			-0,799	156,644	0,425	-0,12222374	0,15291162	-0,42425846	0,17981098
Direct relations	Equal variances assumed	0,382	0,537	-1,258	161	0,210	-0,19732883	0,15690238	-0,50718091	0,11252325
	Equal variances not assumed			-1,254	150,542	0,212	-0,19732883	0,15741135	-0,50834964	0,11369198

H₁₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to age of the company.

H₁₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to age of the company.

H₁₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to age of the company.

H₁₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to age of the company.

H₁₁₉: There is a statistically significant difference in developing virtualization technologies with respect to age of the company.

H₁₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to age of the company.

H₁₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to age of the company.

H₁₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to age of the company.

H₁₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to age of the company.

For testing hypotheses, Mann-Whitney U Test has been used. This is because variables were not normally distributed and there were two groups of establishment year.

According to Mann-Whitney U Test results, hypotheses H₁₁₉ and H₁₂₀ have been accepted ($p < 0.05$). In addition, the other hypotheses are rejected because of their p value was greater than 0,05. The results are given Table 7.84.

Table 7.84 : Mann-Whitney U test p value results for the age of the company.

		N	Mean Rank	Sum of Ranks	Sig.
Developing virtualization technologies	Before 2010	47	43,43	2041,00	0,022
	After 2010	53	56,77	3009,00	
	Total	100			
Benefit from external shareholders	Before 2010	66	67,70	4468,50	0,006
	After 2010	92	87,96	8092,50	
	Total	158			

It can be say that there is a statistically significant difference in developing virtualization technologies with respect to age of the company. This difference militates in favor of firms that founded after 2010. Also, there is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to age of the company. This difference militates in favor of firms that founded after 2010.

7.3.2 Target market

Participants in this section are divided into three groups in terms of target markets as only internal, only external and both internal and external. Then, the normality test was applied to the variables, and the ANOVA was used for those with normally distributed and the Kruskal-Wallis test for the not normally distributed. The reason for this is that there are more than two groups.

H201: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to target market of the company.

H202: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to target market of the company.

H203: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to target market of the company.

H204: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to target market of the company.

H205: There is a statistically significant difference in developing data man target management technologies with respect to target market of the company.

H206: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to target market of the company.

H207: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to target market of the company.

H208: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to target market of the company.

H209: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to target market of the company.

H210: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to target market of the company.

H211: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to target market of the company.

H212: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to target market of the company.

H213: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to target market of the company.

H214: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to target market of the company.

According to ANOVA results, all hypotheses H201, H202, H203, H204, H205, H206, H207, H208, H209, H210, H211, H212, H213, and H214 have been rejected ($p > 0,05$). There is no statistically significant difference with respect to target market of company. The results are given Table 7.85.

Table 7.85 : ANOVA results for the target market of the company.

		Sum of Squares	df	Mean Square	F	Sig.
Awareness about organizational impact	Between Groups	1,010	2	0,505	0,540	0,584
	Within Groups	185,358	198	0,936		
	Total	186,368	200			
Awareness about environmental impact	Between Groups	2,508	2	1,254	1,269	0,284
	Within Groups	195,705	198	0,988		
	Total	198,213	200			
Awareness about role of technopark and support	Between Groups	2,890	2	1,445	1,413	0,246
	Within Groups	202,529	198	1,023		
	Total	205,419	200			
Infrastructure for digitalization	Between Groups	2,355	2	1,178	1,172	0,312
	Within Groups	193,850	193	1,004		
	Total	196,205	195			
Developing data management technologies	Between Groups	0,348	2	0,174	0,166	0,847
	Within Groups	103,541	99	1,046		
	Total	103,889	101			
Benefit from internal shareholders	Between Groups	0,346	2	0,173	0,173	0,841
	Within Groups	161,145	161	1,001		
	Total	161,492	163			
Skills	Between Groups	4,181	2	2,091	2,107	0,124
	Within Groups	185,552	187	0,992		
	Total	189,733	189			
Workforce challenges	Between Groups	3,698	2	1,849	1,921	0,150
	Within Groups	172,309	179	0,963		
	Total	176,006	181			
Inadequate support	Between Groups	2,105	2	1,052	1,043	0,354
	Within Groups	180,530	179	1,009		
	Total	182,634	181			
Commercial problems	Between Groups	1,121	2	0,561	0,564	0,570
	Within Groups	177,861	179	0,994		
	Total	178,982	181			
Technology-oriented problems	Between Groups	3,523	2	1,761	1,780	0,172
	Within Groups	177,094	179	0,989		
	Total	180,617	181			
Company's own expectations	Between Groups	1,390	2	0,695	0,699	0,498
	Within Groups	185,837	187	0,994		
	Total	187,227	189			
Direct relations	Between Groups	1,838	2	0,919	0,943	0,391
	Within Groups	164,617	169	0,974		
	Total	166,455	171			

H₂₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to target market of the company.

H₂₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to target market of the company.

H₂₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to target market of the company.

H₂₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to target market of the company.

H₂₁₉: There is a statistically significant difference in developing virtualization technologies with respect to target market of the company.

H₂₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to target market of the company.

H₂₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to target market of the company.

H₂₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to target market of the company.

H₂₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to target market of the company.

For testing hypotheses, Kruskal-Wallis has been used. This is because variables were not normally distributed and there were three groups of target market.

According to Kruskal-Wallis Test results, all hypotheses have been rejected ($p > 0.05$). There is no statistically significant difference with respect to target market of company. The results are given Table 7.86.

Table 7.86 : Kruskal-Wallis test results for the target market of the company.

		N	Mean Rank	Sig.
Awareness about competitiveness impact	Only Internal	29	101,24	0,605
	Only External	6	124,33	
	Both	166	100,11	
	Total	201		
Strategy and policy	Only Internal	27	92,96	0,588
	Only External	6	79,50	
	Both	163	100,12	
	Total	196		
Product, services and workforce infrastructure	Only Internal	27	81,78	0,249
	Only External	6	95,67	
	Both	163	101,37	
	Total	196		
Developing digital manufacturing systems technologies	Only Internal	18	53,97	0,888
	Only External	2	57,00	
	Both	82	50,82	
	Total	102		
Developing virtualization technologies	Only Internal	18	45,81	0,271
	Only External	2	25,00	
	Both	82	53,40	
	Total	102		
External shareholders	Only Internal	24	76,88	0,215
	Only External	6	52,42	
	Both	134	84,85	
	Total	164		
Workforce challenges	Only Internal	26	96,65	0,209
	Only External	5	51,60	
	Both	151	91,93	
	Total	182		
Using indirect relations	Only Internal	27	71,69	0,217
	Only External	2	73,00	
	Both	143	89,49	
	Total	172		
Customer expectations	Only Internal	23	71,28	0,488
	Only External	4	89,25	
	Both	136	83,60	
	Total	163		

7.3.3 Capital structure

Participants in this section are divided into two groups in terms of capital structure as having foreign capital partner and domestic. Then, the normality test was applied to the variables, and the t test was used for those with normally distributed and the Mann Whitney U test for the not normally distributed. The reason for this is that there are two groups.

H301: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to capital structure of the company.

H302: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to capital structure of the company.

H303: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to capital structure of the company.

H304: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to capital structure of the company.

H305: There is a statistically significant difference in developing data management technologies with respect to capital structure of the company.

H306: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to capital structure of the company.

H307: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to capital structure of the company.

H308: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to capital structure of the company.

H309: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to capital structure of the company.

H310: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to capital structure of the company.

H311: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to capital structure of the company.

H312: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to capital structure of the company.

H313: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to capital structure of the company.

H₃₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to capital structure of the company.

According to t-Test results, hypotheses H₃₀₁ and H₃₁₁ have been accepted ($p < 0,05$). On the other hand, other all hypotheses have been rejected. There is a statistically significant with respect to capital structure of the company in terms of awareness about organizational impact and facing technology-oriented problems. According to the results, the average mean of companies with domestic capital structure awareness about organizational impact is higher than companies that having foreign capital structure. The results are given Table 7.87.



Table 7.87 : t-test results for the capital structure of the company.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower		Upper
Awareness about organizational impact	Equal variances assumed	7,905	0,005	1,292	195	0,198	0,28891335	0,22360276	-0,15207691	0,72990362
	Equal variances not assumed			1,984	36,968	0,055	0,28891335	0,14560704	-0,00612303	0,58394974
Awareness about environmental impact	Equal variances assumed	2,653	0,105	0,093	195	0,926	0,02133538	0,22914023	-0,43057591	0,47324667
	Equal variances not assumed			0,080	23,391	0,937	0,02133538	0,26580712	-0,52802097	0,57069173
Awareness about role of technopark and support	Equal variances assumed	0,418	0,519	1,789	195	0,075	0,41310799	0,23097067	-0,04241329	0,86862928
	Equal variances not assumed			1,730	24,595	0,096	0,41310799	0,23877910	-0,07907807	0,90529406
Infrastructure for digitalization	Equal variances assumed	1,093	0,297	1,158	191	0,248	0,28028472	0,24194355	-0,19693974	0,75750918
	Equal variances not assumed			1,340	24,029	0,193	0,28028472	0,20915910	-0,15137050	0,71193994
Data management technologies	Equal variances assumed	0,431	0,513	1,439	98	0,153	0,57395149	0,39892669	-0,21770554	1,36560851
	Equal variances not assumed			1,266	6,690	0,248	0,57395149	0,45348308	-0,50852827	1,65643125
Internal shareholders	Equal variances assumed	2,619	0,108	0,437	159	0,663	0,11841964	0,27109665	-0,41699521	0,65383450
	Equal variances not assumed			0,372	16,000	0,715	0,11841964	0,31836590	-0,55648606	0,79332535
Skills	Equal variances assumed	0,683	0,409	1,119	185	0,265	0,28930586	0,25862006	-0,22091789	0,79952961
	Equal variances not assumed			1,248	18,852	0,227	0,28930586	0,23175850	-0,19602761	0,77463934

Table 7.87 (continued) : t-test results for the capital structure of the company.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower		Upper
Facing workforce challenges	Equal variances assumed	0,002	0,965	1,820	177	0,071	0,42567331	0,23393197	-0,03598142	0,88732803
	Equal variances not assumed			1,738	23,454	0,095	0,42567331	0,24488399	-0,08036606	0,93171267
Competencies	Equal variances assumed	0,012	0,914	0,262	196	0,793	0,05900725	0,22483888	-0,38440678	0,50242127
	Equal variances not assumed			0,246	25,664	0,807	0,05900725	0,23958875	-0,43378830	0,55180279
Inadequate support	Equal variances assumed	0,123	0,726	-1,684	177	0,094	-0,40229149	0,23894394	-0,87383713	0,06925415
	Equal variances not assumed			-1,673	23,952	0,107	-0,40229149	0,24042518	-0,89855738	0,09397440
Facing commercial problems	Equal variances assumed	0,000	0,990	-0,108	177	0,914	-0,02552925	0,23579743	-0,49086539	0,43980689
	Equal variances not assumed			-0,103	23,381	0,919	-0,02552925	0,24835780	-0,53883346	0,48777496
Facing technology-oriented problems	Equal variances assumed	4,196	0,042	0,834	177	0,406	0,19819635	0,23776109	-0,27101499	0,66740769
	Equal variances not assumed			0,666	21,751	0,513	0,19819635	0,29780519	-0,41982422	0,81621692
Company's own expectations	Equal variances assumed	0,012	0,913	2,963	185	0,003	0,68119616	0,22992498	0,22758408	1,13480823
	Equal variances not assumed			2,840	23,277	0,009	0,68119616	0,23988705	0,18527820	1,17711411
Direct relations	Equal variances assumed	0,511	0,475	1,116	168	0,266	0,27502026	0,24649086	-0,21159834	0,76163886

H₃₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to capital structure of the company.

H₃₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to capital structure of the company.

H₃₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to capital structure of the company.

H₃₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to capital structure of the company.

H₃₁₉: There is a statistically significant difference in developing virtualization technologies with respect to capital structure of the company.

H₃₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to capital structure of the company.

H₃₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to capital structure of the company.

H₃₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to capital structure of the company.

H₃₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to capital structure of the company.

According to Mann-Whitney U Test results, all hypotheses H₃₁₅, H₃₁₆, H₃₁₇, H₃₁₈, H₃₁₉, H₃₂₀, H₃₂₁, H₃₂₂, and H₃₂₃ have been rejected ($p > 0,05$).

7.3.4 Company structure

Participants in this section are divided into three groups in terms of company structure as dependent with an international company, dependent with a national company and independent company. Then, the normality test was applied to the variables, and the ANOVA was used for those with normally distributed and the Kruskal-Wallis test for the not normally distributed. The reason for this is that there are more than two groups.

H401: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to company structure.

H402: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to company structure.

H403: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to company structure.

H404: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to company structure.

H405: There is a statistically significant difference in developing data management technologies with respect to company structure.

H406: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to company structure.

H407: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to company structure.

H408: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to company structure.

H409: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to company structure.

H410: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to company structure.

H411: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to company structure.

H412: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to company structure.

H413: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to company structure.

H414: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to company structure.

The results are given Table 7.88.

Table 7.88 : ANOVA results for the company structure.

		Sum of Squares	df	Mean Square	F	Sig.
Awareness about organizational impact	Between Groups	1,964	2	0,982	1,062	0,348
	Within Groups	181,264	196	0,925		
	Total	183,228	198			
Awareness about environmental impact	Between Groups	3,602	2	1,801	1,848	0,160
	Within Groups	191,085	196	0,975		
	Total	194,688	198			
Awareness about role of technopark and support	Between Groups	6,661	2	3,331	3,287	0,039
	Within Groups	198,614	196	1,013		
	Total	205,275	198			
Infrastructure for digitalization	Between Groups	1,321	2	0,660	0,681	0,508
	Within Groups	185,383	191	0,971		
	Total	186,704	193			
Developing data management technologies	Between Groups	2,852	2	1,426	1,397	0,252
	Within Groups	101,038	99	1,021		
	Total	103,889	101			
Benefit from internal shareholders	Between Groups	2,068	2	1,034	1,056	0,350
	Within Groups	155,615	159	0,979		
	Total	157,683	161			
Skills	Between Groups	0,640	2	0,320	0,320	0,727
	Within Groups	185,117	185	1,001		
	Total	185,757	187			
Workforce challenges	Between Groups	5,010	2	2,505	2,612	0,076
	Within Groups	170,723	178	0,959		
	Total	175,733	180			
Inadequate support	Between Groups	5,443	2	2,722	2,734	0,068
	Within Groups	177,178	178	0,995		
	Total	182,622	180			
Commercial problems	Between Groups	0,621	2	0,311	0,310	0,734
	Within Groups	178,218	178	1,001		
	Total	178,840	180			
Technology-oriented problems	Between Groups	0,250	2	0,125	0,123	0,884
	Within Groups	180,310	178	1,013		
	Total	180,560	180			
Company's own expectations	Between Groups	3,226	2	1,613	1,641	0,197
	Within Groups	181,817	185	0,983		
	Total	185,043	187			
Direct relations	Between Groups	0,028	2	0,014	0,014	0,986
	Within Groups	166,292	168	0,990		
	Total	166,321	170			

According to ANOVA results hypotheses H₄₀₃ have been accepted ($p < 0,05$). There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to company structure. According to the results, the average

of companies that dependent with a national company's awareness about role of technopark and support is higher than others.

H₄₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to company structure.

H₄₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to company structure.

H₄₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to company structure.

H₄₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to company structure.

H₄₁₉: There is a statistically significant difference in developing virtualization technologies with respect to company structure.

H₄₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to company structure.

H₄₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to company structure.

H₄₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to company structure.

H₄₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to company structure.

For testing hypotheses, Kruskal-Wallis has been used. This is because variables were not normally distributed and there were three groups of company structure. The results are given Table 7.89.

Table 7.89 : Kruskal-Wallis test results for the company structure.

		N	Mean Rank	Sig.
Awareness about competitiveness impact	Dependent International company	13	93,77	0,836
	Dependent National company	18	94,72	
	Independent	168	101,05	
	Total	199		
Strategy and policy	Dependent International company	13	90,69	0,288
	Dependent National company	18	79,00	
	Independent	163	100,09	
	Total	194		
Product, services and workforce infrastructure	Dependent International company	13	100,92	0,018
	Dependent National company	18	132,67	
	Independent	163	93,34	
	Total	194		
Developing digital manufacturing systems technologies	Dependent International company	7	44,43	0,744
	Dependent National company	6	47,33	
	Independent	89	52,34	
	Total	102		
Developing virtualization technologies	Dependent International company	7	38,43	0,420
	Dependent National company	6	54,83	
	Independent	89	52,30	
	Total	102		
External shareholders	Dependent International company	10	52,80	0,068
	Dependent National company	16	96,50	
	Independent	136	81,85	
	Total	162		
Workforce challenges	Dependent International company	13	103,96	0,039
	Dependent National company	16	119,63	
	Independent	152	86,88	
	Total	181		
Using indirect relations	Dependent International company	11	88,55	0,664
	Dependent National company	15	96,63	
	Independent	145	84,71	
	Total	171		
Customer expectations	Dependent International company	10	96,45	0,548
	Dependent National company	14	84,64	
	Independent	138	80,10	
	Total	162		

According to Kruskal-Wallis Test results, hypotheses H₄₁₇ and H₄₂₁ have been accepted ($p < 0,05$). There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to company structure.

There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to company structure.

In addition, according to the Kruskal-Wallis test results, between third and second groups there is a significant difference in terms of product, services and workforce infrastructure and in terms of facing workforce challenges. In both cases, mean value of second group (dependent with a national company) is higher than the third group (independent). (means; 132,67-93,34 and 119,62-86,88 respectively).

7.3.5 Total amount of customer

Participants in this section are divided into three groups in terms of total amount of customer as 1-9, 10-49 and +50. Then, the normality test was applied to the variables, and the ANOVA was used for those with normally distributed and the Kruskal-Wallis test for the not normally distributed. The reason for this is that there are more than two groups.

H501: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to total amount of customer.

H502: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to total amount of customer.

H503: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to total amount of customer.

H504: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to total amount of customer.

H505: There is a statistically significant difference in developing data management technologies with respect to total amount of customer.

H506: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to total amount of customer.

H507: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to total amount of customer.

H508: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to total amount of customer.

H509: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to total amount of customer.

H510: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to total amount of customer.

H511: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to total amount of customer.

H512: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to total amount of customer.

H513: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to total amount of customer.

H514: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to total amount of customer.

The results are given Table 7.90.

Table 7.90 : ANOVA results for the total amount of customer.

		Sum of Squares	df	Mean Square	F	Sig.
Awareness about organizational impact	Between Groups	9,176	2	4,588	5,155	0,007
	Within Groups	169,989	191	0,890		
	Total	179,166	193			
Awareness about environmental impact	Between Groups	0,184	2	0,092	0,094	0,910
	Within Groups	187,427	191	0,981		
	Total	187,611	193			
Awareness about role of technopark and support	Between Groups	5,573	2	2,786	2,729	0,068
	Within Groups	195,027	191	1,021		
	Total	200,600	193			
Infrastructure for digitalization	Between Groups	3,177	2	1,588	1,628	0,199
	Within Groups	181,511	186	0,976		
	Total	184,688	188			
Developing data management technologies	Between Groups	0,180	2	0,090	0,084	0,919
	Within Groups	102,161	96	1,064		
	Total	102,340	98			
Benefit from internal shareholders	Between Groups	2,939	2	1,470	1,502	0,226
	Within Groups	153,576	157	0,978		
	Total	156,515	159			
Skills	Between Groups	6,178	2	3,089	3,205	0,043
	Within Groups	174,464	181	0,964		
	Total	180,642	183			
Workforce challenges	Between Groups	1,140	2	0,570	0,582	0,560
	Within Groups	168,452	172	0,979		
	Total	169,592	174			
Inadequate support	Between Groups	0,815	2	0,408	0,401	0,670
	Within Groups	174,949	172	1,017		
	Total	175,764	174			
Commercial problems	Between Groups	1,071	2	0,535	0,523	0,593
	Within Groups	175,894	172	1,023		
	Total	176,965	174			
Technology-oriented problems	Between Groups	4,095	2	2,048	2,056	0,131
	Within Groups	171,323	172	0,996		
	Total	175,419	174			
Company's own expectations	Between Groups	6,718	2	3,359	3,387	0,036
	Within Groups	177,532	179	0,992		
	Total	184,250	181			
Direct relations	Between Groups	1,805	2	0,902	0,909	0,405
	Within Groups	162,797	164	0,993		
	Total	164,602	166			

According to ANOVA results hypotheses H₅₀₁, H₅₀₁, and H₅₀₁ have been accepted ($p < 0,05$). There is a statistically significant difference in Industry 4.0 awareness about organizational impact, company's employee skills and success of company's own expectations with respect to company's total customer amount that served Industry 4.0 technologies. According to the results, the average mean of companies' that have over the 50 customers' success on expectations and their employee skills higher than others.

Also, the average mean of companies' that have 1-10 customers' Industry 4.0 awareness about organizational impact is higher than the others.

H₅₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to total amount of customer.

H₅₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to total amount of customer.

H₅₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to total amount of customer.

H₅₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to total amount of customer.

H₅₁₉: There is a statistically significant difference in developing virtualization technologies with respect to total amount of customer.

H₅₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to total amount of customer.

H₅₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to total amount of customer.

H₅₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to total amount of customer.

H₅₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to total amount of customer.

For testing hypotheses, Kruskal-Wallis has been used. This is because variables were not normally distributed and there were three groups in terms of total amounts of customer. The results are given Table 7.91.

Table 7.91 : Kruskal-Wallis test results for the total amount of customer.

		N	Mean Rank	Sig.
Awareness about competitiveness impact	1-9	47	101,60	0,337
	10-50	58	88,40	
	+50	89	101,27	
	Total	194		
Strategy and policy	1-9	49	107,63	0,045
	10-50	57	99,68	
	+50	83	84,33	
	Total	189		
Product, services and workforce infrastructure	1-9	49	88,18	0,393
	10-50	57	92,26	
	+50	83	100,90	
	Total	189		
Developing digital manufacturing systems technologies	1-9	23	53,17	0,469
	10-50	34	45,12	
	+50	42	52,21	
	Total	99		
Developing virtualization technologies	1-9	23	50,04	0,996
	10-50	34	49,65	
	+50	42	50,26	
	Total	99		
External shareholders	1-9	39	92,12	0,100
	10-50	48	82,82	
	+50	73	72,77	
	Total	160		
Workforce challenges	1-9	44	80,22	0,476
	10-50	54	88,96	
	+50	77	91,77	
	Total	175		
Using indirect relations	1-9	42	82,38	0,763
	10-50	51	80,94	
	+50	74	87,03	
	Total	167		
Customer expectations	1-9	39	74,26	0,387
	10-50	48	73,91	
	+50	69	84,09	
	Total	156		

According to Kruskal-Wallis Test results, hypotheses H₅₁₆ have been accepted ($p < 0,05$). There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to total amount of customer.

In addition, according to the Kruskal-Wallis test results, between first and third groups, there is a significant difference in terms of Industry 4.0 strategy and policy. Mean value of first group (1-10 customer) is higher than the third group (+50). (means; 107,63 and 84,33 respectively)

7.3.6 Companies with German customers

Industry 4.0 which is a concept that is arise from Germany [7]. For this reason, companies were divided into two groups, one with the German customer and the other one without the German customer, and the following hypotheses were tested. Since there are 2 variables, t test was applied to normal distributions and the Mann Whitney U test for the not normally distributed.

H₆₀₁: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to customer structure of the company.

H₆₀₂: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to customer structure of the company.

H₆₀₃: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to customer structure of the company.

H₆₀₄: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to customer structure of the company.

H₆₀₅: There is a statistically significant difference in developing data management technologies with respect to customer structure of the company.

H₆₀₆: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₀₇: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to customer structure of the company.

H₆₀₈: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₀₉: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₁₀: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₁₁: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₁₂: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to customer structure of the company.

H₆₁₃: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to customer structure of the company.

According to t-Test results, hypotheses H₆₀₃ have been accepted ($p < 0,05$). On the other hand, other all hypotheses have been rejected. There is a statistically significant with respect to customer structure of the company in terms of Industry 4.0 awareness about role of technopark and support. According to the results, the average mean of companies which have not German customers' Industry 4.0 awareness about role of technopark and support is higher than companies that having German customers. The results are given Table 7.92.

Table 7.92 : t-test results for the customer structure of the company.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower		Upper
Awareness about organizational impact	Equal variances assumed	0,119	0,730	-0,104	153	0,917	-0,02658300	0,25460873	-0,52958553	0,47641953
	Equal variances not assumed			-0,097	20,903	0,923	-0,02658300	0,27297928	-0,59443524	0,54126924
Awareness about environmental impact	Equal variances assumed	2,931	0,089	1,396	153	0,165	0,33670784	0,24126432	-0,13993163	0,81334730
	Equal variances not assumed			1,756	25,953	0,091	0,33670784	0,19175961	-0,05749427	0,73090994
Awareness about role of technopark and support	Equal variances assumed	5,386	0,022	0,965	153	0,336	0,24475173	0,25350523	-0,25607074	0,74557420
	Equal variances not assumed			1,405	30,932	0,170	0,24475173	0,17420608	-0,11057565	0,60007910
Infrastructure for digitalization	Equal variances assumed	3,068	0,082	0,503	152	0,616	0,11630800	0,23118956	-0,34045180	0,57306781
	Equal variances not assumed			0,417	22,539	0,681	0,11630800	0,27894322	-0,46138364	0,69399964
Data management technologies	Equal variances assumed	0,079	0,779	-0,059	78	0,953	-0,02663587	0,45423061	-0,93093954	0,87766779
	Equal variances not assumed			-0,059	5,859	0,955	-0,02663587	0,45032628	-1,13501843	1,08174668
Internal shareholders	Equal variances assumed	0,307	0,580	1,224	125	0,223	0,33466388	0,27330797	-0,20624651	0,87557427
	Equal variances not assumed			1,281	20,193	0,215	0,33466388	0,26133923	-0,21014647	0,87947423
Skills	Equal variances assumed	0,048	0,827	0,860	146	0,391	0,23802415	0,27683244	-0,30909244	0,78514075
	Equal variances not assumed			0,893	17,662	0,384	0,23802415	0,26640305	-0,32243679	0,79848510

Table 7.92 (continued) : t-test results for the customer structure of the company.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Facing workforce challenges	Equal variances assumed	1,751	0,188	0,533	139	0,595	0,13839326	0,25953975	-0,37476294	0,65154947
	Equal variances not assumed			0,721	22,030	0,478	0,13839326	0,19190013	-0,25955188	0,53633841
Competencies	Equal variances assumed	0,012	0,913	0,755	153	0,451	0,18062165	0,23913057	-0,29180239	0,65304570
	Equal variances not assumed			0,751	24,873	0,460	0,18062165	0,24051098	-0,31484845	0,67609176
Inadequate support	Equal variances assumed	0,001	0,981	-1,019	139	0,310	-0,28793827	0,28266356	-0,84681437	0,27093784
	Equal variances not assumed			-0,984	17,195	0,339	-0,28793827	0,29273748	-0,90502741	0,32915088
Facing commercial problems	Equal variances assumed	0,247	0,620	0,394	139	0,694	0,10964071	0,27800187	-0,44001840	0,65929983
	Equal variances not assumed			0,427	18,336	0,674	0,10964071	0,25659108	-0,42873096	0,64801239
Facing technology-oriented problems	Equal variances assumed	0,316	0,575	0,554	139	0,581	0,15957444	0,28812951	-0,41010881	0,72925769
	Equal variances not assumed			0,592	18,180	0,561	0,15957444	0,26958574	-0,40640139	0,72555027
Company's own expectations	Equal variances assumed	2,508	0,115	0,251	148	0,802	0,06278209	0,25001468	-0,43127753	0,55684172
	Equal variances not assumed			0,298	24,894	0,768	0,06278209	0,21083764	-0,37154026	0,49710444
Direct relations	Equal variances assumed	0,127	0,722	-0,647	136	0,518	-0,17524579	0,27067610	-0,71052424	0,36003265

H₆₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to customer structure of the company.

H₆₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to customer structure of the company.

H₆₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to customer structure of the company.

H₆₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to customer structure of the company.

H₆₁₉: There is a statistically significant difference in developing virtualization technologies with respect to customer structure of the company.

H₆₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to customer structure of the company.

H₆₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to customer structure of the company.

According to Mann-Whitney U Test results, all hypotheses H₆₁₅, H₆₁₆, H₆₁₇, H₆₁₈, H₆₁₉, H₆₂₀, H₆₂₁, H₆₂₂, and H₆₂₃ have been rejected ($p > 0,05$). There is no statistically significant difference with respect to customer structure of the company.

7.3.7 Total amount of employee

Participants in this section are divided into three groups in terms of total amount of employee as 1-9, 10-49 and +50. Then, the normality test was applied to the variables, and the ANOVA was used for those with normally distributed and the Kruskal-Wallis test for the not normally distributed. The reason for this is that there are more than two groups.

H701: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to total amount of employee.

H702: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to total amount of employee.

H703: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to total amount of employee.

H704: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to total amount of employee.

H705: There is a statistically significant difference in developing data management technologies with respect to total amount of employee.

H706: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to total amount of employee.

H707: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to total amount of employee.

H708: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to total amount of employee.

H709: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to total amount of employee.

H710: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to total amount of employee.

H711: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to total amount of employee.

H₇₁₂: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to total amount of employee.

H₇₁₃: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to total amount of employee.

H₇₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to total amount of employee.

The results are given Table 7.93.



Table 7.93 : ANOVA results for the total amount of employee.

		Sum of Squares	df	Mean Square	F	Sig.
Awareness about organizational impact	Between Groups	2,443	2	1,222	1,311	0,272
	Within Groups	180,837	194	0,932		
	Total	183,280	196			
Awareness about environmental impact	Between Groups	0,577	2	0,289	0,290	0,748
	Within Groups	192,870	194	0,994		
	Total	193,447	196			
Awareness about role of technopark and support	Between Groups	2,801	2	1,400	1,386	0,253
	Within Groups	196,043	194	1,011		
	Total	198,844	196			
Infrastructure for digitalization	Between Groups	8,435	2	4,217	4,359	0,014
	Within Groups	183,806	190	0,967		
	Total	192,241	192			
Developing data management technologies	Between Groups	10,959	2	5,480	5,837	0,004
	Within Groups	92,930	99	0,939		
	Total	103,889	101			
Benefit from internal shareholders	Between Groups	6,614	2	3,307	3,465	0,034
	Within Groups	150,803	158	0,954		
	Total	157,417	160			
Skills	Between Groups	7,507	2	3,753	3,927	0,021
	Within Groups	176,808	185	0,956		
	Total	184,314	187			
Workforce challenges	Between Groups	2,040	2	1,020	1,041	0,355
	Within Groups	172,486	176	0,980		
	Total	174,526	178			
Inadequate support	Between Groups	1,540	2	0,770	0,758	0,470
	Within Groups	178,908	176	1,017		
	Total	180,448	178			
Commercial problems	Between Groups	2,377	2	1,188	1,194	0,305
	Within Groups	175,182	176	0,995		
	Total	177,559	178			
Technology-oriented problems	Between Groups	0,363	2	0,181	0,178	0,837
	Within Groups	179,847	176	1,022		
	Total	180,210	178			
Company's own expectations	Between Groups	13,741	2	6,870	7,353	0,001
	Within Groups	172,866	185	0,934		
	Total	186,606	187			
Direct relations	Between Groups	6,202	2	3,101	3,268	0,041
	Within Groups	158,444	167	0,949		
	Total	164,646	169			

According to ANOVA results hypotheses H₇₀₄, H₇₀₅, H₇₀₆, H₇₀₇, H₇₁₃, and H₇₁₄ have been accepted ($p < 0,05$). According to the results, the average mean of companies that have 10-49 employee, Industry 4.0 infrastructure for digitalization, developing data management technologies, benefit from internal shareholders, using direct relations, success on expectations and their employee skills higher than others.

H₇₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to total amount of employee.

H₇₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to total amount of employee.

H₇₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to total amount of employee.

H₇₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to total amount of employee.

H₇₁₉: There is a statistically significant difference in developing virtualization technologies with respect to total amount of employee.

H₇₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to total amount of employee.

H₇₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to total amount of employee.

H₇₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to total amount of employee.

H₇₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to total amount of employee.

For testing hypotheses, Kruskal-Wallis has been used. This is because variables were not normally distributed and there were three groups in terms of total amounts of employee. The results are given Table 7.94.

Table 7. 94 : Kruskal-Wallis test results for the total amount of employee.

		N	Mean Rank	Sig.
Awareness about competitiveness impact	1-9	77	93,40	0,260
	10-50	89	106,33	
	+50	31	91,87	
	Total	197		
Strategy and policy	1-9	78	92,50	0,250
	10-50	82	104,63	
	+50	33	88,67	
	Total	193		
Product, services and workforce infrastructure	1-9	78	85,69	0,048
	10-50	82	101,87	
	+50	33	111,64	
	Total	193		
Developing digital manufacturing systems technologies	1-9	45	48,42	0,599
	10-50	41	52,98	
	+50	16	56,38	
	Total	102		
Developing virtualization technologies	1-9	45	51,64	0,442
	10-50	41	54,51	
	+50	16	43,38	
	Total	102		
External shareholders	1-9	63	81,23	0,691
	10-50	71	83,35	
	+50	27	74,30	
	Total	161		
Workforce challenges	1-9	68	84,15	0,391
	10-50	81	95,66	
	+50	30	87,97	
	Total	179		
Using indirect relations	1-9	61	77,41	0,241
	10-50	77	88,42	
	+50	32	93,89	
	Total	170		
Customer expectations	1-9	61	67,21	0,002
	10-50	72	95,08	
	+50	28	74,82	
	Total	161		

According to Kruskal-Wallis Test results, hypotheses H₇₁₇ and H₇₂₃ have been accepted ($p < 0,05$). There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure and meeting customer's expectations within the scope of Industry 4.0 technologies with respect to total amount of employee.

In addition, according to the Kruskal-Wallis test results, between first and third groups, there is a significant difference in terms of Industry 4.0 product, services and workforce infrastructure. Mean value of third group (+50) is higher than the first group (1-10 employee). (means; 111,64 and 85,69 respectively). Also, between first and

second groups, there is a significant difference in terms of meeting customer's expectations within the scope of Industry 4.0 technologies. Mean value of second group (10-49) is higher than the first group (1-10 employee). (means; 95,08 and 67,21 respectively).

7.3.8 Time spent in technopark

Participants in this section are divided into three groups in terms of time spent in technopark as less than 2 years, 3-5 year and +5. Then, the normality test was applied to the variables, and the ANOVA was used for those with normally distributed and the Kruskal-Wallis test for the not normally distributed. The reason for this is that there are more than two groups.

H₈₀₁: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to time spent in technopark.

H₈₀₂: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to time spent in technopark.

H₈₀₃: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to time spent in technopark.

H₈₀₄: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to time spent in technopark.

H₈₀₅: There is a statistically significant difference in developing data management technologies with respect to time spent in technopark.

H₈₀₆: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to time spent in technopark.

H₈₀₇: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to time spent in technopark.

H₈₀₈: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to time spent in technopark.

H₈₀₉: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to time spent in technopark.

H₈₁₀: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to time spent in technopark.

H₈₁₁: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to time spent in technopark.

H₈₁₂: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to time spent in technopark.

H₈₁₃: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to time spent in technopark.

H₈₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to time spent in technopark.

The results are given Table 7.95.

Table 7.95 : ANOVA results for the time spent in technopark.

		Sum of Squares	df	Mean Square	F	Sig.
Awareness about organizational impact	Between Groups	2,460	2	1,230	1,300	0,275
	Within Groups	180,741	191	0,946		
	Total	183,200	193			
Awareness about environmental impact	Between Groups	3,522	2	1,761	1,855	0,159
	Within Groups	181,262	191	0,949		
	Total	184,784	193			
Awareness about role of technopark and support	Between Groups	0,878	2	0,439	0,427	0,653
	Within Groups	196,098	191	1,027		
	Total	196,976	193			
Infrastructure for digitalization	Between Groups	0,468	2	0,234	0,232	0,793
	Within Groups	185,777	184	1,010		
	Total	186,246	186			
Developing data management technologies	Between Groups	4,863	2	2,431	2,493	0,088
	Within Groups	92,648	95	0,975		
	Total	97,510	97			
Benefit from internal shareholders	Between Groups	4,543	2	2,272	2,293	0,104
	Within Groups	152,579	154	0,991		
	Total	157,122	156			
Skills	Between Groups	0,516	2	0,258	0,255	0,775
	Within Groups	179,922	178	1,011		
	Total	180,437	180			
Workforce challenges	Between Groups	3,060	2	1,530	1,626	0,200
	Within Groups	160,850	171	0,941		
	Total	163,910	173			
Inadequate support	Between Groups	1,275	2	0,638	0,624	0,537
	Within Groups	174,625	171	1,021		
	Total	175,901	173			
Commercial problems	Between Groups	0,161	2	0,080	0,078	0,925
	Within Groups	175,357	171	1,025		
	Total	175,518	173			
Technology-oriented problems	Between Groups	0,769	2	0,385	0,379	0,685
	Within Groups	173,278	171	1,013		
	Total	174,047	173			
Company's own expectations	Between Groups	0,510	2	0,255	0,255	0,776
	Within Groups	181,371	181	1,002		
	Total	181,881	183			
Direct relations	Between Groups	0,721	2	0,361	0,359	0,699
	Within Groups	163,641	163	1,004		
	Total	164,362	165			

According to ANOVA results all hypotheses have been rejected ($p > 0,05$). There is no statistically significant difference with respect to time spent in technopark.

H₈₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to time spent in technopark.

H816: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to time spent in technopark.

H817: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to time spent in technopark.

H818: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to time spent in technopark.

H819: There is a statistically significant difference in developing virtualization technologies with respect to time spent in technopark.

H820: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to time spent in technopark.

H821: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to time spent in technopark.

H822: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to time spent in technopark.

H823: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to time spent in technopark.

For testing hypotheses, Kruskal-Wallis has been used. This is because variables were not normally distributed and there were three groups in terms of time spent in technopark. The results are given Table 7.96.

Table 7.96 : Kruskal-Wallis test results for the time spent in technopark.

		N	Mean Rank	Sig.
Awareness about competitiveness impact	Less than 2 years	77	93,40	0,260
	3-5	89	106,33	
	+5	31	91,87	
	Total	197		
Strategy and policy	Less than 2 years	78	92,50	0,250
	3-5	82	104,63	
	+5	33	88,67	
	Total	193		
Product, services and workforce infrastructure	Less than 2 years	78	85,69	0,048
	3-5	82	101,87	
	+5	33	111,64	
	Total	193		
Developing digital manufacturing systems technologies	Less than 2 years	45	48,42	0,599
	3-5	41	52,98	
	+5	16	56,38	
	Total	102		
Developing virtualization technologies	Less than 2 years	45	51,64	0,442
	3-5	41	54,51	
	+5	16	43,38	
	Total	102		
External shareholders	Less than 2 years	63	81,23	0,691
	3-5	71	83,35	
	+5	27	74,30	
	Total	161		
Workforce challenges	Less than 2 years	68	84,15	0,391
	3-5	81	95,66	
	+5	30	87,97	
	Total	179		
Using indirect relations	Less than 2 years	61	77,41	0,241
	3-5	77	88,42	
	+5	32	93,89	
	Total	170		
Customer expectations	Less than 2 years	61	67,21	0,002
	3-5	72	95,08	
	+5	28	74,82	
	Total	161		

According to Kruskal-Wallis Test results, all hypotheses have been rejected ($p < 0,05$). There is no statistically significant difference with respect to time spent in technopark.

7.3.9 Annually Revenue

Participants in this section are divided into four groups in terms of annually revenue as less than 500 billion TL, 500 billion TL- 1 million TL, 1 million TL- 8 million TL and over the 8 million TL. Then, the normality test was applied to the variables, and the ANOVA was used for those with normally distributed and the Kruskal-Wallis test for the not normally distributed. The results are given Table 7.97. and Table 7.98.

H901: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to annually revenue.

H902: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to annually revenue.

H903: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to annually revenue.

H904: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to annually revenue.

H905: There is a statistically significant difference in developing data management technologies with respect to annually revenue.

H906: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to annually revenue.

H907: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to annually revenue.

H908: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to annually revenue.

H909: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to annually revenue.

H910: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to annually revenue.

H911: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to annually revenue.

H912: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to annually revenue.

H913: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to annually revenue.

H914: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to annually revenue.

Table 7.97 : ANOVA results for the annually revenue.

		Sum of Squares	df	Mean Square	F	Sig.
Awareness about organizational impact	Between Groups	13,064	3	4,355	5,075	0,002
	Within Groups	116,703	136	0,858		
	Total	129,767	139			
Awareness about environmental impact	Between Groups	4,486	3	1,495	1,445	0,233
	Within Groups	140,743	136	1,035		
	Total	145,228	139			
Awareness about role of technopark and support	Between Groups	7,109	3	2,370	2,306	0,079
	Within Groups	139,738	136	1,027		
	Total	146,847	139			
Infrastructure for digitalization	Between Groups	2,584	3	0,861	0,873	0,457
	Within Groups	136,077	138	0,986		
	Total	138,660	141			
Developing data management technologies	Between Groups	3,928	3	1,309	1,198	0,317
	Within Groups	74,340	68	1,093		
	Total	78,269	71			
Benefit from internal shareholders	Between Groups	2,497	3	0,832	0,868	0,460
	Within Groups	106,460	111	0,959		
	Total	108,957	114			
Skills	Between Groups	2,041	3	0,680	0,798	0,497
	Within Groups	110,794	130	0,852		
	Total	112,835	133			
Workforce challenges	Between Groups	7,424	3	2,475	2,704	0,048
	Within Groups	116,244	127	0,915		
	Total	123,668	130			
Inadequate support	Between Groups	6,144	3	2,048	2,110	0,102
	Within Groups	123,288	127	0,971		
	Total	129,433	130			
Commercial problems	Between Groups	1,201	3	0,400	0,353	0,787
	Within Groups	144,233	127	1,136		
	Total	145,434	130			
Technology-oriented problems	Between Groups	0,643	3	0,214	0,218	0,884
	Within Groups	125,074	127	0,985		
	Total	125,717	130			
Company's own expectations	Between Groups	2,725	3	0,908	0,935	0,426
	Within Groups	130,226	134	0,972		
	Total	132,951	137			
Direct relations	Between Groups	2,562	3	0,854	0,942	0,423
	Within Groups	107,845	119	0,906		
	Total	110,407	122			

According to ANOVA results all hypotheses have been rejected ($p > 0,05$) except hypothesis H₉₀₁ and H₉₀₈. According to the ANOVA result, the average mean of companies that have less than 500 billion TL annual revenue, Industry 4.0 awareness about organizational impact higher than others. In addition, the average mean of companies that have 500 billion TL- 1 million TL annual revenue, facing workforce challenges higher than others.

H₉₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to annually revenue.

H₉₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to annually revenue.

H₉₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to annually revenue.

H₉₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to annually revenue.

H₉₁₉: There is a statistically significant difference in developing virtualization technologies with respect to annually revenue.

H₉₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to annually revenue.

H₉₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to annually revenue.

H₉₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to annually revenue.

H₉₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to annually revenue.

For testing hypotheses, Kruskal-Wallis has been used. This is because variables were not normally distributed and there were three groups in terms of annually revenue. The results are given Table 7.98.

Table 7.98 : Kruskal-Wallis test results for the annually revenue.

		N	Mean Rank	Sig.
Awareness about competitiveness impact	less than 500 billion TL	32	61,84	0,436
	500 billion TL- 1 million TL	34	73,18	
	1 million TL- 8 million TL	45	76,47	
	Over 8 million TL	29	67,66	
	Total	140		
Strategy and policy	less than 500 billion TL	35	73,14	0,734
	500 billion TL- 1 million TL	33	77,42	
	1 million TL- 8 million TL	46	67,43	
	Over 8 million TL	28	69,14	
	Total	142		
Product, services and workforce infrastructure	less than 500 billion TL	35	64,60	0,663
	500 billion TL- 1 million TL	33	71,67	
	1 million TL- 8 million TL	46	73,22	
	Over 8 million TL	28	77,11	
	Total	142		
Developing digital manufacturing systems technologies	less than 500 billion TL	17	38,65	0,914
	500 billion TL- 1 million TL	20	34,18	
	1 million TL- 8 million TL	20	35,88	
	Over 8 million TL	15	38,00	
	Total	72		
Developing virtualization technologies	less than 500 billion TL	17	39,88	0,858
	500 billion TL- 1 million TL	20	34,98	
	1 million TL- 8 million TL	20	34,48	
	Over 8 million TL	15	37,40	
	Total	72		
External shareholders	less than 500 billion TL	29	56,98	0,483
	500 billion TL- 1 million TL	30	65,98	
	1 million TL- 8 million TL	36	54,32	
	Over 8 million TL	20	54,13	
	Total	115		
Workforce challenges	less than 500 billion TL	29	57,52	0,088
	500 billion TL- 1 million TL	34	79,65	
	1 million TL- 8 million TL	44	61,20	
	Over 8 million TL	24	65,71	
	Total	131		
Using indirect relations	less than 500 billion TL	28	59,34	0,508
	500 billion TL- 1 million TL	33	56,48	
	1 million TL- 8 million TL	35	63,20	
	Over 8 million TL	27	69,94	
	Total	123		
Customer expectations	less than 500 billion TL	30	53,72	0,557
	500 billion TL- 1 million TL	31	66,24	
	1 million TL- 8 million TL	32	62,11	
	Over 8 million TL	27	59,54	
	Total	120		

According to Kruskal-Wallis Test results, all hypotheses have been rejected ($p < 0,05$).

There is no statistically significant difference with respect to annually revenue.

7.3.10 Budget for Industry 4.0

Participants in this section are divided into three groups in terms of budgets for Industry 4.0 as less than 10%, 10%-50%, and over 50%. Then, the normality test was applied to the variables, and the ANOVA was used for those with normally distributed and the Kruskal-Wallis test for the not normally distributed. The results are given Table 7.99. and Table 7.100.

H₁₀₀₁: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to budgets for Industry 4.0.

H₁₀₀₂: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to budgets for Industry 4.0.

H₁₀₀₃: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to budgets for Industry 4.0.

H₁₀₀₄: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to budgets for Industry 4.0.

H₁₀₀₅: There is a statistically significant difference in developing data management technologies with respect to budgets for Industry 4.0.

H₁₀₀₆: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to budgets for Industry 4.0.

H₁₀₀₇: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to budgets for Industry 4.0.

H₁₀₀₈: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to budgets for Industry 4.0.

H₁₀₀₉: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to budgets for Industry 4.0.

H₁₀₁₀: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to budgets for Industry 4.0.

H₁₀₁₁: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to budgets for Industry 4.0.

H₁₀₁₂: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to budgets for Industry 4.0.

H₁₀₁₃: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to budgets for Industry 4.0.

H₁₀₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to budgets for Industry 4.0.



Table 7.99 : ANOVA results for the budgets for Industry 4.0.

		Sum of Squares	df	Mean Square	F	Sig.
Awareness about organizational impact	Between Groups	12,320	2	6,160	7,269	0,001
	Within Groups	115,257	136	0,847		
	Total	127,578	138			
Awareness about environmental impact	Between Groups	1,006	2	0,503	0,577	0,563
	Within Groups	118,582	136	0,872		
	Total	119,588	138			
Awareness about role of technopark and support	Between Groups	3,963	2	1,981	2,023	0,136
	Within Groups	133,177	136	0,979		
	Total	137,140	138			
Infrastructure for digitalization	Between Groups	10,151	2	5,076	5,876	0,004
	Within Groups	118,342	137	0,864		
	Total	128,494	139			
Developing data management technologies	Between Groups	7,453	2	3,727	3,643	0,031
	Within Groups	76,726	75	1,023		
	Total	84,179	77			
Benefit from internal shareholders	Between Groups	10,998	2	5,499	5,914	0,004
	Within Groups	103,205	111	0,930		
	Total	114,204	113			
Skills	Between Groups	14,651	2	7,326	9,325	0,000
	Within Groups	102,123	130	0,786		
	Total	116,775	132			
Workforce challenges	Between Groups	1,092	2	0,546	0,593	0,554
	Within Groups	116,040	126	0,921		
	Total	117,131	128			
Inadequate support	Between Groups	4,032	2	2,016	1,890	0,155
	Within Groups	134,363	126	1,066		
	Total	138,395	128			
Commercial problems	Between Groups	3,383	2	1,692	1,600	0,206
	Within Groups	133,239	126	1,057		
	Total	136,622	128			
Technology-oriented problems	Between Groups	4,634	2	2,317	2,084	0,129
	Within Groups	140,060	126	1,112		
	Total	144,694	128			
Company's own expectations	Between Groups	3,669	2	1,835	2,091	0,128
	Within Groups	113,169	129	0,877		
	Total	116,839	131			
Direct relations	Between Groups	3,123	2	1,561	1,684	0,190
	Within Groups	113,117	122	0,927		
	Total	116,240	124			

According to ANOVA results all hypotheses have been rejected ($p > 0,05$) except hypothesis H_{1001} , H_{1004} , H_{1005} , H_{1006} , and H_{1007} . According to the ANOVA result, the average mean of companies that have over 50% budget for Industry 4.0, infrastructure for digitalization, developing data management technologies, employee skills and benefit from internal shareholder for Industry 4.0 are higher than others.

H₁₀₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to budget for Industry 4.0.

H₁₀₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to budget for Industry 4.0.

H₁₀₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to budget for Industry 4.0.

H₁₀₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to budget for Industry 4.0.

H₁₀₁₉: There is a statistically significant difference in developing virtualization technologies with respect to budget for Industry 4.0.

H₁₀₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to budget for Industry 4.0.

H₁₀₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to budget for Industry 4.0.

H₁₀₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to budget for Industry 4.0.

H₁₀₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to budget for Industry 4.0.

For testing hypotheses, Kruskal-Wallis has been used. This is because variables were not normally distributed and there were three groups in terms of budget for Industry 4.0. The results are given Table 7.100.

Table 7.100 : Kruskal-Wallis test results for the budget for Industry 4.0.

		N	Mean Rank	Sig.
Awareness about competitiveness impact	-10%	61	75,21	0,279
	10-50%	56	63,48	
	+50%	22	72,14	
	Total	139		
Strategy and policy	-10%	59	56,36	0,000
	10-50%	57	71,14	
	+50%	24	103,75	
	Total	140		
Product, services and workforce infrastructure	-10%	59	64,14	0,137
	10-50%	57	71,60	
	+50%	24	83,54	
	Total	140		
Developing digital manufacturing systems technologies	-10%	34	40,03	0,827
	10-50%	34	38,00	
	+50%	10	42,80	
	Total	78		
Developing virtualization technologies	-10%	34	35,68	0,414
	10-50%	34	42,06	
	+50%	10	43,80	
	Total	78		
External shareholders	-10%	53	56,81	0,650
	10-50%	46	55,91	
	+50%	15	64,80	
	Total	114		
Workforce challenges	-10%	53	67,26	0,664
	10-50%	55	65,27	
	+50%	21	58,57	
	Total	129		
Using indirect relations	-10%	49	65,62	0,761
	10-50%	52	62,31	
	+50%	24	59,15	
	Total	125		
Customer expectations	-10%	48	49,84	0,012
	10-50%	50	61,10	
	+50%	19	76,61	
	Total	117		

According to Kruskal-Wallis Test results, hypotheses H₁₀₁₆ and H₁₀₂₃ have been accepted ($p > 0,05$). There is a statistically significant difference in company's Industry 4.0 strategy and policy and meeting customer's expectations within the scope of Industry 4.0 technologies with respect to budget for Industry 4.0.

In addition, according to the Kruskal-Wallis test results, between first and third groups, second and third groups there is a significant difference in terms of Industry 4.0 strategy and policy. Mean value of third group (+50 %) is higher than the first and second group (-10% and 10-50% respectively). (means; 103,75-50,36 and 103,75-

71,14 respectively). Also, between first and third groups there is a significant difference in terms of meeting customer's expectations within the scope of Industry 4.0 technologies. Mean value of third group (+50 %) is higher than the first groups (-10%). (means; 76,61-49,84 respectively).

7.3.11 Patent acquisition of company

Patent increases the total volume of information and increases the production of human capital in R&D operations [62]. So, participants in this section are divided into two groups in terms of company's patent acquisition. Then, the normality test was applied to the variables, and the t test was used for those with normally distributed and the Mann Whitney U test for the not normally distributed.

H₁₁₀₁: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to company's patent acquisition.

H₁₁₀₂: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to company's patent acquisition.

H₁₁₀₃: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to company's patent acquisition.

H₁₁₀₄: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to company's patent acquisition.

H₁₁₀₅: There is a statistically significant difference in developing data management technologies with respect to company's patent acquisition.

H₁₁₀₆: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₀₇: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to company's patent acquisition.

H₁₁₀₈: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₀₉: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₁₀: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₁₁: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₁₂: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to company's patent acquisition.

H₁₁₁₃: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to company's patent acquisition.

According to t-Test results, hypotheses H₁₁₀₅ and H₁₁₀₆ have been accepted ($p < 0,05$). On the other hand, others are rejected. So, there is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies. The average mean of companies that have patent is higher than the others. Also, there is a statistically significant difference in developing data management technologies with respect to company's patent acquisition. The average mean of companies that have not any patent is higher than the others. The results are given Table 7.101.

Table 7.101 : t-test results for the company's patent acquisition.

		Levine's Test for Equality of Variances				t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
										Lower	Upper
Awareness about organizational impact	Equal variances assumed	0,304	0,582	0,504	183	0,615	0,07709153	0,15296657	-0,22471333	0,37889640	
	Equal variances not assumed			0,529	121,081	0,598	0,07709153	0,14571761	-0,21139298	0,36557604	
Awareness about environmental impact	Equal variances assumed	0,033	0,856	0,918	183	0,360	0,14357490	0,15639812	-0,16500045	0,45215025	
	Equal variances not assumed			0,902	103,211	0,369	0,14357490	0,15920414	-0,17216128	0,45931108	
Awareness about role of technopark and support	Equal variances assumed	0,002	0,961	1,713	183	0,088	0,27156490	0,15850927	-0,04117578	0,58430558	
	Equal variances not assumed			1,729	109,989	0,087	0,27156490	0,15703500	-0,03964195	0,58277175	
Infrastructure for digitalization	Equal variances assumed	2,248	0,136	0,896	182	0,371	0,13859164	0,15466579	-0,16657698	0,44376025	
	Equal variances not assumed			0,924	119,652	0,357	0,13859164	0,14998718	-0,15838134	0,43556461	
Developing data management technologies	Equal variances assumed	3,949	0,050	-0,248	95	0,805	-0,05647825	0,22771463	-0,50854894	0,39559245	
	Equal variances not assumed			-0,230	47,362	0,819	-0,05647825	0,24524547	-0,54974900	0,43679250	
Benefit from internal shareholders	Equal variances assumed	5,724	0,018	1,033	151	0,303	0,17800229	0,17239269	-0,16261099	0,51861557	
	Equal variances not assumed			1,093	105,170	0,277	0,17800229	0,16283558	-0,14486451	0,50086909	
Skills	Equal variances assumed	0,046	0,831	0,757	176	0,450	0,11876968	0,15693804	-0,19095294	0,42849229	
	Equal variances not assumed			0,759	107,593	0,450	0,11876968	0,15649188	-0,19143769	0,42897704	

Table 7.101 (continued) : t-test results for the company's patent acquisition.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Facing workforce challenges	Equal variances assumed	0,339	0,561	-0,735	168	0,463	-0,12002137	0,16329366	-0,44239330	0,20235055
	Equal variances not assumed			-0,731	101,942	0,467	-0,12002137	0,16429846	-0,44590883	0,20586609
Competencies	Equal variances assumed	0,279	0,598	1,019	184	0,310	0,15468998	0,15180422	-0,14481072	0,45419067
	Equal variances not assumed			1,031	119,561	0,305	0,15468998	0,15008386	-0,14247673	0,45185669
Inadequate support	Equal variances assumed	0,044	0,834	-1,456	168	0,147	-0,24329260	0,16706829	-0,57311634	0,08653114
	Equal variances not assumed			-1,472	106,239	0,144	-0,24329260	0,16532046	-0,57104798	0,08446279
Facing commercial problems	Equal variances assumed	0,003	0,959	0,336	168	0,737	0,05588798	0,16615602	-0,27213476	0,38391073
	Equal variances not assumed			0,335	102,529	0,738	0,05588798	0,16678836	-0,27491547	0,38669144
Facing technology-oriented problems	Equal variances assumed	1,124	0,291	-1,869	168	0,063	-0,31194298	0,16686877	-0,64137282	0,01748687
	Equal variances not assumed			-1,783	92,445	0,078	-0,31194298	0,17493715	-0,65936099	0,03547504
Meeting company's own expectations	Equal variances assumed	0,959	0,329	1,776	175	0,077	0,27957147	0,15741775	-0,03111016	0,59025310
	Equal variances not assumed			1,723	104,652	0,088	0,27957147	0,16229502	-0,04224206	0,60138499
Using direct relations	Equal variances assumed	0,338	0,562	-0,778	159	0,438	-0,12803340	0,16463452	-0,45318595	0,19711915
	Equal variances not assumed			-0,767	102,584	0,445	-0,12803340	0,16692311	-0,45910200	0,20303519

H₁₁₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to company's patent acquisition.

H₁₁₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to company's patent acquisition.

H₁₁₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to company's patent acquisition.

H₁₁₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to company's patent acquisition.

H₁₁₁₉: There is a statistically significant difference in developing virtualization technologies with respect to age company's patent acquisition.

H₁₁₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to company's patent acquisition.

H₁₁₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to company's patent acquisition.

For testing hypotheses, Mann-Whitney U Test has been used. This is because variables were not normally distributed and there were two groups.

According to Mann-Whitney U Test results, hypotheses H₁₁₂₂ has been accepted ($p < 0.05$). In addition, the other hypotheses are rejected because of their p value was greater than 0,05. The results are given Table 7.102.

Table 7.102 : Mann-Whitney U test p value results for the company's patent acquisition.

		N	Mean Rank	Sum of Ranks	Sig.
Using indirect relations	Having patent acquisition	54	92,45	4992,50	0,022
	Have not patent acquisition	107	75,22	8048,50	
	Total	161			

It can be say that there is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to company's patent acquisition. This difference militates in favor of firms that have not any patent.

7.3.12 Companies' position for the Industry 4.0 development

Participants in this section are divided into two groups in terms of company's position for the Industry 4.0 development (leaders and followers, relevant and irrelevant). Then, the normality test was applied to the variables, and the t test was used for those with normally distributed and the Mann Whitney U test for the not normally distributed.

H₁₂₀₁: There is a statistically significant difference in Industry 4.0 awareness about organizational impact with respect to company's position for the Industry 4.0 development.

H₁₂₀₂: There is a statistically significant difference in Industry 4.0 awareness about environmental impact with respect to company's position for the Industry 4.0 development.

H₁₂₀₃: There is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to company's position for the Industry 4.0 development.

H₁₂₀₄: There is a statistically significant difference in company's Industry 4.0 infrastructure for digitalization with respect to company's position for the Industry 4.0 development.

H₁₂₀₅: There is a statistically significant difference in developing data management technologies with respect to company's position for the Industry 4.0 development.

H₁₂₀₆: There is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₀₇: There is a statistically significant difference in company's employee skills in terms of Industry 4.0 with respect to company's position for the Industry 4.0 development.

H₁₂₀₈: There is a statistically significant difference in facing workforce problems when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₀₉: There is a statistically significant difference in facing commercial problems when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₁₀: There is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₁₁: There is a statistically significant difference in facing technology-oriented problems when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₁₂: There is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to company's position for the Industry 4.0 development.

H₁₂₁₃: There is a statistically significant difference in using direct relations when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₁₄: There is a statistically significant difference in achieving company's own expectations within the scope of Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

According to t-Test results, hypotheses H₁₂₀₃ and H₁₂₁₂ have been accepted ($p < 0,05$). On the other hand, others are rejected. So, there is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to company's position for the Industry 4.0 development. The average mean of companies

that their position is leader and follower is higher than the others. Also, there is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to company's position for the Industry 4.0 development. The average mean of companies that their position is leader and follower is higher than the others. The results are given Table 7.103.



Table 7.103 : t-test results for the company's position for the Industry 4.0 development.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Awareness about organizational impact	Equal variances assumed	3,722	0,055	5,471	177	0,000	0,78826182	0,14408698	0,50391233	1,07261131
	Equal variances not assumed			5,360	152,501	0,000	0,78826182	0,14706436	0,49771532	1,07880832
Awareness about environmental impact	Equal variances assumed	1,168	0,281	0,508	177	0,612	0,07687335	0,15138845	-0,22188527	0,37563196
	Equal variances not assumed			0,515	176,586	0,607	0,07687335	0,14934631	-0,21785996	0,37160665
Awareness about role of technopark and support	Equal variances assumed	4,155	0,043	0,822	177	0,412	0,12537659	0,15259692	-0,17576690	0,42652007
	Equal variances not assumed			0,806	154,288	0,421	0,12537659	0,15548419	-0,18177604	0,43252921
Infrastructure for digitalization	Equal variances assumed	3,439	0,065	2,317	174	0,022	0,34941304	0,15077649	0,05182678	0,64699930
	Equal variances not assumed			2,269	148,374	0,025	0,34941304	0,15397206	0,04515170	0,65367437
Developing data management technologies	Equal variances assumed	2,234	0,139	1,312	89	0,193	0,26680969	0,20339194	-0,13732575	0,67094513
	Equal variances not assumed			1,291	78,136	0,200	0,26680969	0,20663570	-0,14455914	0,67817853
Benefit from internal shareholders	Equal variances assumed	0,005	0,944	1,264	144	0,208	0,21255362	0,16810930	-0,11972703	0,54483428
	Equal variances not assumed			1,263	139,375	0,209	0,21255362	0,16833407	-0,12026490	0,54537215
Skills	Equal variances assumed	0,620	0,432	2,128	164	0,035	0,32805374	0,15415868	0,02366210	0,63244537
	Equal variances not assumed			2,119	155,186	0,036	0,32805374	0,15481535	0,02223637	0,63387111

Table 7.103 (continued) : t-test results for the company's Industry 4.0 position.

		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Facing workforce challenges	Equal variances assumed	0,176	0,676	0,597	156	0,551	0,09436912	0,15803007	-0,21778570	0,40652394
	Equal variances not assumed			0,605	148,670	0,546	0,09436912	0,15593721	-0,21377046	0,40250870
Competencies	Equal variances assumed	3,333	0,070	1,898	174	0,059	0,29263690	0,15420484	-0,01171587	0,59698968
	Equal variances not assumed			1,843	141,066	0,067	0,29263690	0,15880472	-0,02130788	0,60658169
Inadequate support	Equal variances assumed	0,961	0,328	1,446	156	0,150	0,22855365	0,15805429	-0,08364902	0,54075632
	Equal variances not assumed			1,411	128,494	0,161	0,22855365	0,16193785	-0,09185629	0,54896360
Facing commercial problems	Equal variances assumed	0,000	0,985	0,751	156	0,454	0,12095722	0,16115256	-0,19736541	0,43927985
	Equal variances not assumed			0,750	141,664	0,455	0,12095722	0,16136936	-0,19804601	0,43996045
Facing technology-oriented problems	Equal variances assumed	0,069	0,793	0,262	156	0,794	0,04117402	0,15711235	-0,26916805	0,35151608
	Equal variances not assumed			0,264	146,739	0,792	0,04117402	0,15571709	-0,26656382	0,34891186
Meeting company's own expectations	Equal variances assumed	0,923	0,338	1,767	166	0,079	0,27032392	0,15297588	-0,03170520	0,57235305
	Equal variances not assumed			1,739	143,295	0,084	0,27032392	0,15542221	-0,03689255	0,57754039
Using direct relations	Equal variances assumed	0,206	0,651	2,330	148	0,021	0,37815462	0,16228820	0,05745326	0,69885598
	Equal variances not assumed			2,289	124,526	0,024	0,37815462	0,16521644	0,05115863	0,70515061

H₁₂₁₅: There is a statistically significant difference in Industry 4.0 awareness about competitiveness impact with respect to company's position for the Industry 4.0 development.

H₁₂₁₆: There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to company's position for the Industry 4.0 development.

H₁₂₁₇: There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to company's position for the Industry 4.0 development.

H₁₂₁₈: There is a statistically significant difference in developing digital manufacturing systems technologies with respect to company's position for the Industry 4.0 development.

H₁₂₁₉: There is a statistically significant difference in developing virtualization technologies with respect to age company's position for the Industry 4.0 development.

H₁₂₂₀: There is a statistically significant difference in benefit from external shareholders when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₂₁: There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₂₂: There is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

H₁₂₂₃: There is a statistically significant difference in meeting customer's expectations within the scope of Industry 4.0 technologies with respect to company's position for the Industry 4.0 development.

For testing hypotheses, Mann-Whitney U Test has been used. This is because variables were not normally distributed and there were two groups.

According to Mann-Whitney U Test results, hypotheses H₁₂₁₆, H₁₂₁₇, H₁₂₁₈, and H₁₂₂₀ have been accepted ($p < 0.05$). In addition, the other hypotheses are rejected because of their p value was greater than 0,05. The results are given Table 7.104.

Table 7.104 : Mann-Whitney U test p value results for the company's Industry 4.0 position.

		N	Mean Rank	Sum of Ranks	Sig.
Strategy and policy	Leader and followers	99	101,33	10032,00	0,000
	Relevant and irrelevant	77	72,00	5544,00	
	Total	176			
Product, services and workforce infrastructure	Leader and followers	99	98,67	9768,00	0,003
	Relevant and irrelevant	77	75,43	5808,00	
	Total	176			
Developing digital manufacturing systems technologies	Leader and followers	40	52,68	2107,00	0,033
	Relevant and irrelevant	51	40,76	2079,00	
	Total	91			
Benefit from external shareholders	Leader and followers	79	81,73	6457,00	0,011
	Relevant and irrelevant	67	63,79	4274,00	
	Total	146			

It can be say that, there is a statistically significant difference in company's Industry 4.0 strategy and policy, product, services and workforce infrastructure, developing digital manufacturing systems technologies and benefit from external shareholders with respect to company's position for the Industry 4.0 development. These differences militate in favor of firms that leader and followers in terms of position for the Industry 4.0 development.

7.4 Regression Analysis

In this section, multiple regression analysis was performed to examine impacts of all factors arising from factor analysis on companies' achievement level in terms of market competitiveness expectations. The result showed that some of factors has no statistically significance effect on the achievement level in terms of companies' market competitiveness expectations. And these factors that have no statistically significance effect were dropped from the model.

Meanwhile, factors that have a statistically significance effect on the achievement level in terms of markets competitiveness expectations such as employee skills within the scope of Industry 4.0, product, services and workforce infrastructure for Industry 4.0,

using direct and indirect relations and benefit from external and internal shareholders are illustrated in Figure 7.1. Also, analysis results of the model have shown in Table 7.105 and Table 7.106.

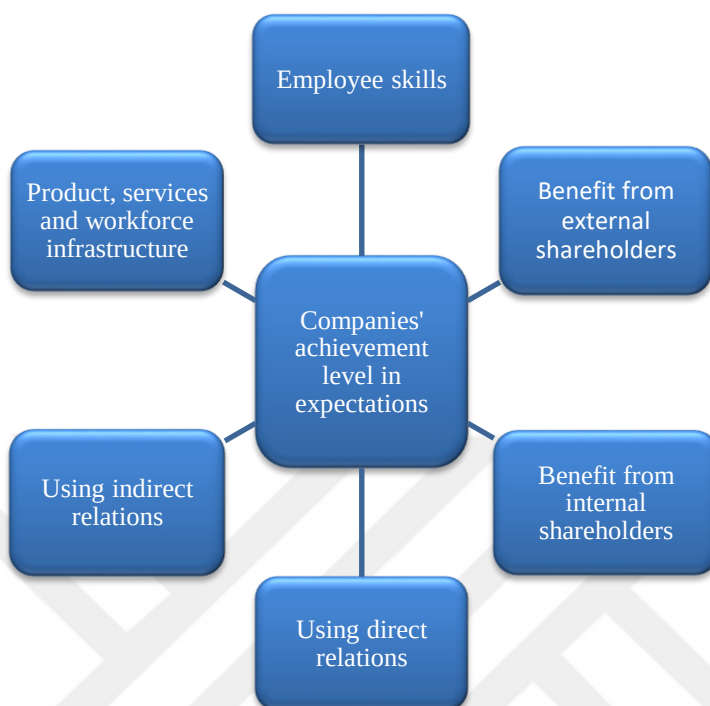


Figure 7.8 : Regression Model.

Table 7.105 : ANOVA results of model.

		Sum of Squares	df	Mean Square	F	Sig.
Model	Regression	42,191	6	7,032	9,433	0,000
	Residual	92,439	124	0,745		
	Total	134,630	130			

As seen in the Table 7.105, the model is significant.

Table 7.106 : Coefficients of model.

		B	Std. Error	Beta	t	Sig.	VIF
Model	Employee skills	0,393	0,087	0,388	4,531	0,000	1,323
	Product, services and workforce infrastructure for Industry 4.0	0,182	0,084	0,181	2,168	0,032	1,252
	Benefit from external shareholders	0,162	0,088	0,154	1,844	0,068	1,266
	Benefit from internal shareholders	0,072	0,083	0,070	0,860	0,391	1,210
	Using direct relations	-0,122	0,077	-0,123	-1,591	0,114	1,087
	Using indirect relations	0,049	0,079	0,050	0,622	0,535	1,189

According to the Table 7.106, the achievement level in terms of companies' market competitiveness expectations is explained six variables such as employee skills, product, services and workforce infrastructure for Industry 4.0, benefit from external and internal shareholders and using direct and indirect relations. Last four variable's beta and significance value are quite low than first two variables. On the other hand, between success in company's own expectations and employee skills and product, services and workforce infrastructure for Industry 4.0, there is a positively relation.



8. CONCLUSIONS AND RECOMMENDATIONS

The world has experienced three major industrial revolutions until today. During the first industrial revolution in the 18th century, water and steam power and mechanization took place. Then in the 19th century the second industrial revolution brought mass production together. In the 20th century, automation was provided, and electronics and information technology entered our lives. Finally, today we are in a new industrial revolution which is called “Industry 4.0”.

Industry 4.0 is a collective concept which includes many modern automation systems, data exchanges and production technologies. This revolution is a whole made up of cyber-physical systems, the internet of things. This revolution will lead to the formation of a smart factory system. In addition, all kinds of data will be collected, followed and analyzed in the production environment. For this way, efficient business models will emerge.

The development of the fourth industrial revolution in our country has a vital importance. This is because, this revolution will increase the competitiveness of our country and take one step further. For this reason, this study was carried out in the technopark companies which have a crucial importance in the technology production. There is not yet a study in the literature that reveals the studies and awareness of technopark companies in this respect. So, the main aim of this study is to shed light on national and international literature in this respect.

In total, 231 technopark companies participated in the study. Industry 4.0 awareness of the participants, their level of strategy and organizational structure, the activities that will provide the digital transformation and the level of these activities, the Industry 4.0 technologies that they intend to work in the future, the cooperation level within the scope of Industry 4.0 activities, the application areas in which they offer products/services within the scope of Industry 4.0, when developing these technologies, companies’ challenges that they faced, customer expectations, the company's own expectations and the degree of success from these expectations, and the opportunities that they used to develop technology in relation to Industry 4.0.

First of all, descriptive analyzes were made using the SPSS 25.0 statistical program. Then exploratory factor analysis and reliability analyze were applied.

In the first part, which measures the level of awareness of companies, is summed up in four factors. These are; awareness about organizational impact, awareness about competitiveness impact, awareness about role of technopark and support and awareness about environmental impact. In the second part, which measures company's Industry 4.0 strategies and their organizational structure is summed up in three factors as; strategy and policy, product, services and work force infrastructure and infrastructure for digitalization.

Industry 4.0 technologies, which companies are aiming to develop and are developing now, is concentrated in three factors. These are; digital manufacturing systems technologies, virtualization technologies and data management technologies.

The collaborations that companies have realized while developing products / services under Industry 4.0 are summed up in two factors as external and internal shareholders. And opportunities that companies have realized while improving products/services within the scope of Industry 4.0 are concentrated as direct and indirect relations.

The challenges that encountered by the companies were collected in four groups. These are; workforce challenges, commercial problems, inadequate support and technology-oriented problems.

Companies' expectations are collected in two groups as market competitiveness and organizational competitiveness. In addition, customer expectations are collected as improvement of competitive advantage, improvement of operational performance, improvement of product and services and improvement of production efficiency. Employee competence and skills are collected in one factor separately.

Considering the descriptive analysis, over half of the participants are managers and company owners (56%). In addition, half of the participants are companies established after 2010. (51%). 83.1% of the participants are in technopark in Istanbul. In addition, all the companies involved in the analysis are software and engineering oriented companies.

According to the results, considering the participants average mean of answers in the part of "Overview of Industry 4.0", participant firms think that Industry 4.0 has an

important role in achieving market share and technoparks are important to technology development. However, they find that their support is inadequate in this respect.

Participants responses of regarding to the role of Industry 4.0 technologies on acquiring more market share is in the same way as the results of a survey results which is conducted by Boston Consulting Group and TÜSİAD in manufacturing firms in 2016. According to two research, most of the companies think that Industry 4.0 technologies will contribute to getting more market share [10].

In addition, according to the answers in the part of “Strategy and Organization”, technoparks have a low average in terms of training or organizing under Industry 4.0. However, it also has a high average in terms of the adaptability of its products and their employee skills.

When the Industry 4.0 technologies are taken into consideration, most of the participants who answered this question, offered their solutions which are related to these technologies is in the range of 0-4 predominantly. In addition, the participants' average mean of contribution to development to these technologies is 2,22, while the target mean value is 3,14. Therefore, we can say that the participants are aiming to contribute more in the future because it is a new subject.

Another descriptive statistic is related the participants' cooperation's. According to the results of the survey, customers and employees have the highest mean average of business associations. Also, when we look at the results of the research in terms of opportunities, the most important and most useful opportunity for participating companies is "the advantages offered by the technopark".

In addition, according to the survey results, participating companies present Industry 4.0 products in the fields of information technology the most. The human resources application area is the least average area.

When we look at the competencies and skills of employees, the highest average of employee skills was “software development” with the value of 4,22. Besides, automation technology had the lowest average means with the value of 3,29. Also, the highest average of employee competence was “problem solving” with the value of 4,22. Besides, “emotional intelligence” had the lowest average means with the value of 3,71. In a published article on the internet page of the world economic forum, the top ten skills to be owned by 2020 are ranked according to their importance. It is stated

that the first ability to possess is “complex problem solving” as it is in the answers given by participants in this thesis study [64].

When the difficulties encountered by participants are considered, the highest average mean of the difficulties that they faced when developing Industry 4.0 technologies was “inadequate financial support and funding sources” with the value of 3,30. A study supporting this result was made by Fahri Sakarya in 2012 within the scope of master's thesis. In the study, the technopark support activities were investigated and the result was that the technopark administrations could not sufficiently support the commercialization of the technopark products [65]. However, “lack of information sharing among employees” had the least average mean with the value of 2,22.

Finally, according to the participants' responses in terms of customer expectations, the highest average mean of the customer expectation regarding Industry 4.0 technologies is the “to increase profitability”. Also, the highest success level average mean regarding Industry 4.0 technologies is “to improve the quality of the products / services offered”. Besides, considering participant expectations, the highest average mean of the expectation when developing Industry 4.0 technologies is the “to increase market share” and the highest success level average mean when developing Industry 4.0 technologies is “creating and developing company image”.

Descriptive analyzes and factor analyzes followed by hypothesis testing. Hypotheses are among each factor and the general characteristics of the companies. It was then analyzed whether there was a meaningful difference between each factor and each general characteristics of companies.

For the analysis of hypotheses, the normality test was performed first. The t-test and the Anova test were performed for normal distributed. Mann Whitney U test and Kruskal Wallis test were performed for nonnormal distributed.

According to the establishment year of the companies, there is a statistically significant difference in facing inadequate support when developing Industry 4.0 technologies with respect to age of the company. The average mean of companies facing insufficient support after 2010 is higher than the companies established before 2010. In addition, there is a statistically significant difference in developing virtualization technologies with respect to age of the company. This difference militates in favor of firms that founded after 2010. Also, there is a statistically significant difference in benefit from

external shareholders when developing Industry 4.0 technologies with respect to age of the company. This difference militates in favor of firms that founded after 2010.

In terms of the target markets of the companies, there is no statistically significant difference with respect to target market of company.

In addition, there is a statistically significant with respect to capital structure of the company in terms of awareness about organizational impact and facing technology-oriented problems. According to the results, the average mean of companies with domestic capital structure awareness about organizational impact is higher than companies that having foreign capital structure.

Also, there is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to company structure. According to results, the average of companies that dependent with a national company's awareness about role of technopark and support is higher than others.

There is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure with respect to company structure. There is a statistically significant difference in facing workforce challenges when developing Industry 4.0 technologies with respect to company structure.

In addition, according to the Kruskal-Wallis test results, between third and second groups there is a significant difference in terms of product, services and workforce infrastructure and in terms of facing workforce challenges. In both cases, mean value of second group (dependent with a national company) is higher than the third group (independent). (means; 132,67-93,34 and 119,62-86,88 respectively).

In terms of employee skills, there is a statistically significant difference in Industry 4.0 awareness about organizational impact, company's employee skills and success of company's own expectations with respect to company's total customer amount that served Industry 4.0 technologies. According to the results, the average mean of companies' that have over the 50 customer success on expectations and their employee skills higher than others.

In terms of number of customers, the average mean of companies' that have 1-10 customers' Industry 4.0 awareness about organizational impact is higher than the others. There is a statistically significant difference in company's Industry 4.0 strategy and policy with respect to total amount of customer.

In addition, according to the Kruskal-Wallis test results, between first and third groups, there is a significant difference in terms of Industry 4.0 strategy and policy. Mean value of first group (1-10 customer) is higher than the third group (+50). (means; 107,63 and 84,33 respectively).

The place where Industry 4.0 emerged is known as Germany [7]. For this reason, the companies that own the client are compared with those who do not. However, no significant difference was observed in this respect.

Considering in terms of number of employees of the companies, there is a statistically significant difference in company's Industry 4.0 product, services and workforce infrastructure and meeting customer's expectations within the scope of Industry 4.0 technologies with respect to total amount of employee.

In addition, according to the Kruskal-Wallis test results, between first and third groups, there is a significant difference in terms of Industry 4.0 product, services and workforce infrastructure. Mean value of third group (+50) is higher than the first group (1-10 employee). (means; 111,64 and 85,69 respectively). Also, between first and second groups, there is a significant difference in terms of meeting customer's expectations within the scope of Industry 4.0 technologies. Mean value of second group (10-49) is higher than the first group (1-10 employee). (means; 95,08 and 67,21 respectively).

In a study that examines the factors that have an impact on developing innovative technologies in 2017. According to results the number of employees in the business has positively influence in the development of innovative technology [66]. However, in this study, could not find any significant relationship between the development of Industry 4.0 technologies and the number of employee.

Considering the year of companies that spent in technopark, there is no statistically significant difference between any factors with respect to time spent in technopark. However, in a research conducted in 2007 in the technopark located in Ankara, it was stated that companies with high R&D cooperation have been in the technopark for a longer time [67]. On the other hand, in this research conducted under this thesis study, no relation was found between the collaboration and the time spent in technopark within the scope of developing Industry 4.0 technologies.

In addition, considering the company's annually revenues, the average mean of companies that have less than 500 billion TL annual revenue, Industry 4.0 awareness about organizational impact higher than others. In addition, the average mean of companies that have 500 billion TL- 1 million TL annual revenue, facing workforce challenges higher than others.

In a study which was conducted in developed countries in 2012, a positive and significant relationship was found between R&D spending and innovation creation. In other words, the increase in the budgets that companies allocate to research development positively affects innovative production and development activities [68]. For this reason, the budgets for Industry 4.0 is also considered. According to the result, the average mean of companies that have over 50% budget for Industry 4.0, infrastructure for digitalization, developing data management technologies, employee skills and benefit from internal shareholder for Industry 4.0 was found higher than others.

Patent increases the total volume of information and increases the production of human capital in R&D operations [62]. For this reason, hypotheses have been developed concerning patent acquisition. According to the results, there is a statistically significant difference in benefit from internal shareholders when developing Industry 4.0 technologies. The average mean of companies that have patent is higher than the others. Also, there is a statistically significant difference in developing data management technologies with respect to company's patent acquisition. The average mean of companies that have not any patent is higher than the others. In other words, companies that do not have patent yet, has a higher average mean in terms of developing data management technologies. In addition, there is a statistically significant difference in using indirect relations when developing Industry 4.0 technologies with respect to company's patent acquisition. This difference militates in favor of firms that have not any patent.

In terms of awareness of companies, there is a statistically significant difference in Industry 4.0 awareness about role of technopark and support with respect to company's position for the Industry 4.0 development. The average mean of companies that their position is leader and follower is higher than the others. Also, there is a statistically significant difference in company's employee competencies in terms of Industry 4.0 with respect to company's position for the Industry 4.0 development. The average

mean of companies that their position is leader and follower is higher than the others. Also, there is a statistically significant difference in company's Industry 4.0 strategy and policy, product, services and workforce infrastructure, developing digital manufacturing systems technologies and benefit from external shareholders with respect to company's position for the Industry 4.0 development. These differences militate in favor of firms that leader and followers in terms of position. This result, which is related to benefiting from external shareholders, supported by Tuğba Gül and Serhat Çakır's research which is conducted in 2014 regarding technopark. Their work suggests that cooperation with external stakeholders, such as benefiting from the academic area and working in partnership with other companies in technopark, has a positive contribution to firms' innovative technology production [41].

After hypothesis testing in the study, regression analysis was performed. The analyze was performed to examine the impacts of employee skills within the scope of Industry 4.0, product, services and workforce infrastructure for Industry 4.0, using direct and indirect relations and benefit from external and internal shareholders on companies' achievement level in expectations. According to results, companies' achievement level in expectations is explained six variables such as employee skills, product, services and workforce infrastructure for Industry 4.0, benefit from external and internal shareholders and using direct and indirect relations. In addition, last four variable's beta and significance value are quite low than first two variables. On the other hand, between companies' achievement level in expectations and employee skills and product, services and workforce infrastructure for Industry 4.0, there is a positive relation.

An article published in 2011 supports this result in terms of employee skills. It is stated that intellectual capital, owned by businesses, that is, the knowledge and skills of employees are effective in ensuring competitive advantages of enterprises [69]. In addition, in another issue published in 2008, it was concluded that the firm's performance and its ability to achieve competitive advantage were influenced by the basic skills (knowledge, technology, skill, flexibility) that the firm had. This study supports the conclusion of the regression analysis [70]. On the other hand, in a paper published in 2009, it is stated that the cooperation has a positive effect on the firm performance and the competitive advantage of the firms is increased [71]. Nonetheless, the beta coefficient of the collaboration factor in the regression analysis results is low.

This study is the first exploration of Industry 4.0 practices in technology centered companies in Turkey. But, there are some limitations in this study. First of all, technopark companies have been selected only from software and engineering sector. Furthermore, only companies operating in technoparks have been studied. Thus, results of the study cannot be generalized to the all technology centered companies in Turkey.

On the other hand, findings of this thesis study encourage researchers to study about Industry 4.0 in technopark companies despite its limitations. Industry 4.0 is quite new term. So, this study can be repeated in the future to investigate and compare technopark companies in Industry 4.0 era regarding time. Also, other studies including technopark companies from other sectors can be analyzed in the future. In addition, in future researches, technopark companies in Turkey can be compared with technopark companies in other countries. Moreover, future studies should also consider companies that they are not located in technopark. So, final recommendation is that, the similarities and differences in terms of Industry 4.0 awareness and activities between companies that located in technopark and others can be analyzed.



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APPENDICES

APPENDIX A: Survey Study



THE ROLE OF TECHNOPARK COMPANIES IN THE DEVELOPMENT OF THE FOURTH INDUSTRIAL REVOLUTION IN TURKEY

03/01/2018

To whom it may concern,

As you know, the World is in a new industrial revolution, in other words, in Industry 4.0. with this revolution, also called digital transformation, it is expected that all the tools used in the Industry, the devices will be smart, self-learning and more efficient hardware and software products. Also, the speed of industrial production, volume and productivity will increase. In this direction, we are working on a graduate thesis in order to obtain technopark companies' role, state and position in the digital transformation that have a critical importance for our country.

We would like to answer your questionnaire and contribute to this work. The success and value of our research is directly related to your involvement and answers. All information relating to your company will be kept strictly confidential, the company name will not be given, and it will not be used for any other purpose. All the information obtained will be evaluated and published in a statistical frame. We are pleased to provide you with a general overview of the results of our research, if requested.

Thank you in advance for your interest and participation.

Our respect,

Prof. Dr. Ferhan ÇEBİ

Ind. Eng. Gizem ATAK

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PART 1: OVERVIEW OF INDUSTRY 4.0

1- Which of the following best describes your company's position for the development of Industry 4.0?

() Leader () Follower () Relevant () Irrelevant

Mark the number that best describes your participation in the following expressions.

(1) Strongly disagree (5) Strongly agree

1.1	I have information about Industry 4.0	(1)	(2)	(3)	(4)	(5)
1.2	I have information about Industry 4.0 technologies	(1)	(2)	(3)	(4)	(5)
1.3	Top management is aware of Industry 4.0	(1)	(2)	(3)	(4)	(5)
1.4	All our organization has information about Industry 4.0	(1)	(2)	(3)	(4)	(5)
1.5	Our company has information about the Industry 4.0 platform	(1)	(2)	(3)	(4)	(5)
1.6	Our company knows how much Industry 4.0 will affect the Industry we are in.	(1)	(2)	(3)	(4)	(5)
1.7	Our company understood the content of the Industry 4.0 concept much better than our competition	(1)	(2)	(3)	(4)	(5)
1.8	Developing products / services within the context of Industry 4.0 has great importance for the future of our business.	(1)	(2)	(3)	(4)	(5)
1.9	Digital transformation in the Industry will increase the competitiveness of companies	(1)	(2)	(3)	(4)	(5)
1.10	Digital transformation in the Industry will increase the international competitiveness of Turkey	(1)	(2)	(3)	(4)	(5)
1.11	Industry 4.0 will change the general market structure of the country.	(1)	(2)	(3)	(4)	(5)
1.12	Industry 4.0 will make it possible to gain more global market share	(1)	(2)	(3)	(4)	(5)
1.13	Industrial investment in 4.0 will provide the growth of Turkey's global market share in the long term.	(1)	(2)	(3)	(4)	(5)
1.14	Turkey's need to add more value to gain more share of the global market.	(1)	(2)	(3)	(4)	(5)
1.15	Industry 4.0 will provide employees with new jobs and increase employment	(1)	(2)	(3)	(4)	(5)
1.16	It is enough for companies to work on their own for the development of Industry 4.0.	(1)	(2)	(3)	(4)	(5)
1.17	Industry 4.0 concept in Turkey are discussed enough by the government.	(1)	(2)	(3)	(4)	(5)
1.18	Industry 4.0 concept in Turkey are discussed enough by academics.	(1)	(2)	(3)	(4)	(5)
1.19	Industry 4.0 concept in Turkey are discussed enough by non-governmental organizations, trade unions and press.	(1)	(2)	(3)	(4)	(5)
1.20	Technopark has a vital role on the development and spread of Industry 4.0 in Turkey	(1)	(2)	(3)	(4)	(5)
1.21	Technoparks have a great importance in developing new products, services or technology.	(1)	(2)	(3)	(4)	(5)
1.22	Turkey supports to technopark companies which are aiming to develop technology, enough.	(1)	(2)	(3)	(4)	(5)
1.23	Turkey supports to technopark companies aiming to develop technology within the scope of Industry 4.0 enough.	(1)	(2)	(3)	(4)	(5)

PART 2: STRATEGY AND ORGANIZATION

2- Mark the number that best describes your participation in the following expressions.

(1) Strongly disagree (5) Strongly agree

2.1	Within the scope of Industry 4.0, we have goals and objectives as a company.	(1)	(2)	(3)	(4)	(5)
2.2	As a company, we have our roadmap and strategies under the scope of Industry 4.0.	(1)	(2)	(3)	(4)	(5)
2.3	Our company uses indicators to monitor the implementation status of our Industry 4.0 strategy.	(1)	(2)	(3)	(4)	(5)
2.4	Our company plans to work on Industry 4.0 technologies in the long run.	(1)	(2)	(3)	(4)	(5)
2.5	While our company fulfills its processes, it benefits from technologies within the scope of Industry 4.0.	(1)	(2)	(3)	(4)	(5)
2.6	Technologies within Industry 4.0 are among the solutions / products we offer to our customers.	(1)	(2)	(3)	(4)	(5)
2.7	Our services / products are adaptable to customer preferences.	(1)	(2)	(3)	(4)	(5)
2.8	We have employees with digital skills in our company	(1)	(2)	(3)	(4)	(5)
2.9	We have employees with analytical skills in our company	(1)	(2)	(3)	(4)	(5)
2.10	In our different departments, there are employees who produce innovative projects within the scope of Industry 4.0.	(1)	(2)	(3)	(4)	(5)
2.11	Our Company has a dedicated team that only produces innovative projects within the scope of Industry 4.0.	(1)	(2)	(3)	(4)	(5)
2.12	Our company has an organizational structure based on data.	(1)	(2)	(3)	(4)	(5)
2.13	Our company allocates resources to digital business models.	(1)	(2)	(3)	(4)	(5)
2.14	Our existing products / services are compatible with innovative digital business models.	(1)	(2)	(3)	(4)	(5)
2.15	Our company has the knowledge to unite Industry 4.0 initiatives in a common framework.	(1)	(2)	(3)	(4)	(5)
2.16	Our company provides guidance / consulting services for Industry 4.0 technologies.	(1)	(2)	(3)	(4)	(5)
2.17	Our company is pursuing technological developments at the national and international level regarding Industry 4.0.	(1)	(2)	(3)	(4)	(5)
2.18	Our company provides training on digital transformation.	(1)	(2)	(3)	(4)	(5)
2.19	Our company participates in events such as seminars, conferences organized in relation to digital transformation.	(1)	(2)	(3)	(4)	(5)
2.20	Our company is receiving guidance and consulting services for Industry 4.0 technologies.	(1)	(2)	(3)	(4)	(5)
2.21	We have employees who are receiving / studying graduate / doctorate degree in the field of Industry 4.0 in our company.	(1)	(2)	(3)	(4)	(5)

3- Within the scope of Industry 4.0 are the following technologies among your solutions? (First column)

Taking into consideration the last 5 years, please indicate approximately how much you use these technologies in your projects. (You can select more than one option.)

		For the Last 5 Years Number of Projects			
		0-4	5-9	10-14	15 +
☐	Sensor Technology	☐	☐	☐	☐
☐	Big Data	☐	☐	☐	☐
☐	Robot and Automation	☐	☐	☐	☐
☐	Horizontal / Vertical System Integration	☐	☐	☐	☐
☐	Cyber Security	☐	☐	☐	☐
☐	Cloud Computing	☐	☐	☐	☐
☐	Augmented Reality Technology	☐	☐	☐	☐
☐	Additive Manufacturing	☐	☐	☐	☐
☐	Internet of Things	☐	☐	☐	☐
☐	Machine Learning and Artificial Intelligence	☐	☐	☐	☐
☐	Simulation	☐	☐	☐	☐
☐	Virtual Reality	☐	☐	☐	☐

4- When you consider your work up to today, indicate in the first answer column (Current Status) the technologies you have directly contributed to the development and the contribution degree.

(1) Unimportant (5) Very Important

When you consider the next 10 years, specify the technologies you plan to work on and the extent to which you will work in the second answer column (Targeted).

(1) Never (5) Very Intense

	Current Status					Targeted				
Sensor Technology	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Big Data	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Robot and Automation	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Horizontal / Vertical System Integration	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Cyber Security	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Cloud Computing	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Augmented Reality Technology	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Additive Manufacturing	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Internet of Things	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Machine Learning and Artificial Intelligence	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Simulation	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Virtual Reality	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

5- Indicate at what stage your company has performed the business cooperation with the following organizations / organizations within the scope of the activities of Industry 4.0.

(1) Never (5) Very Frequent

5.1	Universities	(1)	(2)	(3)	(4)	(5)
5.2	Other academic institutions	(1)	(2)	(3)	(4)	(5)
5.3	Technology transfer offices	(1)	(2)	(3)	(4)	(5)
5.4	Economic development institutions	(1)	(2)	(3)	(4)	(5)
5.5	Other companies in technopark	(1)	(2)	(3)	(4)	(5)
5.6	Suppliers	(1)	(2)	(3)	(4)	(5)
5.7	Customers	(1)	(2)	(3)	(4)	(5)
5.8	Employee	(1)	(2)	(3)	(4)	(5)
5.9	Competitors	(1)	(2)	(3)	(4)	(5)
5.10	Consulting companies	(1)	(2)	(3)	(4)	(5)
5.11	Other (Specify:)	(1)	(2)	(3)	(4)	(5)
5.12	Other (Specify:)	(1)	(2)	(3)	(4)	(5)

6- Indicate how many products you offer under Industry 4.0 according to the following areas of application. (Consider the last 2 years.)

(1) Never (5) Very Intense

6.1	Production	(1)	(2)	(3)	(4)	(5)
6.2	Purchase	(1)	(2)	(3)	(4)	(5)
6.3	Logistics	(1)	(2)	(3)	(4)	(5)
6.4	Sales	(1)	(2)	(3)	(4)	(5)
6.5	Finance/Accounting	(1)	(2)	(3)	(4)	(5)
6.6	Service	(1)	(2)	(3)	(4)	(5)
6.7	Information Technologies	(1)	(2)	(3)	(4)	(5)
6.8	After sales service	(1)	(2)	(3)	(4)	(5)
6.9	Human resources	(1)	(2)	(3)	(4)	(5)
6.10	R&D	(1)	(2)	(3)	(4)	(5)
6.11	Other (Specify:)	(1)	(2)	(3)	(4)	(5)
6.12	Other (Specify:)	(1)	(2)	(3)	(4)	(5)

7- When you consider Industry 4.0 requirements, how do you evaluate the skills of your employees in your company in terms of followings

(1) Very Poor (5) Very Strong

7.1	In terms of infrastructures of information technologies	(1)	(2)	(3)	(4)	(5)
7.2	In terms of automation technology	(1)	(2)	(3)	(4)	(5)
7.3	In terms of data analysis	(1)	(2)	(3)	(4)	(5)
7.4	In terms of data security / communication	(1)	(2)	(3)	(4)	(5)
7.5	In terms of developing or implementation of auxiliary systems	(1)	(2)	(3)	(4)	(5)
7.6	In terms of software development	(1)	(2)	(3)	(4)	(5)
7.7	In terms of systematic thinking and process understanding	(1)	(2)	(3)	(4)	(5)

8- When you consider Industry 4.0 requirements, how do you evaluate the competencies of your employees in your company according to the following items?

(1) Very Poor (5) Very Good

8.1	Problem solving	(1)	(2)	(3)	(4)	(5)
8.2	Critical thinking	(1)	(2)	(3)	(4)	(5)
8.3	Creativity	(1)	(2)	(3)	(4)	(5)
8.4	Coordination with others	(1)	(2)	(3)	(4)	(5)
8.5	Emotional intelligence	(1)	(2)	(3)	(4)	(5)
8.6	Decision making	(1)	(2)	(3)	(4)	(5)
8.7	Service-oriented	(1)	(2)	(3)	(4)	(5)
8.8	Cognitive flexibility	(1)	(2)	(3)	(4)	(5)
8.9	Resource management competence	(1)	(2)	(3)	(4)	(5)
8.10	Other (Specify:)	(1)	(2)	(3)	(4)	(5)
8.11	Other (Specify:)	(1)	(2)	(3)	(4)	(5)

PART 3: REQUIREMENTS and EXPECTATIONS

9- Identify the difficulties and degrees that you encounter when developing your technology / products related to Industry 4.0.

(1) Never (5) Very Often

9.1	High employee turnover rate	(1)	(2)	(3)	(4)	(5)
9.2	Reluctance to share information between employees	(1)	(2)	(3)	(4)	(5)
9.3	Inability to work with current workforce	(1)	(2)	(3)	(4)	(5)
9.4	Resistance of employees to change and innovation	(1)	(2)	(3)	(4)	(5)
9.5	Difficulty finding workforce in accordance with requirements	(1)	(2)	(3)	(4)	(5)
9.6	Lack of information about digital technologies	(1)	(2)	(3)	(4)	(5)
9.7	Data security risks	(1)	(2)	(3)	(4)	(5)
9.8	Difficulty and inadequacy in finding advanced technology buyers	(1)	(2)	(3)	(4)	(5)
9.9	Unable to provide up-to-date and reliable data from horizontal integration customers and suppliers	(1)	(2)	(3)	(4)	(5)
9.10	Risk of not working developed technology as planned	(1)	(2)	(3)	(4)	(5)
9.11	Risk of unforeseen costs	(1)	(2)	(3)	(4)	(5)
9.12	Risks of management approaching negatively developed technology	(1)	(2)	(3)	(4)	(5)
9.13	Risk of customers find technology investment costs very high	(1)	(2)	(3)	(4)	(5)
9.14	Risk of customers and users not finding or accepting the system profitable	(1)	(2)	(3)	(4)	(5)
9.15	The risk that systems cannot integrate with existing technologies and systems	(1)	(2)	(3)	(4)	(5)
9.16	Standardization problem among all other industries	(1)	(2)	(3)	(4)	(5)
9.17	Difficulties in the commercialization of products	(1)	(2)	(3)	(4)	(5)
9.18	Inadequate financial support and funds for technopark companies	(1)	(2)	(3)	(4)	(5)
9.19	Failure to benefit from the academic environment	(1)	(2)	(3)	(4)	(5)
9.20	Inadequate financial support and funding sources	(1)	(2)	(3)	(4)	(5)
9.21	Weakness of the support services given to technopark (technical support, administrative support, training support, etc.)	(1)	(2)	(3)	(4)	(5)
9.22	Lack of the companies that are working on the Industry 4.0 in the technopark	(1)	(2)	(3)	(4)	(5)
9.23	Ineffective technopark management	(1)	(2)	(3)	(4)	(5)
9.24	The complexity of the intellectual property rights, the fear of infringement	(1)	(2)	(3)	(4)	(5)
9.25	Other (Specify:)	(1)	(2)	(3)	(4)	(5)

10- In the first answer column (Priority Degree), indicate how important the following opportunities are when developing your products / services under Industry 4.0.

(1) Unimportant (5) Very Important

When developing your products / services under Industry 4.0, indicate in the second answer column (Benefit Scale) how much you will benefit from the following opportunities.

(1) Never (5) Very Intense

		Priority Degree					Benefit Scale				
10.1	International business association	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.2	University-Industry business association	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.3	Support of national development agencies	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.4	Support of non-governmental organizations such as TÜSIAD	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.5	Meetings, meeting tea, fair events	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.6	Scientific activities like symposium, conference	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.7	Technology transfer offices	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.8	Advantages of technopark	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.9	Business association with companies in technopark	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.10	Technopark's physical facilities such as library, computer laboratories etc.	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.11	The university, academic consulting, information accumulation facilities provided by technopark	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.12	Other (Specify:)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

11- When developing your products / services under Industry 4.0, please state your expectation of how important the following criteria are for your company in the first answer column (Expectation).

(1) Unimportant (5) Very important

In the second answer column, indicate the degree of achievement for each criterion (Success Degree).

(1) Unimportant (5) Very important

		Expectation					Success Degree				
11.1	International business association	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.2	University-Industry business association	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.3	Support of national development agencies	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.4	Support of non-governmental organizations such as TÜSIAD	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.5	Meetings, meeting tea, fair events	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.6	Scientific activities like symposium, conference	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.7	Technology transfer offices	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.8	Advantages of technopark	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.9	Business association with companies in technopark	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.10	Technopark's physical facilities such as library, computer laboratories etc.	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.11	Other (Specify:)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

12- In the first (Customer Expectations) answer column, indicate how important the following customer expectations are important as you develop the services you offer to our customers within the scope of Industry 4.0.

(1) Unimportant (5) Very Important

In the second (Success Degree answer column, indicate the degree of achievement you have achieved for each criterion.

(1) Unimportant (5) Very Important

		Customer Expectations					Success				
		(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.1	To reduce costs	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.2	To provide flexibility in production and increase it	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.3	To increase productivity in production	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.4	To increase resource efficiency	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.5	To shorten the period of product / service development and market presentation	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.6	To develop new products / services	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.7	To improve the quality of the products / services offered	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.8	To increase the effectiveness of processes	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.9	To raise the quality of life of employees	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.10	To increase the competitive advantage	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.11	To develop the customer base	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.12	To increase sales	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.13	To increase profitability	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.14	To increase market share	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.15	To create and develop company image	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.16	Other (Specify:)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

PART 4: GENERAL INFORMATION ABOUT COMPANY

- 1- Please indicate your establishment year: _____
- 2- Please indicate the technopark you are located in. _____
- 3- Which one best represents your position in the company?

☐ Company Owner
☐ Software Specialist
☐ Support Staff

☐ Manager
☐ Engineer
☐ Other (Specify:.....)
- 4- Please indicate the category that best represents your business.

☐ Engineering ☐ Software ☐ Other (Specify:.....)
- 5- Which is your target market?

☐ Domestic Market ☐ Foreign Market ☐ Both Domestic and Foreign Market
- 6- Has your company a foreign capital partner?

☐ Yes (%.....) ☐ No

7- How do you define your company?

- ☐ Dependent with an international company
☐ Dependent with a National company
☐ Independent Company

8- Which sector group do you include?

- ☐ Defense Industry Technologies ☐ Aerospace Technologies
☐ Maritime Technologies ☐ Advanced Electronic Technologies
☐ Energy Technologies ☐ Health Sciences Technologies
☐ Advanced Materials Technologies ☐ Other (Specify:)
☐ Industrial Software Technologies

9- Please indicate the total number of customers you offer your products or services.

- ☐ 1-4 ☐ 5-9 ☐ 10-19 ☐ 20-49 ☐ 50-100 ☐ 100+

10- Please indicate the percentage of your customers by their capital structure.

Nation	Percentage (%)
Turkish	
American	
German	
English	
More than one foreign partner	
Other (Please specify:)	
Other (Please specify:)	
TOTAL:	100

11- How much your company is in the technopark?

- ☐ Less than 1 year ☐ 2 year ☐ 3 year ☐ 4 year ☐ 5-9 year ☐ +10

12- What is the profile of your employees? (Please specify by number.)

High school	Associate	Undergraduate	Graduate	Doctorate
Total:				

13- Have you received a patent for your studies up to today? If yes, please indicate number.

- ☐ Yes (Amount:.....) ☐ No

14- Have you received a patent under Industry 4.0 technology in last 10 years?

- ☐ Yes (Amount:.....) ☐ No

15- What is the total number of employees of your company?

☐ 1-9 ☐ 10-19 ☐ 20-49 ☐ 50-100 ☐ 100-249 ☐ 250+

16- Which of the following is your total income last year?

☐ Less than 500 billion TL ☐ 8 million TL-25 million TL
☐ 500 billion TL- 1 million TL ☐ 25 million TL-40 million TL
☐ 1 million TL-8 million TL ☐ More than 40 million TL

17- What is the percentage you allocate for the activities of Industry 4.0 in the total budget?

%-----

18- According to you, what is the ratio of your activities related to Industry 4.0 in your overall activities? (Specify approximately)

%-----

19- Do you want to be notified of the results?

☐ Yes ☐ No

Researcher's:

Name and Surname: _____

Title: _____

Company Name: _____

Phone: _____

E-mail: _____

DÖRDÜNCÜ SANAYİ DEVRİMİNİN GELİŞİMİNDE TEKNO PARK ŞİRKETLERİNİN ROLÜ VE ALGISI

03/01/2018

Sayın Yönetici,

Bildiğiniz üzere, Dünya yeni bir sanayi devrimi diğer bir deyişle, Endüstri 4.0'ın içinde bulunmaktadır. Dijital dönüşüm olarak da adlandırılan bu devrimle birlikte, sanayide kullanılan tüm araçların, cihazların akıllı olması, kendi kendine öğrenebilmesi ve daha verimli donanımsal ve yazılımsal ürünler üretilerek, endüstriyel üretim hızının, hacminin ve verimliliğinin artırılması beklenmektedir. Bu doğrultuda, teknolojinin kalbi olarak adlandırabileceğimiz Teknoparklarda yer alan şirketlerin, ülkemiz için de kritik bir öneme sahip olan dijital dönüşümün sağlanması ve gelişimindeki rolünü ve algılarını ortaya koymaya yönelik olarak yüksek lisans tezi kapsamında bir çalışma yapmaktayız.

Anketimize vereceğiniz cevaplar ve ayıracağınız süre ile bu çalışmaya katkıda bulunmanızı diliyoruz. Araştırmamızın başarısı ve değeri sizin katılımınız ve vereceğiniz cevaplar ile doğrudan ilişkilidir. Şirketinize ilişkin elde edilen tüm bilgiler kesinlikle gizli tutulacak, şirket adı verilmeyecek ve başka hiçbir amaçla kullanılmayacaktır. Elde edilen tüm bilgiler istatistiki çerçevede toplu olarak değerlendirilecek ve yayınlanacaktır. İstenildiği takdirde araştırma sonuçlarının genel bir özetini tarafınıza iletmekten memnuniyet duyarız.

İlginiz ve katılımınız için şimdiden teşekkür ederiz.
Saygılarımızla,

Prof. Dr. Ferhan ÇEBİ

End. Müh. Gizem ATAK

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BÖLÜM 1: ENDÜSTRİ 4.0'E GENEL BAKIŞ

1- Aşağıdakilerden hangisi şirketinizin Endüstri 4.0 algısını en iyi şekilde tanımlamaktadır?

() Lider () Takipçi () İlgili () İlgisiz

Aşağıdaki ifadelerle ne ölçüde katıldığınızı en doğru şekilde açıklayan rakamı işaretleyiniz.

(1) Kesinlikle Katılmıyorum (5) Kesinlikle Katılıyorum

1.1	Endüstri 4.0 hakkında bilgi sahibiyim.	(1)	(2)	(3)	(4)	(5)
1.2	Endüstri 4.0 teknolojileri hakkında bilgi sahibiyim.	(1)	(2)	(3)	(4)	(5)
1.3	Üst yönetim Endüstri 4.0'ın farkındadır.	(1)	(2)	(3)	(4)	(5)
1.4	Örgütümüzün tamamı Endüstri 4.0 hakkında bilgi sahibidir.	(1)	(2)	(3)	(4)	(5)
1.5	Şirketimiz Endüstri 4.0 platformu hakkında bilgi sahibidir.	(1)	(2)	(3)	(4)	(5)
1.6	Şirketimiz, Endüstri 4.0'ın, bulunduğumuz sanayi alanını ne ölçüde etkileyeceğini bilmektedir.	(1)	(2)	(3)	(4)	(5)
1.7	Şirketimiz, Endüstri 4.0 kavramının içeriğini rakiplerine göre çok daha iyi anlamış durumdadır.	(1)	(2)	(3)	(4)	(5)
1.8	Endüstri 4.0 kapsamında ürün/hizmet geliştirmek, işimizin geleceği ile ilgili olarak büyük öneme sahiptir.	(1)	(2)	(3)	(4)	(5)
1.9	Sanayide dijital dönüşüm şirketlerin rekabetçiliğini artıracaktır.	(1)	(2)	(3)	(4)	(5)
1.10	Sanayide dijital dönüşüm Türkiye'nin uluslararası rekabetçiliğini artıracaktır.	(1)	(2)	(3)	(4)	(5)
1.11	Endüstri 4.0 ülkenin genel pazar yapısını değiştirecektir.	(1)	(2)	(3)	(4)	(5)
1.12	Endüstri 4.0 daha fazla küresel pazar payı kazanmayı mümkün kılacaktır.	(1)	(2)	(3)	(4)	(5)
1.13	Endüstri 4.0'a yapılan yatırımlar uzun vadede Türkiye'nin küresel pazar payının büyümesini sağlayacaktır.	(1)	(2)	(3)	(4)	(5)
1.14	Türkiye'nin daha fazla küresel pazar payı kazanması için daha fazla katma değere ihtiyacı vardır.	(1)	(2)	(3)	(4)	(5)
1.15	Endüstri 4.0 çalışanlara yeni iş kolları sağlayacak, istihdamı artıracaktır.	(1)	(2)	(3)	(4)	(5)
1.16	Endüstri 4.0'ın gelişmesi için şirketlerin kendi başına çaba göstermeleri yeterlidir.	(1)	(2)	(3)	(4)	(5)
1.17	Türkiye'de Endüstri 4.0 kavramı hükümet tarafından yeterince tartışılmaktadır.	(1)	(2)	(3)	(4)	(5)
1.18	Türkiye'de Endüstri 4.0 kavramı akademik çevre tarafından yeterince tartışılmaktadır.	(1)	(2)	(3)	(4)	(5)
1.19	Türkiye'de Endüstri 4.0 kavramı sivil toplum kuruluşları, sendikalar ve basın tarafından yeterince tartışılmaktadır.	(1)	(2)	(3)	(4)	(5)
1.20	Türkiye'de Endüstri 4.0 gelişimi ve yayılmasında Teknoparklar önemli bir rol oynamaktadır.	(1)	(2)	(3)	(4)	(5)
1.21	Yeni ürün, hizmet ya da teknoloji geliştirmede Teknoparkların büyük önemi vardır.	(1)	(2)	(3)	(4)	(5)
1.22	Türkiye'de teknoloji geliştirmeyi hedefleyen Teknopark şirketlerine yapılan destekler yeterlidir.	(1)	(2)	(3)	(4)	(5)
1.23	Türkiye'de Endüstri 4.0 kapsamındaki teknolojileri geliştirmeyi hedefleyen Teknopark şirketlerine yapılan destekler yeterlidir.	(1)	(2)	(3)	(4)	(5)

BÖLÜM 2: STRATEJİ ve ORGANİZASYON

2- Aşağıdaki ifadelere ne ölçüde katıldığınızı en doğru şekilde açıklayan rakamı işaretleyiniz.

(1) Kesinlikle Katılmıyorum (5) Kesinlikle Katılıyorum

2.1	Endüstri 4.0 kapsamında, şirket olarak hedef ve amaçlarımız bulunmaktadır.	(1)	(2)	(3)	(4)	(5)
2.2	Şirket olarak Endüstri 4.0 kapsamında yol haritamız, stratejilerimiz belirlidir.	(1)	(2)	(3)	(4)	(5)
2.3	Şirketimizde Endüstri 4.0 stratejimizin uygulama durumunu izlemek için göstergeler kullanılmaktadır.	(1)	(2)	(3)	(4)	(5)
2.4	Şirketimiz uzun dönemde Endüstri 4.0 teknolojileri üzerinde çalışmalar yapmayı planlamaktadır.	(1)	(2)	(3)	(4)	(5)
2.5	Şirketimiz süreçlerini yerine getirirken Endüstri 4.0 kapsamındaki teknolojilerden yararlanmaktadır.	(1)	(2)	(3)	(4)	(5)
2.6	Endüstri 4.0 kapsamındaki teknolojiler, müşterilerimize sunduğumuz çözümler/ürünler içinde yer almaktadır.	(1)	(2)	(3)	(4)	(5)
2.7	Hizmetlerimiz/ürünlerimiz müşteri tercihlerine göre uyarlanabilir yapıdadır.	(1)	(2)	(3)	(4)	(5)
2.8	Şirketimizde dijital becerilere sahip çalışanlarımız mevcuttur.	(1)	(2)	(3)	(4)	(5)
2.9	Şirketimizde analitik beceriye sahip çalışanlarımız mevcuttur.	(1)	(2)	(3)	(4)	(5)
2.10	Şirketimizin farklı departmanlarında, Endüstri 4.0 kapsamında yenilikçi proje üreten çalışanlar bulunmaktadır.	(1)	(2)	(3)	(4)	(5)
2.11	Şirketimizde, yalnızca Endüstri 4.0 kapsamında yenilikçi proje üreten özel bir ekip bulunmaktadır.	(1)	(2)	(3)	(4)	(5)
2.12	Şirketimiz veriye dayalı bir organizasyon yapısına sahiptir. (örn; veri bilimcileri, analitik ekip, dijital dönüşüm direktörü mevcuttur)	(1)	(2)	(3)	(4)	(5)
2.13	Şirketimiz dijital iş modellerine kaynak ayırmaktadır.	(1)	(2)	(3)	(4)	(5)
2.14	Mevcut ürünlerimiz/hizmetlerimiz yenilikçi dijital iş modelleri ile uyumludur.	(1)	(2)	(3)	(4)	(5)
2.15	Şirketimiz Endüstri 4.0 girişimlerini ortak bir çatıda birleştirebilecek bilgi birikimine (know-how) sahiptir.	(1)	(2)	(3)	(4)	(5)
2.16	Şirketimiz Endüstri 4.0 teknolojileri konusunda rehberlik, danışmanlık hizmeti vermektedir.	(1)	(2)	(3)	(4)	(5)
2.17	Şirketimiz, Endüstri 4.0 ile ilgili ulusal ve uluslararası düzeyde teknolojik gelişmeleri takip etmektedir.	(1)	(2)	(3)	(4)	(5)
2.18	Şirketimizde dijital dönüşüm ile ilgili eğitimler düzenlenmektedir.	(1)	(2)	(3)	(4)	(5)
2.19	Şirketimiz dijital dönüşüm ile ilgili olarak düzenlenen, seminer, konferans gibi etkinliklere katılmaktadır.	(1)	(2)	(3)	(4)	(5)
2.20	Şirketimiz Endüstri 4.0 teknolojileri konusunda rehberlik, danışmanlık hizmeti almaktadır.	(1)	(2)	(3)	(4)	(5)
2.21	Şirketimizde Endüstri 4.0 alanında yüksek lisans/doktora eğitimi alan/almakta olan çalışanlarımız bulunmaktadır.	(1)	(2)	(3)	(4)	(5)

- 3- Endüstri 4.0 kapsamında aşağıdaki teknolojilerden hangileri müşterilere sunduğunuz çözümlerinizi arasında yer almaktadır? (İlk sütun)

Son 5 yılı dikkate alarak bu teknolojileri projelerinizde ne kadar kullandığınızı yaklaşık olarak belirtiniz. (Birden fazla seçenek işaretleyebilirsiniz.)

		Son 5 Yıl İçin Teknolojiyi İçeren Proje Sayısı			
		0-4	5-9	10-14	15 +
☐	Sensör Teknolojisi	☐	☐	☐	☐
☐	Büyük Veri ve Veri Analitiği	☐	☐	☐	☐
☐	Robot ve Otomasyon	☐	☐	☐	☐
☐	Yatay/Dikey Sistem Bütünleşmesi	☐	☐	☐	☐
☐	Siber Güvenlik	☐	☐	☐	☐
☐	Bulut Bilişim	☐	☐	☐	☐
☐	Artırılmış Gerçeklik	☐	☐	☐	☐
☐	Eklemeli Üretim	☐	☐	☐	☐
☐	Nesnelerin İnterneti	☐	☐	☐	☐
☐	Makine Öğrenimi ve Yapay Zekâ	☐	☐	☐	☐
☐	Benzetim	☐	☐	☐	☐
☐	Sanal Gerçeklik (VR) Teknolojileri	☐	☐	☐	☐

- 4- Bugüne kadarki çalışmalarınızı dikkate aldığınızda, geliştirilmesine doğrudan katkıda bulunduğunuz teknolojileri ve ne ölçüde katkıda bulunduğunuzu birinci cevap sütununda (Mevcut Durum) belirtiniz.

(1) Hiç (5) Çok Önemli

Gelecek 10 yılı dikkate aldığınızda, üzerinde çalışmayı planladığınız teknolojileri ve ne ölçüde çalışacağınızı ikinci cevap sütununda (Hedeflenen) belirtiniz.

(1) Hiç (5) Çok Yoğun

	Mevcut Durum					Hedeflenen				
Sensör Teknolojisi	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Büyük Veri ve Veri Analitiği	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Robot ve Otomasyon	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Yatay/Dikey Sistem Bütünleşmesi	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Siber Güvenlik	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Bulut Bilişim	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Artırılmış Gerçeklik	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Eklemeli Üretim	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Nesnelerin İnterneti	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Makine Öğrenimi ve Yapay Zekâ	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Benzetim	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Sanal Gerçeklik (VR) Teknolojileri	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

- 5- Şirketinizin, Endüstri 4.0 faaliyetleri kapsamında aşağıda belirtilen kurum/kuruluşlar ile iş birliğini ne ölçüde gerçekleştirdiğini belirtiniz.

(1) Hiç (5) Çok Sık

5.1	Üniversiteler	(1)	(2)	(3)	(4)	(5)
5.2	Diğer akademik kuruluşlar	(1)	(2)	(3)	(4)	(5)
5.3	Teknoloji transfer ofisleri	(1)	(2)	(3)	(4)	(5)
5.4	Ekonomik kalkınma kuruluşları (KOSGEB, Ulusal Kalkınma Ajansı vs.)	(1)	(2)	(3)	(4)	(5)
5.5	Teknoparkta yer alan diğer şirketler	(1)	(2)	(3)	(4)	(5)
5.6	Tedarikçiler	(1)	(2)	(3)	(4)	(5)
5.7	Müşteriler	(1)	(2)	(3)	(4)	(5)
5.8	Çalışanlar	(1)	(2)	(3)	(4)	(5)
5.9	Rakip şirketler	(1)	(2)	(3)	(4)	(5)
5.10	Danışmanlık şirketleri	(1)	(2)	(3)	(4)	(5)
5.11	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)
5.12	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)

- 6- Aşağıda belirtilen uygulama alanlarına göre Endüstri 4.0 kapsamında ne kadar ürün sunduğunuzu belirtiniz. (Son 2 yılı dikkate alınız.)

(1) Hiç (5) Çok Fazla Sayıda

6.1	Üretim	(1)	(2)	(3)	(4)	(5)
6.2	Satın alma	(1)	(2)	(3)	(4)	(5)
6.3	Lojistik	(1)	(2)	(3)	(4)	(5)
6.4	Satış	(1)	(2)	(3)	(4)	(5)
6.5	Finans/Muhasebe	(1)	(2)	(3)	(4)	(5)
6.6	Hizmet	(1)	(2)	(3)	(4)	(5)
6.7	Bilişim Teknolojileri (IT)	(1)	(2)	(3)	(4)	(5)
6.8	Satış sonrası hizmet	(1)	(2)	(3)	(4)	(5)
6.9	İnsan Kaynakları	(1)	(2)	(3)	(4)	(5)
6.10	AR-GE	(1)	(2)	(3)	(4)	(5)
6.11	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)
6.12	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)

- 7- Endüstri 4.0 gereksinimlerini dikkate aldığınızda, şirketinizdeki çalışanlarınızın becerilerini aşağıdaki maddeler açısından nasıl değerlendirirsiniz?

(1) Çok Zayıf (5) Çok Güçlü

7.1	Bilişim teknolojileri (IT) altyapısı açısından	(1)	(2)	(3)	(4)	(5)
7.2	Otomasyon teknolojisi açısından	(1)	(2)	(3)	(4)	(5)
7.3	Veri analizi açısından	(1)	(2)	(3)	(4)	(5)
7.4	Veri güvenliği/iletişimi açısından	(1)	(2)	(3)	(4)	(5)
7.5	Yardımcı sistemlerin geliştirilmesi veya uygulaması açısından	(1)	(2)	(3)	(4)	(5)
7.6	Yazılım geliştirme açısından	(1)	(2)	(3)	(4)	(5)
7.7	Sistemsel düşünme ve süreç anlayışı açısından	(1)	(2)	(3)	(4)	(5)

- 8- Endüstri 4.0 gereksinimlerini dikkate aldığınızda, şirketinizdeki çalışanlarınızın yetkinliklerini aşağıdaki maddelere göre nasıl değerlendirirsiniz?

(1) Çok Zayıf (5) Çok İyi

8.1	Problem çözebilme	(1)	(2)	(3)	(4)	(5)
8.2	Eleştirel düşünme	(1)	(2)	(3)	(4)	(5)
8.3	Yaratıcılık	(1)	(2)	(3)	(4)	(5)
8.4	Başkaları ile koordinasyon	(1)	(2)	(3)	(4)	(5)
8.5	Duygusal zekâ	(1)	(2)	(3)	(4)	(5)
8.6	Karar verme	(1)	(2)	(3)	(4)	(5)
8.7	Hizmet odaklı olma	(1)	(2)	(3)	(4)	(5)
8.8	Bilişsel esneklik	(1)	(2)	(3)	(4)	(5)
8.9	Kaynak yönetim becerisi	(1)	(2)	(3)	(4)	(5)
8.10	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)
8.11	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)

BÖLÜM 3: GEREKSİNİMLER ve BEKLENTİLER

- 9- Endüstri 4.0 ile ilgili teknolojilerinizi/ürünlerinizi geliştirirken karşılaştığınız zorlukları ve derecesini belirtiniz.

(1) Hiç Karşılaşmıyoruz (5) Oldukça Sık Karşılaşıyoruz

9.1	Çalışan devir oranının yüksek olması	(1)	(2)	(3)	(4)	(5)
9.2	Çalışanlar arasındaki bilgi paylaşım isteksizliği	(1)	(2)	(3)	(4)	(5)
9.3	Mevcut işgücünün konusunda yetkin olmaması	(1)	(2)	(3)	(4)	(5)
9.4	Çalışanların değişim ve yeniliğe karşı direnç göstermesi	(1)	(2)	(3)	(4)	(5)
9.5	Gereksinimlere uygun nitelikte iş gücünün bulunamaması	(1)	(2)	(3)	(4)	(5)
9.6	Dijital teknolojiler hakkında bilgi eksikliği	(1)	(2)	(3)	(4)	(5)
9.7	Veri güvenliği riskleri	(1)	(2)	(3)	(4)	(5)
9.8	Geliştirilen teknolojiye alıcı bulmada zorluk/talep yetersizliği	(1)	(2)	(3)	(4)	(5)
9.9	Yatay entegrasyondaki müşteriler ve tedarikçilerden güncel ve güvenilir veri sağlayamama	(1)	(2)	(3)	(4)	(5)
9.10	Geliştirilen teknolojilerin planlandığı gibi çalışmama riski	(1)	(2)	(3)	(4)	(5)
9.11	Öngörülmemiş maliyetlerin oluşma riski	(1)	(2)	(3)	(4)	(5)
9.12	Yönetimin geliştirilen teknolojiye olumsuz yaklaşma riski	(1)	(2)	(3)	(4)	(5)
9.13	Müşterilerin teknoloji yatırım maliyetlerini yüksek bulması	(1)	(2)	(3)	(4)	(5)
9.14	Müşteri ve kullanıcıların sistemi karlı bulmama ve kabul etmeme riski	(1)	(2)	(3)	(4)	(5)
9.15	Sistemlerin mevcut teknolojilere ve sistemlere entegre olamama riski	(1)	(2)	(3)	(4)	(5)
9.16	Diğer tüm endüstriler arasında standardizasyon problemi	(1)	(2)	(3)	(4)	(5)
9.17	Ürünlerin ticarileştirme sürecinde yaşanan sorunlar	(1)	(2)	(3)	(4)	(5)
9.18	Teknoparktaki şirketlere verilen mali destek ve fonlarının yetersizliği	(1)	(2)	(3)	(4)	(5)
9.19	Akademik ortamdan yararlanamama	(1)	(2)	(3)	(4)	(5)
9.20	Yeterli mali destek ve fon kaynaklarının bulunmaması	(1)	(2)	(3)	(4)	(5)
9.21	Teknoparka verilen destek hizmetlerinin zayıflığı (teknik destek, idari destek, eğitim desteği vs.)	(1)	(2)	(3)	(4)	(5)
9.22	Teknoparkta Endüstri 4.0 konusunda çalışan nitelikli şirketlerin azlığı	(1)	(2)	(3)	(4)	(5)
9.23	Teknopark yönetiminin etkin olmaması	(1)	(2)	(3)	(4)	(5)
9.24	Fikri mülkiyet haklarının karmaşıklığı, ihlal korkusu	(1)	(2)	(3)	(4)	(5)
9.25	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)

10- Endüstri 4.0 kapsamındaki ürünlerinizi/hizmetleri geliştirirken aşağıdaki fırsatların ne ölçüde önemli olduğunu birinci cevap sütununda (Önem Derecesi) belirtiniz.

(1) Hiç Önemli Değil (5) Çok Önemli

Endüstri 4.0 kapsamındaki ürünlerinizi/hizmetleri geliştirirken aşağıdaki fırsatlardan ne ölçüde yararlandığınızı ikinci cevap sütununda (Yararlanma Ölçüsü) belirtiniz.

(1) Hiç (5) Çok Yoğun

		Önem Derecesi					Yararlanma Ölçüsü				
10.1	Ülkelerarası iş birliği	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.2	Üniversite-sanayi iş birliği	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.3	Ulusal kalkınma kuruluşları desteği	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.4	TÜSİAD gibi STK kuruluşlarıyla iş birliği	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.5	Toplantılar, tanışma çayı ve fuar etkinlikleri vs.	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.6	Sempozyum, konferans gibi bilimsel etkinlikler	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.7	Teknoloji transfer ofisleri	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.8	Teknoparkın sunduğu avantajlar	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.9	Teknoparktaki diğer şirketlerle iş birliği	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.10	Teknoparkta bulunan kütüphane, bilgisayar laboratuvarları vs. gibi fiziksel olanaklar	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.11	Teknoparkın sağladığı üniversite, akademik danışmanlık, bilgi birikimi olanakları	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
10.12	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

11- Endüstri 4.0 kapsamındaki ürünlerinizi/hizmetleri geliştirirken aşağıdaki kriterlerin şirketiniz için ne ölçüde önemli olduğuna ilişkin beklentilerinizi birinci cevap sütununda (Beklenti) belirtiniz.

(1) Hiç (5) Çok önemli

Her bir kriter için beklenen amaçlara ulaşmada elde ettiğiniz başarı derecesini ise ikinci cevap sütununda (Elde Edilen Başarı) belirtiniz.

(1) Hiç (5) Çok önemli

		Beklenti					Elde Edilen Başarı				
11.1	Rekabet avantajını artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.2	Müşteri tabanını geliştirmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.3	Satışları artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.4	Karlılığı artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.5	Pazar payını büyütmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.6	Şirket imajı yaratmak ve geliştirmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.7	İnovasyon yaratmak ve geliştirmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.8	Yeni ortaklıklar kurmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.9	Yeni iş fırsatları yaratmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.10	Destek kuruluşlarından fon sağlamak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
11.11	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

12- Müşterilerinize Endüstri 4.0 kapsamında sunduğunuz hizmetleri geliştirirken aşağıdaki müşteri beklentilerinin ne ölçüde önemli olduğunu birinci (Müşteri Beklentileri) cevap sütununda belirtiniz.

(1) Hiç (5) Çok Önemli

Her bir kriter için beklenen amaçlara ulaşmada elde ettiğiniz başarı derecesini ise ikinci (Elde Edilen Başarı) cevap sütununda belirtiniz.

(1) Hiç (5) Çok Önemli

		Müşteri Beklentileri					Elde Edilen Başarı				
		(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.1	Maliyetleri azaltmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.2	Üretimde esneklik sağlamak/artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.3	Üretimde verimliliği artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.4	Kaynak verimliliğini artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.5	Ürün/hizmetleri geliştirme ve pazara sunma süresini kısaltmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.6	Yeni ürün/ hizmet geliştirmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.7	Sunulan ürünlerin/hizmetlerin kalitesini geliştirmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.8	Süreçlerin etkinliğini artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.9	Çalışanların yaşam kalitesini artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.10	Rekabet avantajını artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.11	Müşteri tabanını geliştirmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.12	Satışları artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.13	Karlılığı artırmak	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.14	Pazar payını büyütmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.15	Şirket imajı yaratmak ve geliştirmek	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
12.16	Diğer (Belirtiniz:)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

BÖLÜM 4: FİRMANIZ HAKKINDA GENEL BİLGİLER

1- Lütfen kuruluş yılınızı belirtiniz: _____

2- Lütfen yer aldığınız Teknoparkı belirtiniz. _____

3- Şirketteki pozisyonunuzu en iyi temsil eden aşağıdakilerden hangisidir?

- () Şirket sahibi () Müdür/Yönetici
 () Yazılım Uzmanı () Mühendis
 () Destek Personeli () Diğer (Belirtiniz.....)

4- Lütfen şirketinizin yaptığı işi en iyi temsil eden kategoriye belirtiniz.

- () Mühendislik () Üretim () Yazılım/Bilişim () Diğer(Belirtiniz.....)

5- Hedef pazarınız aşağıdakilerden hangisidir?

- () İç pazar () Dış pazar () Hem iç hem dış Pazar

6- Şirketiniz yabancı sermaye ortaklı mıdır?

- () Evet (%.....yabancı) () Hayır

7- Şirketinizi nasıl tanımlarsınız?

☐ Uluslararası şirkete bağlı şirket ☐ Ulusal şirkete bağlı şirket ☐ Bağımsız

8- Dahil olduğunuz sektör grubu aşağıdakilerden hangisidir?

☐ Savunma Sanayii Teknolojileri ☐ Havacılık ve Uzay Teknolojileri
☐ Denizcilik Teknolojileri ☐ İleri Elektronik Teknolojileri
☐ Enerji Teknolojileri ☐ Sağlık Bilimleri Teknolojileri
☐ İleri Malzeme Teknolojileri ☐ Diğer
(Belirtiniz:.....)
☐ Endüstriyel Yazılım Teknolojileri

9- Lütfen ürün ya da hizmetlerinizi sunduğunuz toplam müşteri sayısını belirtiniz.

☐ 1-4 ☐ 5-9 ☐ 10-19 ☐ 20-49 ☐ 50-100 ☐ 100+

10- Lütfen sermaye yapılarına göre müşterilerinizin oranını (%) belirtiniz.

Ulus	Yüzde Oran (%)
Türk	
Amerikan	
Alman	
İngiliz	
Birden fazla yabancı ortaklı	
Diğer (Belirtiniz:.....)	
Diğer (Belirtiniz:.....)	
TOPLAM:	100

11- Şirketiniz ne kadar süredir “Teknopark” bünyesinde bulunmaktadır?

☐ 1 yıl ve daha az ☐ 2 yıl ☐ 3 yıl ☐ 4 yıl ☐ 5-9 yıl ☐ +10

12- Çalışanlarınızın eğitim profili nedir? (Lütfen sayı ile belirtiniz.)

Lise	Ön lisans	Lisans	Yük. Lisans	Doktora
TOPLAM:				

13- Bugüne kadarki çalışmalarınızda patent alımınız oldu mu? Evet ise lütfen sayısını belirtiniz.

☐ Evet (Sayısı:.....) ☐ Hayır

14- Son 10 yılda Endüstri 4.0 teknolojileri kapsamında patent alımınız oldu mu?

☐ Evet (Sayısı:.....) ☐ Hayır

15- Şirketinizin toplam çalışan sayısı nedir?

☐ 1-9 ☐ 10-19 ☐ 20-49 ☐ 50-100 ☐ 100-249 ☐ 250+

16- Geçen yılki toplam geliriniz aşağıdakilerden hangisidir?

- | | |
|---|---|
| ☐ 500bin TL'den az | ☐ 8 milyon TL-25 milyon TL |
| ☐ 500bin TL- 1 milyon TL | ☐ 25 milyon TL- 40 milyon TL |
| ☐ 1 milyon TL- 8 milyon TL | ☐ 40 milyon TL üzeri |

17- Toplam bütçe içinde Endüstri 4.0 faaliyetlerine ayırdığınız yüzde yaklaşık olarak nedir?

%-----

18- Size göre Endüstri 4.0'a ilişkin faaliyetlerinizin toplam faaliyetleriniz içindeki oranı nedir? (Yaklaşık olarak belirtiniz)

%-----

19- Çalışmanın sonuçlarının tarafınıza iletilmesini ister misiniz?

- ☐ Evet ☐ Hayır

Araştırma Formunu Dolduran Kişinin;

Adı Soyadı: _____

Ünvanı: _____

Şirket Adı: _____

Telefon: _____

E-posta: _____



CURRICULUM VITAE

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PROFESSIONAL EXPERIENCE

- **2015-...** : La Software Group, Application Consultant