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EVALUATION OF THE CHANGE IN PERSPECTIVES OF SME EXECUTIVES TOWARDS THE INDUSTRY 4.0 PROCESS AND OPPORTUNITIES IN DIGITAL TRANSFORMATION WITH THE SWARA METHOD

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ABSTRACT

The aim of this study is to determine the perspectives of small and medium-sized enterprises (SMEs) in Turkey towards the digital transformation that comes with Industry 4.0 and to determine the potential development and orientation of the information they had. In this study, the questions asked to thirty-two SME executives five years ago with a semi-structured interview were again directed to the same individuals. According to the results, it's been seen that the executives have more knowledge of the Industry 4.0 process and have more information about the relevant technologies compared to the answers in 2017. In addition, executives have started to take more part in activities in this field. During the five-year period, the issue that the executives are corcerned about most was cyber security and budget planning. In the second application of the study, it's also aimed to determine the importance levels of some opportunities that are predicted to be caused by the Industry 4.0 transformation process on SMEs. In order to realize this aim, Step-Wise Weight Assessment Ratio Analysis (SWARA) application was made with five experts, and the first three opportunities with the highest level of importance were determined as low-cost production, competitiveness and improvement in production defects.

Keywords: Digital Transformation, Industry 4.0 advantages in SMEs, Industry 4.0 in SMEs, Opportunities, SWARA.

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KOBİ YÖNETİCİLERİNİN ENDÜSTRİ 4.0 SÜRECİNE YÖNELİK BAKIŞ AÇILARINDAKİ DEĞİŞİMİNİN VE DİJİTAL DÖNÜŞÜMDEKİ FIRSATLARIN SWARA YÖNTEMİYLE DEĞERLENDİRİLMESİ

ÖZ

Çalışmanın amacı, Türkiye'deki KOBİ'lerin Endüstri 4.0 ile gelen dijital dönüşüme yönelik bakış açılarının tespit edilmesi ve sahip oldukları bilgilerin potansiyel gelişiminin ve yöneliminin belirlenmesidir. Çalışma beş yıl önce yarı yapılandırılmış mülakat ile otuz iki KOBİ yöneticisine yöneltilen soruların tekrar aynı bireylere yöneltilmesi yoluyla gerçekleşmiştir. Bu uygulama sonuçlarına göre yöneticilerin 2017 yılındaki verdikleri cevaplara nazaran Endüstri 4.0 sürecine daha fazla hakim oldukları ve ilgili teknolojiler hakkında daha fazla bilgi sahibi oldukları görülürken, bu alandaki etkinliklerde de daha fazla yer almaya başlamıştır. Beş yıllık dönem içinde yöneticilerin en fazla endişe duyduğu alan siber güvenlik ve bütçe planlaması olarak belirlenmiştir. Diğer taraftan çalışmanın ikinci uygulamasında; Endüstri 4.0 dönüşüm sürecinin KOBİ'ler üzerinde sebep olacağı öngörülen bir takım fırsatların uzmanlar tarafından önem düzeylerinin belirlenmesi de amaçlanmıştır. Bu amacı gerçekleştirmek üzere beş uzmanla SWARA uygulaması yapılmış olup, en yüksek önem seviyesine sahip ilk üç fırsat düşük maliyetli üretim, rekabet gücü ve üretim hatalarında iyileştirme olarak belirlenmiştir.

Anahtar Kelimeler: Dijital Dönüşüm, KOBİ'lerde Endüstri 4.0 Avantajları, KOBİ'lerde Endüstri 4.0, Fırsatlar, SWARA

INTRODUCTION

Businesses have the need to adapt to change and transformation with the constantly changing outside world. With the ongoing technological developments, issues such as managing product and process complexity, shortening production times, mass customization, and increasing productivity occur (Soltysova & Bednar, 2015). Today's businesses also need to have a flexible production system that will adapt to customer needs (Koren, 2010). Developments and increasing pressures in many directions have been effective in the development of new industrial periods. The fourth industrial revolution is a transformation in which smart systems, future-oriented technologies and cyber physical systems (CPS) are applied in terms of human-machine interaction (Sanders, Elangeswaran & Wulfsberg, 2016). The new industrial era is about having information technologies based on machine and device communication and human aspect (Dorst et al., 2015). The new industrial era, also referred to as Industry 4.0, is a process that requires a very complex and holistic approach.

Due to the fact that Industry 4.0 studies mainly focus on large-scale companies, it is seen that certain situations in SMEs are ignored. Moeuf, Pellerin, Lamouri, Tamayo-giraldo and Barbaray (2017)'s study on Industry 4.0 revealed that only 28 percent of the existing research are related to SMEs. The applicability and development of Industry 4.0 is an important area in SMEs, which constitute a large part of the economy in countries and are seen as an important part of the value chain. Therefore, there is need for research that can help SMEs effectively implement new digital technologies so that they can strengthen their cooperation with their partners and remain strong in the supply chain (Moeuf et al., 2017; Müller, Buliga & Voigt, 2018; Han & Trimi, 2022).

Although the emergence of the new industrial era and its potential benefits has led many small and medium-sized enterprises to adopt the smart business paradigm, it has recently been more discussed due to a number of obstacles. Facing many challenges in the adoption of Industry 4.0 technologies in SMEs is one of the issues emphasized by both practitioners and researchers in the field. SMEs have found it difficult to adapt to the changes in their production environment caused by Industry 4.0. There are still challenges for SMEs as new technologies require large investments and high levels of expertise (Han & Trimi, 2022). In addition, some guidance that determines the strategy of new industry elements may be required for these enterprises with significantly limited resources (Safar, Sopko, Bednar & Poklemba, 2018). On the investment side, developments continue to make especially information and communication technology resources more affordable for SMEs most of the time (Moeuf et al., 2017).

The lack of information on the new transformation is still a critical issue today, especially within the framework of SMEs. It is known that many executives are reluctant to share their knowledge about innovations. This situation can cause obstacles in terms of cooperation. On the other hand, the speed of development of technology can leave behind the adoption of technologies by SMEs (Oliff & Liu, 2017). Although businesses have to make more efforts to not stay behind their competitors, it is often not economically and administratively possible to keep up with the speed of technology. In addition, at the point of data management, one of the most fundamental issues of Industry 4.0, cloud computing technology supports the management of big data in SMEs. However, despite its many benefits, SMEs have been found to be quite concerned about the use of big data. Especially the processes of storing, analyzing and transforming big data for effective decision making are quite difficult (Sitton & Rodríguez, 2017).

There are important findings in the literature regarding the applicability of Industry 4.0 in SMEs and the opportunities it will provide. It can be stated that the process leading SMEs to shift their production and organizational structures to Industry 4.0 and their implementation provides various opportunities (Schröder, 2017; Rauch, Dallasega & Matt, 2017). By leveraging Industry 4.0 technologies, a small and medium-sized business can increase its corporate agility, adaptability and flexibility to cope with today's competitive environment by becoming a valuable and innovative partner (Han & Trimi, 2022). Especially the cost advantages that Industry 4.0 will provide in SMEs are also a subject studied by different researchers (Lasi, Fettke, Kemper, Feld & Hoffmann, 2014; Posada et al., 2015; Valdeza, Braunera, Schaara, Holzingerb & Zieflea, 2015). Manufacturing businesses invest heavily in innovative technologies to reduce production costs and remain competitive in the market (Colotla et al., 2016). Since SMEs generally do not have large resources to invest in new technologies, they are expected to be efficient in capital allocation (Erol, Jaeger, Hold, Ott & Sihn, 2016). Another is that Industry 4.0 provides higher resource efficiency (Tortorella & Fettermann, 2018). This situation also allows businesses to gain operational and strategic advantages by using their resources more effectively. The fact that these opportunities, which Industry 4.0 will potentially create on SMEs, have been studied in a limited area, has once again revealed the need for studies in the field.

In the literature, a number of studies have been conducted in recent years on the applicability of Industry 4.0 in SMEs. However, existing studies show that Industry 4.0 roadmaps, frameworks and readiness assessments in SMEs reflect the limited specific needs and challenges (Mittal, Ahman Khan, Romero & Wuest, 2018). A number of researchers focused on identifying barriers to the implementation of Industry 4.0 (Ancillo, Gavrilla, Diez & Beseler, 2021; Kazantsez et al., 2022), while a group of researchers focused on identifying facilitators (Turkes et al., 2019, Stentoft, Wickstrøm, Philipsen & Haug, 2021). However, it has been determined that existing studies partially focus on the special needs of SMEs. Turkes et al., (2019) conducted a survey with 176 people in order to determine the views and perceptions of SME managers in Romania about the driving forces and obstacles in implementing Industry 4.0 (Turkes et al., 2019). Stentoft et al., (2021) conducted a survey with 308 respondents to test their SMEs readiness for digitized production. In these two studies, instead of a specific sector, many large-scale production sectors were studied. From this point of view, studies that evaluate the perspectives of managers on the application of Industry 4.0 technologies in SMEs and accordingly determine a roadmap have been limited to a few studies as far as is known. In addition, the fact that the studies were not carried out directly in the automotive sector has been a matter of curiosity for the businesses that carry out this activity. For this reason, the limited literature has revealed the gap in the field and has led to the preparation of this study.

The objective of this study is to determine the perspectives of SMEs towards Industry 4.0 and how their knowledge has changed in today's digital business environments. This study focuses on identifying the potential development and direction in five years by re-performing the application for SMEs in 2017 in the same businesses. In addition, one of the important issues is how Industry 4.0, which is advancing with new technological developments, can change the business models and process management of enterprises. In this study, it is also aimed to determine the importance levels of possible opportunities to be encountered in SMEs in the Industry 4.0 transformation process. Another aim of the study is to evaluate the category weights reached as a result of expert evaluations and the answers given to the semi-structured questions by the experts.

The study is important in terms of determining how much SMEs have improved themselves in the Industry 4.0 process in the last five years and how close they have come to the process. In the business world, where information technologies and access to information are now easier, it is expected that it will be important in terms of determining the obstacles and advantages that businesses think they will face and revealing the current progress of the industry process. In this respect, it is thought that the results of the study will guide new technology developers and practitioners.

The study is believed to be one of the original studies in its field in terms of being repeated with the same focus group in a 5-year time period and revealing the potential development in SMEs. As far as is known, no other study has been conducted in which the study was repeated on the same sample. In this respect, it is thought that the findings will contribute to the literature. In addition, it is thought that a different evaluation will be put forward in terms of presenting the answers together by weighting the relevant criteria in the questions. The application in the research is carried out on the executives of thirty-two SMEs in the automotive sector. Each of the experts was selected from (male) engineers who have been working in their sector for ten years or more. Within this group, there are employees from different fields such

as industrial, mechanical, mechatronics and automotive engineering. These enterprises were selected from the Marmara Region, mostly from Sakarya, Kocaeli and Istanbul. Due to the ease of accessibility to businesses, we have focused especially on businesses in this region. At the same time, one-on-one interviews with five people were required for the expert opinions on the weighting of the categories in the research question seven. These people were selected from executive-level engineers who have been working full-time in the automotive industry for more than ten years. Two of the engineers are mechanical engineers, two are industrial engineers and one is a mechatronics engineer.

I. MATERIALS AND METHODS

In the study, research questions prepared as a result of both literature review and one-to-one interviews with people in the sector were used. In-depth interviews have been very important in the preparation of these research questions and the criteria have been categorized by supporting the literature. Provided that the purpose of the research questions remains the same with the previous study, only the sentences are expressed in a more understandable form. In total, thirty-two SME executives were interviewed one-on-one, and semi-formatted interviews were conducted within the framework of pre-prepared questions. A total of seven questions were asked to thirty two SME executives and the results were visualized with graphics in line with the answers received. On the other hand, the SWARA method was needed to weight the criteria in the last research question.

A. SWARA (Step-Wise Weight Assessment Ratio Analysis)

SWARA is a multi-criteria decision-making method developed and applied by Keršulien, Zavadskas and Turskis in 2010. The method is preferred for wanting to assign weights to the criteria in any problem solution where there are many criteria. At SWARA, experts play a critical role in prioritizing and weighting criteria. Most of the time, in cases where the decision makers are at different levels of importance, research can be carried out in SWARA by giving different degrees to the decision makers. The skills and experiences of the decision makers are the most decisive point in revealing the importance of each criterion in the method (Ghorshi Nezhad, Zolfani, Moztarzadeh, Zavadskas & Bahrami, 2015). Linguistic terms are used in the method, which is based on determining criterion weights by taking into account expert opinions.

The SWARA method has been used in various studies within different research fields and subjects. Considering the studies in recent years, in 2021, the method was used in studies such as evaluating risk factors (Ulutas, Meidute-Kavaliauskiene, Topal & Demir, 2021; Ghoushchi et al., 2021), weighting the criteria affecting medical tourism (Ghasemi, Mehdiabadi, Spulbar & Birau, 2021), prioritizing location selection criteria in logistics activities (Hashemkhani Zolfani, Gorcun & Kucukonder, 2021), evaluating the most appropriate production strategy for the efficiency of the automotive industry (Mahdiraji, Zavadskas, Arab, Turskis & Sahebi, 2021), weighting the green supplier selection criteria (Tas, Cakir & Ulukan, 2021), weighting the performance evaluation criteria (Khalili & Alinezhad, 2021), evaluating the barriers to the adoption of the internet of things in the circular economy (Cui, Liu, Rani & Alrashedi, 2021), weighting the socioeconomic risk factors in the health sector (Rehman, Rehman, Naz, Mumtaz & Jianglin, 2021).

In 2022, SWARA method was used in studies such as weighting the environmental, economic and social criteria that affect the selection of the most suitable place for medical waste storage (Ghoushchi et al., 2022), analyzing the risks in supply chain management (Sivageerthi, Bathrinath, Uthayakumar & Bhalaji, 2022), prioritizing the risks in electricity generation processes (Karamollaoglu, Yucedag & Dogru, 2022), weighting the green supplier evaluation criteria (Tus & Adali, 2022), evaluating the drivers and challenges of the circular economy in the clothing industry (Koca, Egilmez, Demir, Karamaşa & Gokcan, 2022), evaluating the financial criteria of companies that generate electricity from energy sources (Erdogan, Tutcu, Talas & Terzioglu, 2022), assessing technology risks for supply chain management (Hu, Al-Barakati & Rani, 2022), weighting the proposed criteria to evaluate green approaches and digital marketing strategies (Korucuk, Aytekin, Ecer, Karamasa, & Zavadskas, 2022).

Recently, the method was used in studies such as weighting the criteria that affect the supplier selection (Gezmisoglu, Unlu & Cagil, 2023), finding the importance of the military helicopter pilot selection criteria (Kurnaz, Ozdagoglu & Keles, 2023), prioritizing the earthquake risk criteria (Guler, Avci & Aladag, 2023), evaluating the criteria that ensure the long-term sustainability of the rail transport system (Bouraima, Qiu, Stević, & Simić, 2023), prioritizing lean facilitators in improving supply chain agility (Sharma, Sohani & Yadav, 2023), evaluating the criteria that are effective in establishing distribution centers (Puška, Štilić & Stević, 2023) ranking energy consumption optimization strategies in buildings (Ranjbar, Balali, Valipour, Pignatta & Wei, 2023).

In this study, the SWARA method was applied in order to rank the importance levels of the criteria in some research questions of the application by the experts. It is a good approach to benefit from expert opinions in problems where data is difficult to access. The biggest reason for preferring the method is that decision makers consisting of experts can use their own "subjective evaluations" in practice. It is easier to operate with fuzzy sets, which are used to model the instability of decision makers. Also, one of the reasons is that the method requires less processing. SWARA needs fewer pairwise comparisons compared to the AHP method (Stanujkic, Karabasevic & Zavadskas, 2015). For this reason, the use of the method has been an advantage in terms of time. Since the five decision makers in the study work in the same sectors and have similar experiences, the weighting of the decision makers in SWARA is considered equal. However, depending on a different experience, different weights can be assigned to decision makers in practice. Finally, one of the reasons why the method is preferred is due to the limited use of SWARA in studies on Industry 4.0. As far as is known, SWARA has not been used in studies prepared against the Industry 4.0 approach in SMEs. For this reason, it can be stated that the method has original value in terms of the relevant literature.

SWARA Method Steps:

The steps of the SWARA method are as follows (Kersuliene et al., 2010):

Step 1: All criteria in the study are listed first. All criteria are then ranked by the decision makers in order of importance from highest to lowest. According to this order, the geometric mean of the criteria is calculated.

Step 2: Each of the criteria is compared in pairs by the decision makers. S_j notation is defined to show how important each criterion is from the next criterion.

Step 3: For each decision maker, the values of K_j, Q_j indicating the importance weight, and W_j indicating the relative importance weight are calculated.

$$K_j=\{1, j=1; S_j + 1, j > 1\}) \quad (1)$$

$$Q_j=\{1, j=1; Q_{j-1}/K_j, j > 1\} \quad (2)$$

As in Equations (1) and (2), the value of K_1 and Q_1 of the first criterion is always 1. The values of the other criteria are reached in line with the expressed equations.

$$W_j=Q_j/\left(\sum_{k=1}^{n} Qk\right) \quad (3)$$

Equation (3) is applied to obtain relative importance weights. The relative importance weight value is obtained by dividing the importance weight (Q_j) of each criterion by the total importance weight (Q_k) of all criteria.

Step 4: The relative importance weights of the criteria are summarized in a single table by each decision maker and the final weight values are reached by taking the geometric averages.

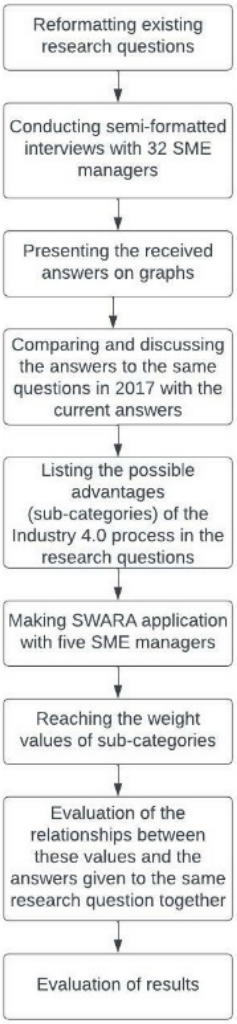
II. APPLICATION

A. RESEARCH DESIGN

Figure 1 shows the process steps followed in the application. During the application process, the existing questions were rearranged so that the research questions, which were previously prepared and studied on this

subject, could be understood more easily and not cause any confusion. Then, the questions prepared in the first step were asked to thirty two SME managers who were interviewed before, and the interview was continued in a semi-formatted manner. In the third step, the answers from the managers were prepared in graphic form as a result of simple analysis. Together with these graphs, the data collected in 2017 (Cevik (2018)'s study) were brought together and the results were compared and discussed. In the next step, the criteria for the second application of the study were determined and listed in a more understandable and simple way. Then, five experts were interviewed in order to reach the weight values of the criteria. At this stage, the steps of the method were followed in order to apply SWARA, which is one of the multi-criteria decision-making methods. In the continuation of the process, it was interpreted by thirty two SME managers by comparing the evaluations made to the research questions in the previous application and the weight values reached for the criteria.

FIGURE 1| Research Steps



B. SEMI-FORMATTED INTERVIEW

In this section, direct questions were asked to thirty two SME executives in order to determine their perspectives on the Industry 4.0 process. The criteria in the study were determined in line with the literature reviews and expert opinions in the previous Cevik (2018)'study period.

1. Research questions and results

All researh questions in the study were taken from Cevik (2018) and Cevik (2019)'s studies. All the answers of SME executives to the relevant research questions are visualized below. At the same time, the answers given to the same questions in 2017 are evaluated together with their current situation.

Research Question 1: Which level do you think you have mastery of the applications, technologies, objectives, in short, processes used in Industry 4.0?

FIGURE 2| General Knowledge of SME Executives for Industry 4.0

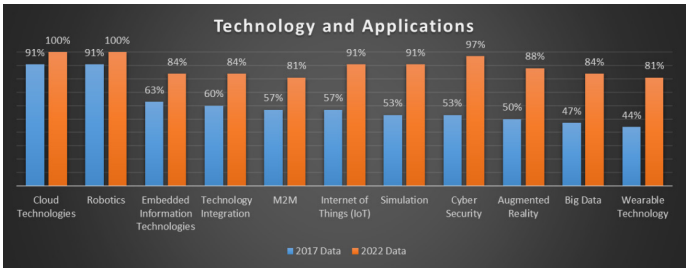
As seen in Figure 2, 22% of experts today find their general knowledge level about the applications, technologies and targets used in Industry 4.0 to be very good; 72% find it at a good level and 6% at a moderate level. No expert thinks they have limited knowledge of Industry 4.0.

Compared to the answers from five years ago, while the experts who answered "good or very good" regarding their dominance in Industry 4.0 processes were at the level of 62%, this rate has reached 94% today.

Research Question 2: Which of the following technologies and applications, which are specifically evaluated within the scope of Industry 4.0, do you think you have enough information about their application areas and possible effects?

These technologies and applications are technology integration, simulation, cyber security, robotics, machine-to-machine communication (M2M), internet of things (IoT), embedded information technologies, wearable technology, cloud technologies, big data and augmented reality.

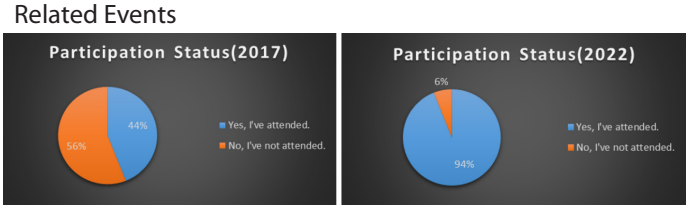
FIGURE 3| General Knowledge of SME Executives on Industry 4.0 Technologies



As seen in Figure 3, each of the interviewed SME executives considers their knowledge of cloud technologies and robotics to be fully sufficient today. According to the answers received from the executives five years ago, these two technologies were the technologies about which the most information was learned, and this priority situation has not changed over time. Another sufficient technology is cyber security with a rate of 97%. However, in 2017, the level of knowledge on cyber security by executives remained at the level of 53%. The Internet of Things (IoT) and Machine-to-Machine (M2M) technologies resulted in a critical rate of 91% as other technologies with sufficient knowledge of their application areas and possible effects.

Research Question 3: Have you attended any (online/face to face) congresses, fairs or seminars related to Industry 4.0?

FIGURE 4| Participation of SME Executives in Industry 4.0 Related Events

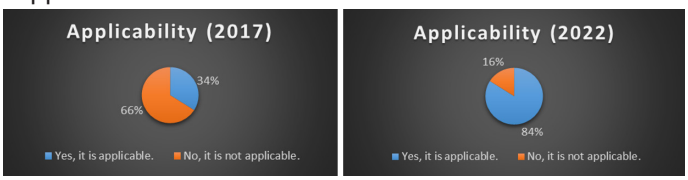


As seen in Figure 4; 94% of the executives declared that they attended congresses, fairs or seminars on any platform (online/face-to-face) related to Industry 4.0. The activities developed by both the public

and many private sectors with the increasing awareness of the process started to grow rapidly. According to Figure 4; in these five years, 38% of the executives participated in the relevant activities and increased their share in the total to 94%. This is a rate that can be seen as a very successful rate. Almost all of the participants took part in Industry 4.0.

Research Question 4: Do you think Industry 4.0 applications are applicable in SMEs with today's developments?

FIGURE 5| Views on the Applicability of Industry 4.0 Applications in SMEs



According to Figure 5; 84% of executives think that Industry 4.0 is applicable in SMEs; 16% still think that it cannot be applied. When we look at the change in five years, 18% of the group who answered "Not applicable" had the difference that it was applicable, and the segment who found it applicable comprised a larger portion.

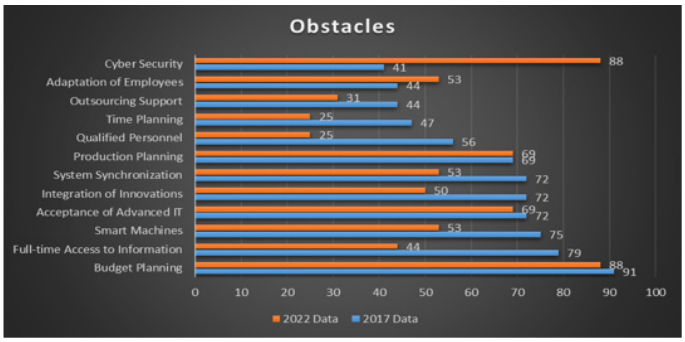
Research Question 5: Do you think SMEs may face difficulties with the application of technologies in Industry 4.0?

Each of the thirty-two SME executives interviewed for this research question agreed that there may be many challenges in the Industry 4.0 process. Although many executives think that Industry 4.0 can be applied in SMEs, they declare that there will be some difficulties in the same way. This research question resulted in the exact same answers given in 2017. The next research question is customized according to the answers to this question. It is important for businesses to examine the problems they will encounter and the possible problems that will arise.

Research Question 6: Which barriers do you see as likely to be encountered in the implementation of Industry 4.0 in SMEs?

These obstacles are budget planning, adaptation of employees, cyber security, outsourcing support, time planning, qualified personnel, production planning, system synchronization, integration of innovations, acceptance of advanced information technologies, smart machines, full-time access to information.

FIGURE 6| Possible Obstacles to be Encountered in the Industry 4.0 Proces



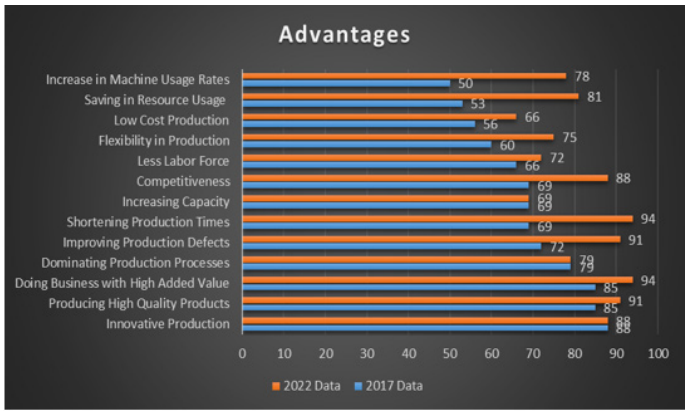
According to Figure 6, the most likely obstacles to the implementation of Industry 4.0 in SMEs are seen by 88% of executives as cyber security and budget planning. Especially cyber security is one of the most crucial points of this graphic. Looking at the data in 2017, only 41% of the executives saw this as an obstacle, but today it is considered as one of the biggest constraints by the vast majority of executives. In this case, there is no doubt that the cyber attacks that even very large corporate companies are faced with have been effective. The security of the systems that provide the data is in a critical place today, as all the actions and movements of the businesses are kept as data.

The third obstacle that today's executives think they will encounter in the Industry 4.0 process is access to advanced information technologies and the integration of innovations into the existing system. The inclusion of new technologies in existing production systems, the use of information technologies in the production system and the planning of production in this direction with innovations are seen as the main obstacles of the Industry 4.0 process.

Another important point of this research question was the difference in executives' evaluations of access to information. While in 2017, 79% of the executives stated that access to information regarding Industry 4.0 is a major obstacle, today 44% of the executives define this as a problem. Executives began to see these challenges less worrisomely in other categories under the survey.

Research Question 7: In which areas do you think SMEs will gain advantage by implementing Industry 4.0?

FIGURE 7| Possible Advantages to be Encountered in the Industry 4.0 Process



According to Figure 7, with the implementation of Industry 4.0 in SMEs, the situations that 94% of the executives think will provide the most opportunities were determined as shortening the production times and doing business with high added value. Other advantages of Industry 4.0 were determined by 91% of the researchers as reducing production errors and producing quality products. It was observed that the rates for these four advantages reached higher values when compared to the results of previous studies. In particular, the opportunity that Industry 4.0 will provide in terms of production times was approved by 69% of the executives in 2017 data, while this rate is 25% higher today. In short, in the past five years, SME executives have increased their awareness in this direction by reaching more detailed information about the real potential results of Industry 4.0.

When all categories are evaluated together, in terms of the benefits of Industry 4.0, low-cost manufacturing has been approved and accepted by only 66% of executives. In this case, the high budget requirement of Industry 4.0 (based on the answer given in Research Question 6) was undoubtedly effective. Some of the executives continue to be concerned about the production costs as a result of the high investments of the process. When the answers for 2017 and 2022 are compared, a category that creates a remarkable situation in the bars in Figure 7 is the increase in machine usage rates. In 2017, 50% of the executives thought that Industry 4.0 applications would improve machine utilization rates; today, this rate has reached the level of 78%. Due to the fact that new technologies and equipment produce and use real data, it is expected that the increase in machine usage rates will be in this direction.

C. CRITERIA WEIGHTING WITH SWARA

In order to determine the importance level of the sub-categories (opportunities) in the research question 7 and directed to the executives, the SWARA application was carried out. The related equations and data of this application were entered directly into the EXCEL program and the results were obtained with the help of the solver.

The criteria used in the study are shown in Table 1.

TABLE 1| Criteria in the study

Criteria	Explanation
C1	increasing in machine usage rates
C2	saving in resource usage
C3	low cost production
C4	flexibility in production
C5	less labor force
C6	competitiveness
C7	increasing capacity
C8	shortening of production times
C9	improvement in production defects
C10	dominating production processes
C11	doing business with high added value
C12	producing quality products
C13	innovative production

The experts involved in the study are also indicated by Ej.

Steps followed to weight the relevant criteria:

Step 1: The order of importance of 13 different criteria in the study was determined by five decision makers, and their geometric averages were taken accordingly. Then, Table 2 was created according to this order of importance.

TABLE 2| Ranking of Criteria and Determining the General Ranking

	E1	E2	E3	E4	E5	Geo. Average
C3	1	5	5	1	1	1.903
C6	2	1	4	2	2	2
C9	3	2	3	5	3	3.063
C12	4	3	2	3	4	3.103
C11	7	4	1	4	5	3.545
C2	5	6	8	8	6	6.490
C8	6	7	9	10	9	8.060
C4	11	11	6	6	11	8.631
C1	10	10	7	7	12	8.992
C10	9	8	10	11	8	9.127
C13	12	9	12	9	7	9.602
C7	8	12	12	9	10	10.07
C5	13	13	13	13	13	13

According to Table 2, the top five indicators that experts consider the most important from the possible advantages of the Industry 4.0 process are low-cost production, competitiveness, improvement in production defects, producing quality products and doing business with high added value, respectively.

Step 2: According to Table 3, each criterion is compared with the next criterion by the decision makers and it is determined how much more important it is. The criterion with the lowest geometric mean should remain blank and it is expressed as Sj by taking the ratios of the binary criteria for each other criterion (Ruzgys, Volvačiovas, Ignatavičius & Turskis, 2014).

TABLE 3| Binary Comparison and Weighting of Criteria

			E1	E2	E3	E4	E5
Rank	Criteria	G. Av.	S_1	S_2	S_3	S_4	S_5
1	C3	1.903					
2	C6	2	0.15	0.00	0.00	0.10	0.20*
3	C9	3.063	0.05	0.00	0.00	0.15	0.05
4	C12	3.103	0.10	0.10	0.00	0.00	0.10
5	C11	3.545	0.10	0.10	0.00	0.15	0.10
6	C2	6.490	0.00	0.05	0.20	0.10	0.05
7	C8	8.060	0.15	0.10	0.15	0.15	0.15
8	C4	8.631	0.15	0.10	0.00	0.00	0.15
9	C1	8.992	0.00	0.00	0.10	0.10	0.10
10	C10	9.127	0.00	0.00	0.05	0.10	0.00
11	C13	9.602	0.10	0.10	0.10	0.00	0.00
12	C7	10.07	0.0	0.0	0.0	0.0	0.10
13	C5	13	0.15	0.10	0.10	0.10	0.10

**The expert, who is expressed as the fifth decision maker in the study, considers C3 (low cost production) to be relatively more important by 20% than C6 (Competitiveness).*

Step 3: K_j, Q_j (weight of importance) and Wj (weight of relative importance) are calculated for each experts. For this, all relevant tables are customized for each of the experts individually. Equations (1,2, and 3) of the method were used for Table 4 obtained in this step. Table 4 was created for E1 only.

TABLE 4| Calculation of Criterion Weights for E1

Rank	Criteria	S_j	K_j	Q_j	W_j
1	C3		1.00	1.00	0.120*
2	C6	0.15	1.15	0.869	0.104
3	C9	0.05	1.05	0.827	0.099
4	C12	0.10	1.10	0.751	0.090
5	C11	0.10	1.10	0.682	0.082
6	C2	0.00	1	0.682	0.082
7	C8	0.15	1.15	0.593	0.071
8	C4	0.15	1.15	0.515	0.062
9	C1	0.00	1	0.515	0.062
10	C10	0.00	1	0.515	0.062
11	C13	0.10	1.10	0.468	0.056
12	C7	0.00	1	0.468	0.056
13	C5	0.15	1.15	0.406	0.056
				T: 8.291	

It is obtained by dividing the importance weight (Q_j) of the relevant criterion by the total Q_j value to obtain the final overall weight values. For example, the weight value of the C3 criterion is obtained by E1 with the equation "1/0.8291=0.120". While Table 4 reveals the weight values of only the first expert (E1), similar tables are obtained for the other four decision makers. At this point, the final overall weight values expressed as W_j are particularly important and the weights of the criteria are shown in Table 5.

TABLE 5| Overall Weights of Performance Criteria

C	W_1	W_2	W_3	W_4	W_5	G. Av.
C3	0.120*	0.101	0.099	0.122	0.131	0.114
C6	0.104	0.101	0.099	0.111	0.108	0.105
C9	0.099	0.101	0.099	0.097	0.103	0.100
C12	0.090	0.091	0.099	0.097	0.094	0.094
C11	0.082	0.084	0.099	0.085	0.085	0.087
C2	0.082	0.080	0.082	0.077	0.081	0.080
C8	0.071	0.073	0.071	0.066	0.071	0.070
C4	0.062	0.066	0.071	0.066	0.061	0.065
C1	0.062	0.066	0.064	0.060	0.056	0.062
C10	0.062	0.066	0.059	0.055	0.056	0.060
C13	0.056	0.059	0.054	0.055	0.056	0.056
C7	0.056	0.059	0.054	0.055	0.051	0.055
C5	0.056	0.054	0.048	0.050	0.046	0.051

As can be seen in Table 5, the first five indicators, which are considered the most important among the possible advantages of Industry 4.0 by

SME executives, constitute half of the total weight score. Among the opportunities that the Industry 4.0 process will offer, the most important activities with a total weight value of 50% are low-cost production, competitiveness, improvement in production defects, producing quality products and doing business with high added value. The other eight advantages were also given 50% share by the experts in terms of the opportunities that the Industry 4.0 process will provide. In this study, the last priority category from the potential benefits of Industry 4.0 was determined by the experts as "less labor force".

CONCLUSION

The most important point of the interview with the executives is that the awareness and knowledge of the executives about Industry 4.0 has increased. The general level of knowledge regarding the application areas and the effects of some technologies that are specially evaluated within the scope of Industry 4.0 has resulted in the knowledge of at least 80% of the executives. In the five years that have passed, the executives' own research on Industry 4.0 technologies or some informative meetings and trainings they attended have been effective in the rise of these values. In the research on the applicability of Industry 4.0 applications in SMEs, the 16% who do not think that it is applicable today still think that Industry 4.0 requires a lot of effort, especially on SMEs. For this reason, executives have declared that it will not be possible for new technologies to be applicable unless these deficiencies are eliminated. Although some executives agreed with this idea, the majority agreed that it would be feasible when looking at the big picture.

The combination of the results of the "Research Question 7" together with the weight values reached in the second part of the application can be interpreted differently. Although experts express the greatest opportunity they want to reach with the new industrial period as low-cost production, only 66% of 32 SME executives think that an advantage will be provided in this direction. In other words, although low-cost production was seen as the top priority opportunity, the confidence in its realization remained at 66%. In the category of competitiveness, which is shown as the second most important, it was revealed that 88% of SME executives see Industry 4.0 as a process that increases the competitiveness of businesses. It has been determined that the experts have confidence in the realization of this with the results of the new industrial era supporting the competitiveness of the businesses. At the point of improvement in production defects, which has the third highest weight, 91% of the experts believe in the opportunities that Industry 4.0 will offer in this direction. In the category of producing quality products, which is shown as the fourth important advantage, it has been revealed that 91% of SME executives see Industry 4.0 as a process that increases the quality of the products produced by businesses. With the results that the new industrial era supports the quality improvement of the products, it has been determined that the experts have high confidence in this realization. With the findings on "doing business with high added value", almost all of the executives have revealed their confidence in this potential that Industry 4.0 will provide.

Executives expressed the advantage with the lowest priority as capacity increase in the enterprise and less labor required. 69% of the executives are in favor of the fact that Industry 4.0 will provide an advantage for capacity increase. However, the desire of the executives for the advantage they will gain in terms of production capacity has lagged behind compared to other situations. It is possible that they see this advantage behind, especially because businesses produce according to demand and often cannot work at full capacity. On the other hand, 72% of SME executives agree that Industry 4.0 requires less workforce. Other executives did not give a positive opinion, possibly due to the workforce they need in the use and application of technologies.

Researchers with similar research areas can repeat the work for businesses of different sizes in different sectors in the future. The existence of studies in this direction can bring new perspectives to the literature by changing the tendency of different sectors to Industry 4.0 and the order of expected advantages. Low-cost production is seen as the top priority with the application of Industry 4.0 in the automotive sector, while priority may change in different industries. This may contribute to technology developers and practitioners developing special software for different systems and offering different solutions.

In another application point of the study, it was aimed to determine the importance levels of possible advantages in the Industry 4.0 process and 13 criteria were evaluated by five experts. The SWARA method was used for criterion weighting and the most important and least important advantages were listed as a result of the analysis. The industrial revolution, which developed on the basis of information technologies, brings radical changes in businesses. According to the findings, the most important advantage of Industry 4.0 is low cost production. Already the Industry 4.0 initiative focuses on the ability of manufacturing systems to respond dynamically and cost-effectively to respond to market needs (Jepsen et al., 2021; Herrero, Sanguesa., Martinez, Garrido & Calafate, 2021; Asif, Searcy & Castka, 2022) . It can be stated that the process offers many fast and low-cost solutions for manufacturing companies with old machines aiming to adopt the Industry 4.0 paradigm (Vuković, Jorg, Hosseinifard, & Fantoni, 2022). The second highest weighted criterion is that Industry 4.0 can increase the competitiveness of enterprises. The fourth industrial revolution is a critical issue for the sustainability of firm competition (Tvaronaviciene & Burinskas, 2020). The effect of competition was seen as important for the experts in this study. The impact of Industry 4.0 on global competition increases the importance of the process (Yalcin, 2018). Many studies also show that the effects of this transformation on competition depend on the technology applied (Somohano-Rodríguez & Madrid-Guijarro, 2022).

The third important criterion among the possible advantages in the Industry 4.0 process by the experts is that improvement in production defects can be achieved. This advantage is a strength that can be obtained with the existence of a very good quality control system. Quality Control has emerged as a major global trend among manufacturers adopting smart manufacturing practices (Johnson, Bali, Kolanur & Tanwashi, 2022). Industry 4.0 has the tools to realize zero-defect production (Cheng et al., 2022), which provides a significant power to businesses in production. The criterion of producing quality products, which is also a measure of meeting customer needs, has taken its place among the most important criteria as expected. This criterion is also linked in many ways with the improvement criterion in manufacturing defects. The quality of manufactured products is a key factor for success in the manufacturing industry. It is known that the Industry 4.0 process significantly affects the results of businesses by increasing quality and efficiency (Milošević, Arsić, Glogovac, Rakić & Ruso, 2022). Existing production systems that are consistent in meeting customer wants and needs must be adaptable while maximizing the quality of their products (May & Kiritsis, 2019)

Finally, in this application where the potential effects of Industry 4.0 are prioritized, the study can be repeated by using different methods of multi-criteria decision making methods. By using the same criteria, different researchers may prefer criterion weighting methods such as Fuzzy Analytical Hierarchy Process, Fuzzy Analytical Network Process, BWM (Best Worst Method) and FUCOM (Full Consistency Method). It may also be important to compare the results obtained by different methods with the results of this study. In addition, it will be important for researchers who are interested in the subject to improve the study by adding different criteria. Finally, although the application was made in the automotive sector, it is also a matter of curiosity what the results will be in different sectors.

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ETHICAL STATEMENT

It was decided that this study does not pose any ethical objections by the Kırklareli University Scientific Research and Publication Ethics Board dated 28.11.2022 and numbered E-35523585-302.99-69463.

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