BMIJ
ISSN: 2148-2586

bmij (2022) 10 (1):22-40
doi: https://doi.org/10.15295/bmij.v10i1.1905
Research Article

Essentials of sustainable development: SMEs and R&D. A research to determine the barriers to R&D in SMEs

Sürdürülebilir gelişmenin vazgeçilmezleri: KOBİ'ler ve Ar-Ge. KOBİ'lerde Ar-Ge'nin önündeki engelleri belirlemeye yönelik bir araştırma

Güzide Karakuş[1]

Kasım Güneş[2]

[1] Assist. Prof. Dr., Necmettin Erbakan University, Konya, Turkey, gkarakus@erbakan.edu.tr

ORCID: 0000-0002-2897-7222

[2] Graduate student, Necmettin Erbakan University, Konya, Turkey, mkasimgunes@gmail.com

ORCID: 0000-0001-9351-4059

Corresponding Author:

Güzide Karakuş,

Necmettin Erbakan University, Konya, Turkey, gkarakus@erbakan.edu.tr

Abstract

This study aims to determine the obstacles to SMEs' R&D activities, which have an essential role in sustainable development. In this direction, Turkey performed a descriptive multi-case analysis to determine the barriers to R&D success. The results achieved in line with the research design consisting of literature review, interview and document review, interview, analysis and evaluation stages are as follows. Obstacles to R&D activities in SMEs are classified into four categories: human capital-related factors, cost-related factors, information-related factors and management-related factors. While outlining these categories in the conclusion section, thoughts and suggestions of R&D professionals are also embraced.

Keywords: Sustainability, SMEs, Research and Development, R&D, R&D Barriers

Jel Codes: O30, O32

Öz

Bu çalışmanın amacı sürdürülebilir gelişme için önemli role sahip olan KOBİ'lerde Ar-Ge faaliyetlerinin önündeki engellerin belirlenmesidir. Bu doğrultuda Ar-Ge başarısının önündeki engellerin belirlenmesi için açıklayıcı çoklu durum analizi uygulanmıştır. Literatür araştırması, görüşme ve doküman inceleme, mülakat, analiz ve değerlendirme aşamalarından oluşan araştırma deseni doğrultusunda ulaşılan sonuçlar şunlardır. KOBİ'lerde Ar-Ge faaliyetlerinin önündeki engeller dört kategoride sınıflandırılmaktadır: Beşerî sermaye ile ilgili faktörler, maliyet kaynaklı faktörler, bilgi ile ilgili faktörler ve yönetim ile ilgili faktörler. Sonuç bölümünde bu kategoriler tanımlanırken Ar-Ge profesyonellerinin görüş ve önerilerine de yer verilmiştir.

Anahtar Kelimeler: Sürdürülebilirlik, KOBİ, Araştırma Geliştirme, Ar-Ge, Ar-Ge Engelleri

JEL Kodları: O30, O32

Submitted: 9/08/2021

Revised: 15/09/2021

Accepted: 25/09/2021

Online Published: 25/03/2022

Citation: Karakuş, G. & Güneş, K., Essentials of sustainable development: SMEs and R&D. A research to determine the barriers to R&D in SMEs, bmij (2022) 10 (1): 22-40, doi: https://doi.org/10.15295/bmij.v10i1.1905

Introduction

Nowadays, it is inevitable for countries to develop R&D investments as a strategic target to maintain their presence in international markets and gain a competitive advantage. Moreover, new products and production methods generated by a country due to its R&D activities will contribute to the economic growth of that country by increasing its competitiveness and productivity (Korkmaz, 2010, p. 3328). Frascati guide; associates all scientific, technological, organizational, financial and commercial steps that lead to the emergence of technologically new or improved products or processes from scientific and technical education and training with R&D (OECD, 2002, p. 18). R&D is the creative work carried out systematically to increase knowledge of human, cultural, and social expertise and use this information to design new applications.

For countries in the high economic growth class, the sustainability level of R&D activities is an essential competitive advantage and strategic resource for both scientific-economic and socio-economic growth. Along with the government's investment in science, public investment in R&D is an investment in gains such as improving the quality of life of the people, increasing tax revenues, and obtaining more tax revenue from the sales of high-tech products (Ilina, Streltsova, Borodin, and Yakovenko, 2019, p. 1129). Moreover, R&D activities are an essential source of economic growth. It is impossible for businesses and countries that do not pay attention to R&D activities to show a sustainable growth trend (Altın and Kaya, 2009, p. 252). In this context, public authorities should design systematic, industrial, innovative and scientific policies by providing R&D incentives to critical sectors to achieve technological and economic targets at the country level (Coccia, 2011, p.128).

The benefit to be obtained within the scope of R&D incentives should be perceived similarly by the enterprises. The most critical condition for businesses to gain a competitive advantage in the global market and to survive is for them to focus on R&D activities for new products, new processes, new marketing techniques that are different from competitors, which can be seen as value for their customers (Zerenler and Karakuş, 2017, p. 319). In addition to obtaining concrete outputs, businesses that want to benefit from government incentives to improve their R&D activities should take into account the indirect positive effects of the benefits, such as increasing the reputation of the company and supporting the developments in the organization or management (Wong and He, 2003, p. 527). Furthermore, enterprises should understand that the R&D staff employed within the scope of the incentives are a part of the information capital of the enterprise (Piekkola, 2007, p. 204), and they form the basis of the corporate memory of the enterprise. Besides, they are necessary for sustainable growth and development.

A common misconception about R&D is that large-scale enterprises can only carry out these activities. However, research does not support the assumption that firm size affects the business's R&D potential. It is even known that small businesses engaged in R&D tend to be more innovative than large enterprises (Fritsch and Meschede, 2001, p. 348). For this reason, it is vital that SMEs, which have an important place in the economy, should not be neglected in this regard. SMEs need to grow and change in line with the observed growth in the economy. Growth and change are possible by increasing product quality, lowering costs, adapting to new technologies and working with high technology. These requirements can be effectively implemented with R&D activities (Akdemir, 1990, p. 225).

In recent years, studies on the importance of R&D activity-based development have increased. Especially for university-industry cooperation globally, there has been significant progress in implementing the incentive system in Turkey (Akbey, 2014, p. 2). Gülmez and Yardımcıoğlu (2012), investigated the relationship between per capita R&D expenditures and economic growth, using data from 21 OECD countries between 1990 and 2010. They concluded a significant relationship between per capita R&D expenditures and economic growth variables. They suggested that it is crucial to allocate resources to R&D expenditures for sustainable economic growth. However, the problem in Turkey is the failure of enterprises to transfer the necessary time and resources for R&D studies. Therefore, projects carried out within the scope of R&D support are not sustainable, and a qualified R&D system cannot be established (Ünal and Seçilmiş, 2013, p. 24).

Many studies have shown that R&D incentives applied in different countries contribute positively to the increase in R&D investments, economic and social development, efficiency and competitiveness of enterprises (See. Mamuneas and Nadiri, 1996; Zhu, Pingfang, Xu, Weimin and Lundin, 2006; Marino, Lhuillery, Parrotta and Sala, 2016; Huergo, Trenado and Ubierna, 2016; Carboni, 2017; Aiello, Albanese and Piselli, 2019; Klimova, Zitek and Kralova, 2019). In other words, the necessity of public incentives is commonly accepted. Studies to compare R&D indicators and similar research with other

countries have been implemented in Turkey. Research has been conducted by Güzel (2009) that compares the expenditures and incentives related to R&D investments in Turkey with the practices of different countries. As a result of this study, the lack of overall R & D expenditure in Turkey and the low level of the private sector's share in these expenses are highlighted. The author stated that although various incentives were offered with Law No. 5746 on Supporting Research and Development Activities and Law No. 4691 on Technology Development Zones, which entered into force in 2008 to improve these factors, the incentives were insufficient compared to many European countries and OECD countries.

In the following years, Çelebi and Kahriman (2011), Cetin and Isik (2014) have compared incentives for R & D activities in EU countries and Turkey. In the results of these studies, it has been mentioned that adequate incentives are provided, and benefits are significantly increased, especially with the entry into force of Law No. 5746 in Turkey when compared to other countries. Law No. 5746 has been revised over the years and has been improved to provide incentives from a single point through the establishment of R&D and Design Centres. However, academic studies on the operation and outputs of R&D and Design Centres are pretty limited and mainly determine the advantages to be obtained (See. Savcı and Yayla, 2015; Özeroğlu, 2011).

Incentives for R&D and innovation activities appear to be an increasing trend in Turkey. However, the results are still not satisfactory enough considering the global indicators. Every year, studies are carried out to evaluate and rank countries worldwide in line with their R&D and innovation success. One of the most important is the Global Innovation Index (GII), led by the World Intellectual Property Group (WIPO). Within the scope of the Index, 127 countries are analysed within the range of innovative research and products, and the results are published. In the report, taking into account the development levels of the countries, an evaluation is made within the scope of innovation inputs (institutions, human resources, infrastructure, business world), innovation outputs (brands, patents, publications produced with inputs) and innovation efficiency. When the index is reviewed, it is seen that Turkey Ranked 58th in 2015, 42nd in 2016, 43rd in 2017, 50th in 2018, 49th in 2019, 51st in 2020 (GII, 2020). Furthermore, it is notable that countries such as Ukraine, Romania, the Philippines, and Montenegro took place in front of Turkey. Similarly, when the reports regularly announced by the OECD are examined, Turkey's R&D intensity (R&D Expenditures / Gross Domestic Product) is increasing. Still, it seems to lag behind many of the world's developed countries (http://www.oecd.org/sti/msti.htm, Accessed: 19.10.2020) (See, Figure 1).

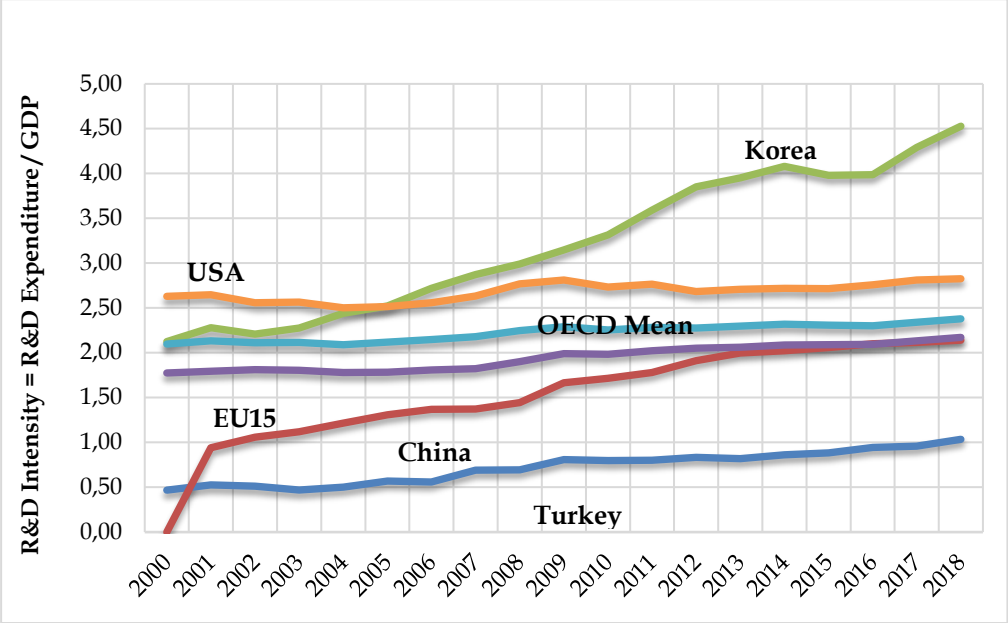

Figure 1. R&D Intensity in OECD Countries and Some Other Economies

* EU15 - The average of 15 European Union countries within the geographical scope including Belgium, France, Italy, Luxembourg, Netherlands, Germany, Denmark, Ireland, United Kingdom, Greece, Spain, Portugal, Austria, Sweden, Finland.

Source: OECD Main Science and Technology Indicators Database, http://oe.cd/msti, E.T.: 19.10.2020

When Figure 1 is examined, the question is ***why Turkey is behind the rest of the world in R&D indicators***. Turkey's relevant institutions, universities, research centres, and academicians should analyse this situation correctly and work on it. Similarly, it is vital to research businesses, universities, public and private research institutions to determine the causes of the problem regardless of its

magnitude. However, research of this wide range requires considerable time and resources. Therefore, the scope of this study has been determined as the R&D activities of SMEs, which have an important place in the economy. Because SMEs are a key source of dynamism, innovation and flexibility in developed and industrialized countries and developing economies (Ortega-Argiles, Vivarelli and Voigt, 2009, p. 4). Therefore, the subject of this study is why SMEs, which are the heart of sustainable development and economy in Turkey, could not achieve success in R&D activities. The research question to be answered in the study is the following:

'What are the obstacles to R&D activities in SMEs?'

In order to answer this question, the article is organized into five sections. Following the introduction, the second chapter presents a theoretical background for the importance of R&D activities and supports applied in this regard and R&D activities in SMEs. In the third section, the methodology of the research is described. In the fourth chapter, the findings obtained from the study are given, and in the last chapter, interpretations regarding the research findings and suggestions for future research are presented.

Background and literature review

The importance of R&D activities and support for developing R&D

The increasing importance of technological change and R&D investments is an indication that R&D is the primary driver of economic growth, and the social rate of return on R&D investments is considered necessary (Lööf and Heshmati, 2005, p. 15). Technological developments are an essential factor for economic growth, and they emerge as a result of R&D activities. While technological innovations increase market share and profitability by improving the enterprise's competitiveness, they also improve efficiency by ensuring efficient use of resources. From a broader perspective, they enhance the quality of life of societies by providing support for economic development (Korkmaz, 2010, p. 3321). Therefore, the fact that the results of R&D activities provide more social development than the benefits they provide to enterprises directs governments to incentive policies to increase R&D investments (Cappelen, Raknerud and Rybalka, 2012, p. 334, Zhu, Pingfang, Xu, Weimin and Lundin, 2006, p. 57).

Although the first goal of an R&D policy is to increase the amount of innovation, the ultimate goal is to strengthen that country's position among nations based on knowledge and competence (Aiello, Albanese and Piselli, 2019, p. 1058). Therefore, public incentives for R&D are expected to encourage enterprises to carry out R&D activities that will provide a public benefit (Liu et al., 2016). Public investments in R&D activities can generally be implemented through three main policy instruments: Research and development activities carried out by the public (government or university), direct support of private-sector R&D activities by the government, and financial incentives such as tax reductions (Guellec and Van Pottelsberghe, 2003, p. 227).

R&D investment, which is the source of economic and human capital, is essential in ensuring financial stability, increasing international competitiveness, economic vitality, and sustainable growth (Altıntaş and Mercan, 2015, p. 347). Therefore, businesses need to improve their product/service innovation capabilities to compete in sectors with high R&D intensity and technology change rates (Bustinza, Gomes, Vendrell-Herrero and Baines, 2019, p 36). Lee (2011) has researched the effects of various public incentives on the R&D investments of enterprises. However, within the scope of the study, it is stated that it is difficult to evaluate the total impact of public R&D support. Besides, public R&D incentives have four different potential effects depending on various characteristics specific to the enterprise or the sector: technological competency enhancing development, demand creating effect, cost-reducing effect, and R&D (project) overlapping (or boosting) effect.

Due to the high risk and uncertainty of R&D investments, private enterprises may prefer not to participate in publicly valuable R&D projects. In these cases, a public intervention that encourages private R&D can positively impact beneficiary businesses and social welfare. (Bellucci, Pennacchio and Zazzaro 2019, p. 215).

Providing public support for the R&D studies of the private sector is a fundamental issue in the design of technology policy. From a theoretical point of view, there are two primary hypotheses. First of all, the presence of R&D support can encourage private enterprises to start R&D or increase their resources allocated to R&D. Because this reduces marginal costs and increases the profitability of R&D projects. On the other hand, providing public support for R&D expenditures of the private sector may reduce the personal efforts of the enterprise in R&D because businesses may prefer public finance overusing their financing resources in their projects that they will carry out in any case (Garcia-

Quevedo, 2004, p. 88). Another consequence of providing public support to improve R&D activities is that it can create an imbalance between the enterprises receiving incentives and the others, resulting in consequences that may disrupt economic competition. The repeated support of some enterprises can lead to a deterioration of the market environment. Some businesses may become dependent on regular incentives, which can permanently reduce their resources allocated to R&D. Therefore, R&D public policy mechanisms that minimize these negative situations need to be considered (Klimova, Zitek and Kralova, 2019, p. 16). Within the framework of the development economy, the optimum resource allocation should be determined depending on the technological characteristics of the output to be obtained for information production and the market structure in which it will be used (Arrow, 1972, p. 609). Measuring the outcomes of support programs in line with the specified resource is also an important issue. Factors to consider within the scope of supports include (Lööf and Heshmati, 2005, p. 4):

1. How to measure the outputs of supported research,
2. How to measure the benefits obtained in research funded by indirect supports, except for those directly supported,
3. How to measure the changes created by the support provided in the corporate infrastructure of the enterprise and the possible long-term change and transformation effects.

In this context, support programs that were previously implemented more generally began to be offered in a guided manner over time. In addition, criteria were developed to measure their output in the short and long term. Another critical issue that has changed over time is the development of collaborative activities. With the increasing importance of open innovation, public incentives have been developed within the scope of the development of joint R&D projects. It is generally accepted that standard R&D programs play an essential role in developing a knowledge base and creating added value (Kostopoulos, Spanos, Soderquist, Prastacos and Vonortas, 2019, p. 1385).

Many studies have been conducted on different countries in the academic literature on public incentives to improve R&D activities and investments (Huergo et al., 2016, p. 207). These studies are important in understanding the importance of incentives and guiding public authorities in their incentive practices. However, the results include various contradictions. There are four main reasons for these contradictions: The first is that most of the current studies aim to analyse a specific public R&D incentive program for a particular sector or country. Second, there is no suitable control group to compare businesses that apply to the public R&D program and are considered supported. Third, ignoring that public R&D incentives have different effects on different business structures (It is natural that differences such as whether the business is large or small, new or old, or manufacturing in the high or low technology area cause variability in the results). Fourth is the lack of a formal theoretical model or framework to analyse how public R&D incentives affect enterprises' R&D work (Lee, 2011, p. 256). However, albeit within the framework of different criteria, the results obtained from many studies that have been conducted overlap with remarkable differences, indicating the validity of the results.

Mamuneas and Nadiri (1996) investigated the effects of R&D incentives on manufacturing and productivity in manufacturing enterprises in the United States. They indicated that publicly funded R&D investments are a convenient tool to increase productivity and encourage production growth. Between 1993 and 2002, Zhu et al. (2006) investigated the impact of the country's direct funding and tax incentives on R&D investments of the manufacturing sector in Shanghai. As a result of the study, they found that direct funding supports positively affected manufacturing industry R&D expenditures, but the impact of tax incentives was not fully observed.

Cappelen et al. (2012), in Norway, which has lower R&D expenditures than the OECD standard, Marino et al. (2016) in France between 1993 and 2009, Liu et al. (2016) in manufacturing enterprises operating in the high-tech product group in China investigated the impact of R&D incentives on R&D investments. Huergo et al. (2016) Investigated the effect of low-interest public loans in Spain on the R&D activities of enterprises. Carboni (2017) examined the impact of the general grant program on investment and R&D expenditures in European manufacturing enterprises. Aiello et al. (2019) evaluated the role of R&D supports on the innovation activities of SMEs operating in Italy, while Klimova et al. (2019) assessed the three variables representing R&D of direct and indirect R&D supports in the Czech Republic during the period 2007-2015 (R&D expenditures, number of R&D employees and number of R&D workplaces). Finally, Bellucci et al. (2019) investigated the effects of two different R&D programs (individual and collaborative/requiring partnership) implemented in Italy in 2015-2018. Although there are differences between the results of the studies, the general

opinion reached is that the enterprises that benefit from the R&D support invest more in R&D and contribute to the development of new products/services and production processes.

Although many studies have been conducted to understand the effect of public R&D incentives on R&D investments (Shen and Lin, 2020, p. 2), the results of these supports on social development have not been ignored Ali-Yrkkö (2005) investigated how public R&D financing affected the labour demand with a panel data analysis on the 187 Finnish enterprises between 1997 and 2002.

At the end of the research, public R&D financing increased R&D employment. Similarly, Piekkola (2007) used employer-employee data in Finland to investigate whether public support for R&D increased engagement and productivity. At the end of the study, it was concluded that R&D supports directly affect productivity growth for small and medium-sized enterprises and complement private R&D expenditures.

Similar research and studies to compare R&D indicators with other countries have been carried out in Turkey. Güzel (2009), Akbulak and Akbulak (2010) and Özeroğlu (2011) investigated the change in R&D tax incentives applied in Turkey and mentioned the lack of R&D expenditures in Turkey in general and the low share of the private sector in these expenditures. Ünal and Seçilmis (2013) compared Turkey's R&D activities with developed economies via EUROSTAT data. In the evaluation performed within the scope of R&D employment, scientific publication, advanced technology group product exports, number of patents and trademarks, information and communication expenditure indicators, they have concluded that Turkey lags far behind developed countries. As a result of the study, they stated that private enterprises should be supported with funds and incentives within an effective system. Altıntaş & Mercan (2015) analysed the effects of R&D expenditures on economic growth through 1996-2011 data of 21 OECD countries. Within the study's scope, they concluded that the increase in R&D expenditures had a robust positive effect on economic growth. Unfortunately, it is seen that Turkey ranks at the bottom among these countries in R&D expenditures.

Taş et al. (2017) examined the effects of R&D investment expenditures on economic growth within the scope of the Industrial Production Index and gross domestic product in the R & D expenditure share variable in Turkey for the 2005-2015 period. As a result of the study, they concluded that R&D expenditures have a causality relationship with economic growth but have a low impact.

Önder and Yıldız (2017), Fidancı (2017) specified the tax advantages applied to R&D expenses within the scope of Law No.5746 on Supporting Research and Development Activities and the conditions to benefit from them. Çelebi and Kahriman (2011), Çetin and Işik (2014) have made a detailed comparison of incentives for R & D activities in EU countries and Turkey. Within the scope of the studies, they mentioned that sufficient levels of incentives were applied in Turkey compared to other countries, especially with law no. 5746, and the benefits were significantly increased. However, they emphasized that the expected development in R&D could not be achieved only with incentives and that structural problems (lack of technology culture, lack of a sufficient number of R&D personnel, ignorance of companies, etc.) should be addressed with radical solutions.

R&D in SMEs

There remains a debate about small and large firms' role in technological progress and innovation, dating back to Economist Josef Schumpeter. While academics and policymakers in the eighties emphasized that large enterprises played a leading role in R&D, the role and influence of SMEs began to be rediscovered in the nineties (European Commission, 2006, p. 27). After decades of research on the effects of firm size on R&D, the only point agreed upon in terms of theoretical arguments and empirical evidence is that no clear conclusion can be drawn about such a relationship (Revilla and Fernández, 2012, p. 621). While business size does not directly affect R&D intensity, it has a positive impact on business-specific technological competence (Lee and Sung, 2005, p. 929). The level of technical competence is also an essential input for R&D along with all operational activities.

Additionally, SMEs are innovative enterprises with lower capital-workforce ratios and operational flexibility (Yang and Huang, 2005, p. 478). The way to create a significant number of jobs depends on the growth and development of SMEs (Riding, Madill and Haines, 2007, p. 47). SMEs are the pillars of the economy in output, employment, technological change, etc. In order to ensure regional and national economic development, it is essential to protect and support the dynamics of SMEs and to place more emphasis on the driving forces and effects of R&D (Ale Ebrahim, Ahmed and Taha, 2010; Ortega-Argiles, Potters and Voigt, 2009, p. 3).

Structural differences in enterprises bring different advantages and disadvantages. The advantages of large businesses are due to their more accessible access to finance and infrastructure. In contrast, in

smaller firms, the benefits are flexible and adapting to new environments. While the advantages of large-scale businesses tend to be physical, they tend to be behavioural for smaller firms (Ortega-Argiles, Potters and Voigt, 2009, p. 8). Since SMEs are in direct contact with customers, they can improve based on customer feedback. Less bureaucracy and more flexible capabilities in SMEs compared to large enterprises positively affect product development success in line with market demands (Tiwari and Buse, 2007, p. 8). Empirical evidence provides many highly successful innovations that revolutionize SMEs in all sectors. Start-up companies, young entrepreneurs, university subsidiaries, and highly innovative small firms have often produced innovations with major technological breakthroughs, leaving behind large global enterprises' R&D efforts and innovation strategies. SMEs serve as essential tools for meeting new consumer demands, creating new markets and producing information. Their ideas, competencies, products, processes, innovations and technologies are often seen as investments and commercialized by larger businesses (European Commission, 2006, p. 27).

R&D activities are considered as the investment of the business in information capital. Investment in intangible assets such as R&D tends to be avoided because it has a higher risk than investment in physical assets (Czarnitzki, 2006, p. 337). However, intellectual capital is a critical element of the future earning potential of the business. A company's competitive advantage is the unique combination of intellectual capital and tangible investments. At this point, R&D and innovation are important elements of intellectual capital (European Commission, 2006). In parallel with this situation, SMEs must access and spread the information within the enterprise with information networks in today's conditions where information rises to the most important resource (Chen, Duan, Edwards and Lehaney, 2006, p 21).

When Literature is examined, it is seen that fewer studies on R&D activities are carried out in SMEs compared to R&D incentives. Akdemir (1990) stated that SMEs could keep up with change quickly with their flexible and agile structures. With the help of R&D, they will be the ideal-scale enterprise in the future. March-Chorda et al. (2002) has indicated that numerous studies have been conducted in large enterprises on the critical success factors in product development, which has a significant place for R&D. Still, there is not enough research in SMEs. Their study investigated the degree of achievement of critical success factors (support of senior management, product development planning and analysis of market requirements) and emerging bottlenecks in product development on a sample of 65 SMEs in a middle-developed region of Spain. The study indicated that the most significant obstacles in product development projects are the risk associated with cost and market acceptance. The rate of fulfilling key success factors suggested in the literature is generally low.

Yang and Huang (2005) investigated the relationship between R&D, company size and growth with panel data analysis in enterprises operating in Taiwan. Within the scope of the study, they indicated that the increase in R&D positively affected the development and led to higher growth rates, especially in small businesses. The European Commission (2006) stated that investments in R&D and innovation are intangible investments and involve more risk and uncertainty than other investments. The report noted that the problem of protecting intellectual capital, the investment's long-term character, and the lack of understanding of research and innovation makes it difficult for investors to evaluate such investments. The main obstacles to investing in R&D and innovation by SMEs are defined under four headings: i) lack of financial resources, ii) lack of knowledge, iii) lack of human capital, and iv) lack of management (European Commission, 2006).

Ortega-Argiles et al. (2009) conducted a situation analysis on R&D in SMEs by identifying the characteristics, strengths, weaknesses, and difficulties experienced in SMEs. As a result of the report, it was stated that SMEs could carry out very successful R&D activities with advantages such as flexibility, information dissemination and speed. Furthermore, it was emphasized that the size of the business, the stages of the life cycle of the company, the location of the business (lack of entrepreneurial spirit in European Union countries, lack of access to finance in Europe compared to the USA, etc.) are significantly important in terms of R&D success. However, the fact that R&D activities are carried out in a short-term and informal manner, the prevalence of adaptation and improvement works, problems in accessing resources, low risk-taking, the inability of globalization, and intellectual property rights are defined as obstacles to SMEs.

Table 1: Studies and Findings Within the Scope of Obstacles to R&D

Author / Year	Purpose	Method	Obstacles to R&D
Audretsch & Vivarelli, 1994	Understanding how R&D inputs from private and public firms and universities are spreading while contributing to the production of innovative output.	Correlation analysis on innovative output, R&D expenditures and patent data in the perspective of the information production function.	- Inability to access R&D inputs produced by private and public institutions (Patents, etc.), - Lack of skilled labour, - Inability to work knowledge-based.
Tsai & Wang, 2005	Determination of the relationship between R&D performance and company size.	Analysis of panel data from a total of 126 manufacturing enterprises listed on the Taiwan Stock Exchange between 1994 and 2000.	- Lack of financial resources, - Difficulty accessing internal and external information sources, - Difficulty carrying out multiple R&D projects.
Czarnitzki, 2006	Determination of financial constraints for research and development activities in SMEs operating in Germany.	Panel data analysis.	- Insufficient funding, - Difficulty in accessing external financing resources, - Lack of information, - Absence of suitable public supports for SMEs engaged in R&D.
Tiwari & Buse, 2007	Identifying the obstacles to innovation in SMEs and determining how the internationalization of R&D will affect the lifting of barriers.	A survey was conducted in the Hamburg Metropolitan Area of Germany.	- Insufficient financing, - Difficulty in finding qualified human resources, - Inadequacy in R&D collaborations, - Bureaucracy - Inability to market innovative products (Internationally), - Inability to conceptualize innovative products.
Freel, 2007	Identifying the success of innovative small businesses in accessing financial resources.	Regression analysis on data of 256 small businesses that applied for bank loans in the UK.	- Access to finance (While the financial providers assess that the increase in R&D intensity negatively affects the risk profile for SMEs, they may also negatively evaluate the lack of innovative activity).
Fiaz & Naiding, 2012	To develop a model for the development of R&D collaborations by identifying the obstacles to R&D collaborations.	Literature review	- Lack of resources, - Difficulty in accessing information, - Risk factor, - Technological deficiencies, - Difficulty in cooperation.
Gilmore, Galbraith & Mulvenna, 2013	Identifying the perceived barriers to SMEs' participation in national and international R&D financing programs.	Literature review and a survey for European SMEs.	- Limited expertise and experience, - Insufficient financial resources, - Technology insufficiency, - Lack of qualified personnel employment due to budget constraint, - Marketing insufficiency, - Inadequate R&D cooperation, - Inadequate project development and execution, - Inexperience/inability to use cooperation networks, - Difficulty in participating in support programs.
Belitz & Lejpras, 2016	Obstacles to R&D in SMEs and evaluation of the role of public support in R&D financing.	Survey	- Insufficient financial resources, - Inadequate access to financial resources, - The shortage of qualified personnel, - Limited access to technological information, - Lack of fair competition conditions, - Legal regulations.

Mazurkiewicz & Poteralska, 2017	Identifying and classifying the barriers to R&D.	Literature review	▪ **Technical barriers** - The tendency to develop a single solution for R&D problems, - The length of project durations, - The high cost of prototype manufacturing - Not adhering to technological concepts, - Prototype product not meeting mass production demands ▪ **Organizational-economic barriers** - Intellectual property rights issues in joint projects, - Organizational change, - Management's interest in financing the result, not the R&D process, - Lack of marketing, - Inadequacy in technology transfer, ▪ **System barriers** - Lack of skills and procedures for commercialization of R&D results, - Inadequate public incentives for technologies missing in SMEs, - Lack of organization for marketing R&D outputs.

As shown in Table 1, various studies have been carried out in different sectors in different countries related to the obstacles encountered in R&D activities in SMEs. Literature research and questionnaire method are used as methods in the studies. The difference of this study from other studies in the literature is the analysis of situations and thoughts beyond perceptions by the qualitative research method. Within the study's scope, it aims to understand better the issues that need to be focused on in the implementation, maintenance and improvement of R&D activities in SMEs.

Methodology

In the literature, many different types of studies have been carried out in other economies related to R&D activities. This study was carried out in Turkey, the developing countries class. Studies in the literature focused on the effects of R&D in Turkey, current situation analysis and comparisons with other countries. In most of the studies, it has been stated that support in Turkey tends to increase over the years. However, in today's conditions where the number of SMEs is sufficient and public support has increased significantly, Turkey is behind in R&D indicators. Of course, the situation points to a problem that needs to be investigated within the scope of all institutions. Still, such a wide range of research requires considerable time and resources. Although large enterprises are carrying out successful R&D projects, the adequacy of the results should also be compared with the world's companies. However, the subject of this study is why SMEs, which are the heart of the economy, have not achieved sufficient success in R&D activities. Accordingly, the research question to be sought in this study is:

'What are the obstacles to R&D activities of SMEs?'

When the studies are examined on a method basis, it is seen that the survey and statistical analysis methodology are utilized in most of the studies. However, because quantitative research is limited in understanding the facts, it has recently become clearer that qualitative research is necessary to comprehensively understand a situation (Can Sağlam, Sezen and Çankaya, 2020, p 20). Case analysis is a systematic method where a single condition or event is examined in-depth in its existing environment, and data is collected, analysed and reported. The process concludes why the current situation is happening as it is now and reveals what should be focused on in future research (Davey, 1990, p. 1). Furthermore, by comparing more than one situation with case analysis, it is possible to reveal and associate similarities and differences. (Subaşı and Okumuş, 2017, p. 424).

There are several classifications of case studies. Yin (2018) addressed the case study in three classes: i) Exploratory), ii) Descriptive, and iii) Explanatory. It is aimed to develop appropriate propositions for further research based on the question of "what" in exploratory analysis. A descriptive study is desired to identify the incidence and prevalence of the research problem by seeking answers to the "what" and "how much" questions. Finally, descriptive case analysis is a method designed to reveal the "how" and "why" of events (Yin, 2018, p. 40). Going beyond whether a finding is specific to a single situation, multi-case analysis enables comparisons to show that a result is repeated consistently across more than one case. Multiple conditions create a more robust, generalizable, and testable theory. Because of the emerging information, relationships with repetition and comparison more precisely

(Eisenhardt and Graebner, 2007, p. 27). In this study, a ***descriptive multi-case analysis*** was performed to determine the obstacles to R&D success. Thus, the information obtained with the primary data can be compared, and generalization will be possible in case of repetition. A research design consisting of literature research, interview and document review, interview, analysis and evaluation stages was used in the study.

Sampling and data collection

Within the scope of the application of the study, the necessary definitions have been made by examining similar studies in the literature regarding SMEs and R&D activities. In addition, the problems encountered by SMEs in R&D activities were discussed, and a semi-structured question form was prepared to be used in interviews.

The purposeful sampling method was used to reach more accurate information while searching for the research question. Professionals who have served as managers in R&D or Design Centres in SMEs have been identified as the most important source of information in defining the obstacles to R&D activities. Professionals who meet these criteria are the most confronted with problems and make the most efforts to come up with solutions to identify the situation best. The enterprises selected from the R&D and Design centres announced by the industry ministry were contacted and informed about the research subject. As a result, eight professionals agreed to participate in the study. The profiles of respondents are given in Table 2.

Table 2: Profiles of Respondents

Respondent's position	R&D Experience (Year)	Industry Sector
1. Design center manager	15-20 years	Agricultural machinery
2. R&D center manager	5-10 years	Automotive
3. R&D center manager	10-15 years	Furniture manufacturing
4. R&D center manager	15-20 years	Industrial oven manufacturing
5. R&D center manager	10-15 years	Industrial automation
6. R&D center manager	10-15 years	Machine manufacturing
7. R&D center manager	5-10 years	Plastic packaging manufacturing
8. R&D center manager	0-5 years	Machine manufacturing

An in-depth semi-structured interview was held using online meeting programs in September-October-November. Since there were repetitions in the answers and no different information was presented, it was decided that the sample size was sufficient by providing theoretical saturation. In the study, two researchers took part in all interviews to prevent bias and obtain more reliable data. Interviews that lasted about 40-50 minutes were recorded.

Data analysis

Qualitative research is based on an inductive approach. It is a type of research in which observation, interview and document analysis methods are used to describe and explain people's experiences to gain in-depth information on a subject (Şimşek, 2018, p. 85). Controlling and auditing all the analysis steps is a natural part of qualitative research, and each step of the analysis needs to be carefully archived for later inspection. The systematic and organized analysis allows the researcher to easily access the information in the data set and track the analysis's interim results backwards (Elliott and Timulak, 2005, p. 152).

Although there are different approaches in analysing qualitative data in the literature, the most widely used and accepted is the descriptive analysis and content analysis approach proposed by Strauss and Corbin (1990) (Erçetin, 2020, p. 70; Şimşek, 2018, p. 85). In this study, content analysis was preferred in determining the obstacles to R&D activities. There are three different approaches based on coding differences in qualitative content analysis. (Hsieh and Shannon, 2005, p. 1286).

Table 3: Key Coding Differences Between Three Approaches to Content Analysis

Content Analysis Type	The starting point of the study	Timing of Defining Codes or Keywords	Source of Codes or Keywords
Traditional content analysis	Observation	Codes are defined during data analysis.	Codes are obtained from data.
Directed content analysis	Theory	Codes are defined before and during data analysis.	Codes are derived from theory or related research findings.
Summary of content analysis	Keywords	Keywords are determined before and during data analysis.	Keywords are derived from the researchers' interest in the subject or the literature review.

Source: Hsieh and Shannon, 2005

As shown in Table 3, content analysis is classified as traditional content analysis, directed content analysis and summary content analysis. While investigating the obstacles to R&D activities in SMEs, this study used directed content analysis to expand the existing knowledge. The codes determined in line with the data obtained from the literature review were compared with the data obtained from semi-structured interviews. The data were analysed according to the repeated codes following a flexible process. In the case of new findings, new regulations different from the codes in the literature were created. Finally, the principles are organized under themes and supported by the arguments obtained.

The cross-state analysis was carried out to improve reliability during the analysis phase of the study. First, each case was analysed, and then patients were compared in line with their similarities and differences. In order to eliminate the bias and subjective approach, the results were reached after the analyses were carried out by two researchers individually. When the obtained findings were compared within the researchers' framework, interviewees, the sector in which they operate, and the size of the business, consistency was determined, and reliability was achieved.

In the data analysis, audio recordings were first scripted into written text. Subsequently, the content analysis stages (coding data, finding themes, organizing codes and data, and interpreting the findings) (Erçetin 2020, p. 75) were implemented. The process used for qualitative data analysis is similar to manual coding or computer use. The inquirer identifies a text segment or image segment, assigns a code tag, and then searches the database for all text segments with the same code tag. The researcher does the coding and classification work in this process, not the computer program (Creswell, 2007, p. 164). Since the program did not significantly reduce the burden of the job, the inquiry and analysis in this study were carried out manually by the researchers.

Findings

It is crucial to identify the barriers to R&D to improve and sustain R&D activities in SMEs. In line with the determination of these obstacles, some factors were repeated more by the interviewees in the interviews made with R&D professionals using a semi-structured interview technique. Barriers to R&D are classified into four main categories: human capital-related factors, cost-related factors, management-related factors, and knowledge-related factors.

Table 4 shows the frequency of the main categories of R&D barriers and the themes that make up these categories in interviews. When the listing frequency is examined, it is seen that the factors related to human capital (57) are defined as the most critical obstacle. Cost-related factors (40) ranked second, information-related factors (29) ranked third, and management-related factors (28) ranked last.

Table 4: Code and Main Categories Obtained From Content Analysis

Main Category	Frequency	Codes	Frequency
Factors related to human capital	57	Failure to establish R&D culture (Common language)	29
		Lack of education	17
		Lack of qualified personnel	11
Cost-related factors	40	Commercial concerns	12
		Inadequate access to financial resources	9
		Lack of financial resources	8
		Considering R&D as a cost	8
		R&D if customer requests	3
Knowledge-related factors	29	Inadequate cooperation with stakeholders (universities, suppliers, customers, competitors, etc.)	14
		Inadequate project management	9
		Lack of information	5
		Intellectual property rights issues	1
Management related factors	28	Management / management support	10
		Failure to ensure sustainability in R&D	5
		Lack of planning	5
		Law / regulatory related difficulties	5
		The risk factor is seen as high	3

Based on the opinions of R&D professionals, the results of this study are arranged as follows, and the views and suggestions of the interviewees on these obstacles are presented with information paragraphs.

Factors related to human capital

When the frequency values of the codes of factors related to human capital are examined, failure to establish an R&D culture in the first place (29), lack of education (17) and the lack of qualified personnel (11) is in the second place.

The code of failure to establish an R&D culture (29) was also expressed as not creating a common language and was defined as the most crucial obstacle among all other codes.

Six interviewees stated that R&D culture does not exist in their businesses and other enterprises in the region. In contrast, the other two indicated that R&D culture exists in their businesses but did not develop due to the incomprehension of the concept of R&D in other enterprises. An interviewer shared the following views on the topic:

> *Business officials should have a positive perspective on R&D activities. In order to achieve this, training should be provided to all business personnel, especially business owners and managers, to answer the questions such as What is R&D? What are the R&D processes? How should R&D be related to other departments? In addition, the importance, requirements and outputs of R & D must be disseminated to all businesses and transformed into culture.*

Lack of education (17) is the second major obstacle in this category. However, when the studies conducted in the literature were examined, no investigation found that the R&D culture and education constitute an obstacle for R&D.

> *With the training that would ensure the development of all personnel, including business management and their participation in R&D, more prosperous and sustainable R&D studies would be enabled.*

Lack of qualified personnel (11) ranks number three in this category, which is in line with the findings of studies conducted by Audretsch and Vivarelli (1994), Tiwari and Buse (2007) and Belitz and Lejpras (2016). Obstacles related to having qualified personnel were stated by all interviewees, and one interviewer expressed her opinion as follows:

> *The start of qualified and experienced personnel to work brings adaptation problems. The orientation, learning and adaptation process can take a long time for inexperienced individuals employed for training. Business owners are impatient with this. Moreover, an employee with improved qualifications within the enterprise can change jobs in the future due to the lack of institutional structure in SMEs.*

Another interviewer stated that compulsory internship practices at universities would contribute to developing the qualifications of newly graduated young people.

Cost-related factors

Considering the frequency values of the codes of cost-related factors, commercial concerns (12) take the first place. The finding that R&D activities are hindered due to commercial circumstances coincides with the discovery of lack of marketing, skills and procedures for the commercialization of R&D results reported by Tiwari and Buse (2007), Gilmore et al. (2013) and Mazurkiewicz and Poteralska (2017).

Business owners are impatient and expect the project they invested in to immediately turn into a commercial product. As the R&D process extends, a negative approach to R&D is developed, considering that it causes loss.

The finding of inadequate to access financial resources, the second most frequently repeated code in this category, is in line with the results obtained by Czarnitzki (2006), Freel (2007), Belitz and Lejpras (2016) and Mazurkiewicz and Poteralska (2017) in the literature. Lack of financial resources (8) and R&D as cost (8) are in third place. They have been identified as the most expressed R&D barriers in the literature (Tsai and Wang (2005), Czarnitzki (2006), Tiwari and Buse (2007), Fiaz and Naiding (2012), Gilmore et al. (2013), Belitz and Lejpras (2016), Mazurkiewicz and Poteralska (2017)).

Business management finds it costly to allocate resources for a new R&D project and wants to convert their already limited financial resources into money by producing and marketing their existing products faster.

They were obtained in interviews. "R&D if customer requests" (3) has not been previously defined in the literature and has been identified as an obstacle in this study.

Act commercially oriented R&D studies in SMEs only for customer needs. If the customer does not have a demand or expressed interest, SMEs avoid R&D.

Knowledge-related factors

When the themes of knowledge-related factors are examined, the inadequate cooperation with stakeholders (suppliers, customers, competitors, etc.) identified as the most crucial obstacle also reported by (14), Tiwari and Buse (2007), Fiaz and Naiding (2012), Gilmore et al. (2013).

We create university-industry collaborations, but the two sides have different focuses and goals, and it can be difficult to meet at a common ground. Since the communication languages of the parties are other, it becomes more difficult to cooperate. While the university looks at R&D with an academic research and publication focus, the business approaches commercialization as soon as possible. When the parties cannot form a common language and meet at a common point, it becomes difficult to achieve an efficient result.

It is tough to find businesses with an R&D culture in suppliers and customers. Even if successful cooperative work is carried out, it is tough to ensure continuity. Cooperation with competitors is unthinkable.

Inadequacy in project management (9) has been identified as the second significant R&D barrier, in line with Gilmore et al.'s (2013) finding. Finally, lack of information (5) was defined as lack of knowledge and difficulty in accessing information by Audretsch and Vivarelli (1994), Czarnitzki (2006), Fiaz and Naiding (2012), Belitz and Lejpras (2016).

Nowadays, doing business depends more on knowledge. Added value can be created if the information is used effectively. However, access to information and information in SMEs is inadequate. The capabilities of SMEs can be improved by creating common information platforms.

Finally, intellectual property rights issues (1) have been identified as the least expressed obstacles in this study and defined as obstacles by Mazurkiewicz and Poteralska (2017).

Management-related factors

When the themes that constitute the factors associated with management are examined, the inadequacy of management support (10) is in the first place. But unfortunately, it is defined as an R&D barrier only by Mazurkiewicz and Poteralska (2017) in the literature.

In particular, business owners and managers need to be aware of R&D.

R&D is only considered as the work of the R&D department. The unresponsiveness of management and other departments negatively affects motivation and productivity.

SMEs have a massive R&D potential, but resources and motivation are lost because they are not appropriately managed.

Ensuring sustainability in R&D (5) was defined as an obstacle in this study and was supported by the barrier of "difficulty in carrying out more than one R&D project" limited only by Tsai and Wang (2005) in the literature.

The lack of planning (5) is defined as necessary in the second place and is in line with the "Inability to develop and execute R&D project" barrier by Gilmore et al. (2013).

Challenges arising from laws and regulations (5) were identified as obstacles in the second place, and this finding was defined as an R&D barrier by Czarnitzki (2006), Gilmore et al. (2013), Belitz and Lejpras (2016), Mazurkiewicz and Poteralska (2017).

Legislation should be changed to ensure that SMEs, which have a significant R&D potential and are enthusiastic, can develop rapidly and benefit more from public support.

If the government makes the content of support models more specific and follows a fairer policy in the distribution of support, businesses can approach the process more participatory.

The high-risk factor of R&D (3) ranked last and was also defined as an R&D barrier by Fiaz and Naiding (2012).

Discussion and further research

Today, the globalizing world, growing capital, growing market and needs, increasing competition and intensifying competition conditions are the biggest triggers of R&D studies in all fields. On the other hand, human life and needs, which started to change rapidly with the industrial revolution, are the main reason underlying the R&D triggers listed above. In this context, R&D activities are essential for SMEs with an important place in the economy. Therefore, this study aims to identify obstacles to R&D activities in SMEs.

Within the scope of the research, the obstacles to R&D activities in SMEs were classified as four main categories formed by 17 codes. Considering the frequency values of the codes, **the factors related to human capital** are identified as the most critical obstacle. The interviewees defined the R&D culture and the lack of qualified personnel as significant obstacles in this category. **The cost-related factors** category was included as the second priority theme within the scope of the research. The **variety of factors related to knowledge** ranked third in the research. Inability to cooperate with stakeholders (suppliers, customers, competitors, etc.), lack of information on project management, and difficulty accessing information have been identified as essential codes. The fourth category in the study is the **factors related to leadership**. In line with the findings, the following recommendations are offered:

- Creating an R&D culture should be one of the government's strategic goals. It should be placed at the centre of education and business life within the framework of the lifelong learning principle. The necessity and importance of R&D and innovation for the country's economic, environmental, and social sustainability should be well understood by all citizens. Therefore, lessons aimed at developing creativity and creating a culture of R&D and innovation should be added to all levels of education.
- Similarly, to create an R&D culture within the enterprise, an R & R&D-oriented change and transformation that spreads throughout the enterprise and is led by senior management is required.
- The issue of training and lack of qualified personnel should be seen as a public problem and should be addressed with structural solutions. In addition, university-industry cooperation programs should be considered product-based and should also be evaluated for creating human resources to design and manufacture those products.
- Effective internship programs should be developed to combine theoretical knowledge with practice in the educational process.
- Business owners' negative point of view on R&D activities due to commercial concerns should be changed, and awareness should be created about the long-term benefits of R&D.
- Inadequate access to financial resources and lack of financial resources are among the chronic problems of SMEs. Therefore, while necessary steps have been taken regarding incentives for SMEs in Turkey, efforts should be made for the visibility and distribution of these incentives. In

addition, it is essential to develop guided financial incentives, informative training and cooperation studies for SMEs.

- The importance of the state and academic units reappears within the scope of solving the problems experienced in terms of lack of information related to R&D or accessing and sharing information. These obstacles can be significantly overcome by supporting projects that encourage cooperation activities and establish common information platforms.
- Management's resistance to change and the inability to establish an institutional structure, which is a general problem in SMEs, also lies based on R&D obstacles. Therefore, the awareness and leadership of SME owners and managers about R&D are vital for the morale and motivation of employees.
- It is imperative to develop a project management perspective in all institutions. Creating a project systematically and R&D roadmap in the enterprise is necessary for sustainable R&D projects.

This study is based on practices and evidence in business life and contributes to the understanding of R&D barriers in SMEs. Within the scope of the study, it is believed that the results obtained in light of the data collected from enterprises in Turkey will guide other developing countries and Turkey. Some of the findings obtained from the study are supported by the literature, while some have not yet been defined in the literature. In order to understand whether the barriers identified in this study were due to the factors related to Turkey or not, the results should be supported by the future qualitative and quantitative research held in different countries.

Peer-review:

Externally peer-reviewed

Conflict of interests:

The author(s) has (have) no conflict of interest to declare.

Grant Support:

The authors declared that this study had received no financial support

Acknowledgement:

We would like to thank Mr. Ahmet Sayrugaş, Mr. Ali Keleş, Mr. Arif Akıllılar, Mr. Beytullah Özdemir, Mr. Fatih Serhat Cacık, Mr. Hakan Şahman, Mr. İsmet Fatih Şekeroglu and our interviewer, who did not want us to mention his name, for their participation and contributions to this study.

Ethics Committee Approval:

Ethics committee approval was received for this study from Necmettin Erbakan University, Social and Human Sciences Scientific Research Ethics Committee on 18/06/2021 and 2021/362 document number.

Author Contributions:

Idea/Concept/Design: **G.K.,** Data Collection and/or Processing: **G.K., K.G.**, Analysis and/or Interpretation: **G.K., K.G.,** Literature Review: **G.K.** Writing the Article: **G.K.,** Critical Review: **G.K., K.G.**, Approval: **G.K., K.G.**

References

Aiello, F., Albanese, G. and Piselli, P. (2019) 'Good value for public money? The case of R&D policy', *Journal of Policy Modeling*, Vol. 41, No. 6, pp. 1057-1076.

Akbey, F. (2014) 'Ar-Ge, inovasyon ve kalkınma ilişkisine yönelik bir literatür taraması: Kuramsal özet', *Maliye Dergisi*, Vol. 166, pp. 1-16.

Akbulak, Y. and Akbulak, S. (2010) 'Türkiye'nin rekabet gücü bağlamında araştırma & geliştirme (Ar-Ge) faaliyetlerinin özendirilmesi', *Finans Politik Ekonomik Yorumlar Dergisi*, Vol. 47, No. 544, pp. 7-14.

Akdemir, A. (1990) 'Küçük ve orta ölçekli işletmelerin Ar-Ge olanakları', *Anadolu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Vol. 8, No. 1, pp. 215-227.

Ale Ebrahim, N., Ahmed, S. and Taha, Z. (2010) 'SMEs; Virtual research and development (R&D) teams and new product development: A literature review', *International Journal of the Physical Sciences*, Vol. 5, No. 7, pp. 916-930.

Ali-Yrkkö, J. (2005) 'Impact of public R&D financing on employment', ETLA Discussion Papers, No. 980, *The Research Institute of the Finnish Economy*, (ETLA), Helsinki.

Altın, O. and Kaya, A. (2009) 'Türkiye'de Ar-Ge harcamaları ve ekonomik büyüme arasındaki nedensel ilişkinin analizi', *Ege Akademik Bakış*, Vol. 9, No. 1, pp. 251-259.

Altıntaş, H. and Mercan, M. (2015) 'Ar-Ge harcamaları ve ekonomik büyüme ilişkisi: OECD ülkeleri üzerine yatay kesit bağımlılığı altında panel eşbütünleşme analizi', *Ankara Üniversitesi SBF Dergisi*, Vol. 70, No. 2, pp. 345-376.

Arrow, K. J. (1972) 'Economic welfare and the allocation of resources for invention', *In Readings In Industrial Economics*, pp. 219-236, Palgrave, London.

Audretsch, D. and Vivarelli, M. (1994) 'Small firms and R&D spillovers: evidence from Italy', *Revue d'économie industrielle*, Vol. 67, No. 1, pp. 225-237.

Belitz, H. and Lejpras, A. (2016) 'Financing patterns of R&D in small and medium-sized enterprises and the perception of innovation barriers in Germany', *Science and Public Policy*, Vol. 43, No. 2, pp. 245-261.

Bellucci, A., Pennacchio, L. and Zazzaro, A. (2019) 'Public R&D subsidies: collaborative versus individual place-based programs for SMEs', *Small Business Economics*, Vol. 52, No. 1, pp. 213-240.

Bustinza, O. F., Gomes, E., Vendrell-Herrero, F. and Baines, T. (2019) 'Product–service innovation and performance: the role of collaborative partnerships and R&D intensity', *R&D Management*, Vol. 49, No. 1, pp. 33-45.

Can Sağlam, Y., Sezen, B. and Çankaya, S. Y. (2020) 'The inhibitors of risk information sharing in the supply chain: A multiple case study in Turkey', *Journal of Contingencies and Crisis Management*, 28(1), pp. 19-29.

Cappelen, A., Raknerud, A. And Rybalka, M. (2012) 'The effects of R&D tax credits on patenting and innovations', *Research Policy*, Vol. 41, No. 2, pp. 334-345.

Carboni, O. A. (2017) 'The effect of public support on investment and R&D: An empirical evaluation on European manufacturing firms', *Technological Forecasting and Social Change*, Vol. 117, pp. 282-295.

Chen, S., Duan, Y., Edwards, J. S. and Lehaney, B. (2006) 'Toward understanding inter-organizational knowledge transfer needs in SMEs: insight from a UK investigation', *Journal of Knowledge Management,* Vol. 10, No. 3, pp. 6-23.

Coccia, M. (2011) 'The interaction between public and private R&D expenditure and national productivity', *Prometheus*, Vol. 29, No. 2, pp. 121-130.

Creswell, J. W. (2007) *Quantitative Inquiry and Research Design – Choosing Among Five Approaches* (2nd edition). Sage Publication Upper Saddle River, USA.

Czarnitzki, D. (2006) 'Research and development in small and medium-sized enterprises: The role of financial constraints and public funding', *Scottish Journal of Political Economy*, Vol. 53, No. 3, pp. 335-357.

Çelebi, A. K. and Kahriman, H. (2011) 'Avrupa Birliği ülkeleri ve Türkiye'de Ar-Gr faaliyetlerine yönelik vergi teşvikleri ve bunların karşılaştırmalı analizi', *Maliye Dergisi*, Vol. 161, Temmuz-Aralık, pp. 33-63.

Çetin, M. and Işık, H. (2014) 'Türkiye ve Avrupa Birliği ekonomilerinde yenilikler ve Ar-Ge'nin teşviki: Karşılaştırmalı bir değerlendirme', *Maliye Dergisi*, Vol. 166, No. 1, pp. 75-94.

Davey, L. (1990) 'The application of case study evaluations', *Practical Assessment, Research, and Evaluation*, Vol. 2, Article 9, pp.1-3.

Eisenhardt, K. M. and Graebner, M. E. (2007) 'Theory building from cases: Opportunities and challenges', *Academy of Management Journal*, Vol. *50, No.*1, pp. 25-32.

Elliott, R., and Timulak, L. (2005) 'Descriptive and interpretive approaches to qualitative research', *A Handbook of Research Methods for Clinical and Health Psychology*, Vol. *, No.* 7, pp. 147-159.

Erçetin, Ş. Ş. (2020) *Araştırma Teknikleri*, Nobel Akademik Yayıncılık, Ankara.

European Commission (2006) *RICARDIS: Reporting Intellectual Capital to Augment Research, Develo pment and Innovation in SMEs*.

Fiaz, M. and Naiding, Y. (2012) 'Exploring the barriers to R&D collaborations: A challenge for industry and faculty for sustainable UI collaboration growth', *International Journal of u-and e-Service, Science and Technology*, Vol. *5, No.*2, pp. 1-15.

Fidancı, N. (2017) 'Araştırma, geliştirme (Ar-Ge) ve tasarım harcamalarının vergisel düzenlemeler ve teşvikler çerçevesinde incelenmesi ve muhasebeleştirilmesi', *Muhasebe ve Vergi Uygulamaları Dergisi (MUVU)*, Vol. 10, No. 1, p. 69-90.

Freel, M. S. (2007) 'Are small innovators credit rationed?', *Small Business Economics*, Vol. *28, No.* 1, pp. 23-35.

Fritsch, M. and Meschede, M. (2001) 'Product innovation, process innovation, and size', *Review of Industrial Organization*, Vol. 19, No. 3, pp. 335-350.

Garcia-Quevedo, J. (2004) 'Do public subsidies complement business R&D? A meta-analysis of the econometric evidence', *Kyklos*, Vol. 57, No.1, pp. 87-102.

GII (Global Innovation Index) (2020) *Who Will Finance Innovation*, Cornell University, INSEAD, and WIPO, Ithaca, Fontainebleau,and Geneva.

Gilmore, A., Galbraith, B. and Mulvenna, M. (2013) 'Perceived barriers to participation in R&D programmes for SMEs within the European Union' *Technology Analysis & Strategic Management*, Vol. *25, No.* 3, pp. 329-339.

Guellec, D. and Van Pottelsberghe De La Potterie, B. (2003) 'The impact of public R&D expenditure on business R&D', *Economics of Innovation and New Technology*, Vol. 12, No.3, pp. 225-243.

Gülmez, A. and Yardımcıoğlu, F. (2012) 'OECD ülkelerinde Ar-Ge harcamaları ve ekonomik büyüme ilişkisi: Panel eşbütünleşme ve panel nedensellik analizi (1990-2010)', *Maliye Dergisi*, Vol. 163, No. 1, pp. 335-353.

Güzel, S. (2009) 'Ar-Ge harcamaları ve vergi teşvikleri: Belirli ülkeler karşısında Türkiye'nin durumu', *Eskişehir Osmangazi Üniversitesi İİBF Dergisi*, Vol. 4, No. 2, pp. 29-48.

Hsieh, H. F. and Shannon, S. E. (2005) 'Three approaches to qualitative content analysis', *Qualitative health research*, Vol. *15, No.* 9, pp. 1277-1288.

Huergo, E., Trenado, M. and Ubierna, A. (2016) 'The impact of public support on firm propensity to engage in R&D: Spanish experience', *Technological Forecasting and Social Change*, Vol.113, pp. 206-219.

Ilina, I., Streltsova, E., Borodin, A. and Yakovenko, I. (2019) 'The impact of public investment on the competitiveness of the Russian R&D sector', *Int. J. Mech. Eng. Technol. IJMET*, Vol. 10, pp. 1128-1140.

Klimova, V., Zitek, V. and Kralova, M. (2019) 'How public R&D support affects research activity of enterprises: Evidence from the Czech Republic', *Journal of the Knowledge Economy*, Vol. 11, pp. 888-907.

Korkmaz, S. (2010) 'Türkiye'de Ar-Ge yatırımları ve ekonomik büyüme arasındaki ilişkinin VAR modeli ile analizi', *Journal of Yaşar University*, Vol. 5, No. 20, pp. 3320-3330.

Kostopoulos, K. C., Spanos, Y., Soderquist, K. E., Prastacos, G. and Vonortas, N. S. (2019) 'Market-, firm-, and project-level effects on the innovation impact of collaborative R&D projects', *Journal of the Knowledge Economy*, Vol. 10, No. 4, pp. 1384-1403.

Lee, C. Y. and Sung, T. (2005) 'Schumpeter's legacy: A new perspective on the relationship between firm size and R&D' *Research Policy*, Vol. 34, No. 6, pp. 914-931.

Lee, C. Y. (2011) 'The differential effects of public R&D support on firm R&D: Theory and evidence from multi-country data', *Technovation*, Vol. 31, No. 5-6, pp. 256-269.

Liu, X., Li, X. and Li, H. (2016) 'R&D subsidies and business R&D: Evidence from high-tech manufacturing firms in Jiangsu', *China Economic Review*, Vol. 41, pp. 1-22.

Lööf, H. and Heshmati, A. (2005) 'The impact of public funds on private R&D investment: New evidence from a firm level innovation study', *MTT Discussion Papers 3*.

Mamuneas, T. P. and Nadiri, M. I. (1996) 'Public R&D policies and cost behavior of the US manufacturing industries', *Journal of Public Economics*, Vol. 63, No. 1, pp. 57-81.

March-Chorda, I., Gunasekaran, A. and Lloria-Aramburo, B. (2002) 'Product development process in Spanish SMEs: An empirical research', *Technovation*, Vol. 22, No. 5, pp. 301-312.

Marino, M., Lhuillery, S., Parrotta, P. and Sala, D. (2016) 'Additionality or crowding-out? An overall evaluation of public R&D subsidy on private R&D expenditure', *Research Policy*, Vol. 45, No. 9, pp. 1715-1730.

Mazurkiewicz, A. and Poteralska, B. (2017) 'Technology transfer barriers and challenges faced by R&D organisations', *Procedia Engineering*, Vol. 182, pp. 457-465.

OECD (2002) *Frascati Kılavuzu*, Araştırma ve Deneysel Geliştirme Taramaları için Önerilen Standart Uygulama, Tübitak, https://www.tubitak.gov.tr/tubitak_content_files/BTYPD/kilavuzlar/frascati_tr.pdf, Erişim Tarihi: 29.06.2020.

Ortega-Argilés, R., Potters, L. And Voigt, P. (2009) 'R&D-intensive SMEs in Europe: What do we know about them?' (No. 15/2009). *IPTS Working Papers on Corporate R&D and Innovation*.

Ortega-Argiles, R., Vivarelli, M. and Voigt, P. (2009) 'R&D in SMEs: a paradox?', *Small Business Economics*, Vol. 33, No. 1, pp. 3-11.

Önder, R. and Yıldız, A. (2017) '5520 ve 5746 Sayılı Kanunlar Çerçevesinde Ar-Ge Harcamalarının Vergisel Durumu', *Firat University Journal of Social Sciences*,Vol. 27, No. 1, pp. 141-158.

Özeroğlu, A. (2011) 'Türkiye'de Ar-Ge düzenlemeleri ve uygulamaları', *Öneri Dergisi*, Vol. 9, No. 36, pp. 105-114.

Piekkola, H. (2007) 'Public funding of R&D and growth: firm-level evidence from Finland'. *Economics of Innovation and New Technology*, Vol. 16, No. 3, pp. 195-210.

Revilla, A. J. and Fernández, Z. (2012) 'The relation between firm size and R&D productivity in different technological regimes', *Technovation*, Vol. 32, No. 11, pp. 609-623.

Riding, A., Madill, J. and Haines, G. (2007) 'Incrementality of SME loan guarantees', *Small Business Economics*, Vol. 29, No. 1-2, pp. 47-61.

Savcı, A. Ş. and Yayla, E. (2015) 'Ar-Ge merkezlerinde 5746 sayılı araştırma ve geliştirme faaliyetlerinin desteklenmesi hakkındaki kanun kapsamında Ar-Ge indirimi', *Vergi Dünyası Dergisi*, Vol. 407, pp. 13-22.

Shen, X. and Lin, B. (2020) 'Policy incentives, R&D investment, and the energy intensity of China's manufacturing sector', *Journal of Cleaner Production*, 255, 120208.

Subaşı, M. and Okumuş, K. (2017) 'Bir araştırma yöntemi olarak durum çalışması', *Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, Vol. 21, No. 2, pp. 419-426.

Şimşek, A. (2018) *Veri çözümleme teknikleri,* Eskişehir: Anadolu Üniversitesi Yayınları.

Taş, Ş., Taşar, İ. and Açcı, Y. (2017) 'Ar-Ge harcamaları ve ekonomik büyüme arasındaki ilişki: Türkiye örneği', *Academic Review of Economics & Administrative Sciences*, Vol. 10, No. 2, pp. 197-206.

Tsai, K. H., and Wang, J. C. (2005) 'Does R&D performance decline with firm size?—A re-examination in terms of elasticity', *Research Policy*, Vol. *34, No.* 6, pp. 966-976.

Tiwari, R. and Buse, S. (2007, October) 'Barriers to innovation in SMEs: Can the internationalization of R&D mitigate their effects?', In *Proceedings of the First European Conference on Knowledge for Growth: Role and Dynamics of Corporate R&D-CONCORD,* pp. 8-9.

Ünal, T. and Seçilmiş, N. (2013) 'Ar-Ge göstergeleri açısından Türkiye ve gelişmiş ülkelerle kıyaslaması', *İşletme ve İktisat Çalışmaları Dergisi*, Vol. 1, No. 1, pp. 12-25.

Wong, P. K. and He, Z. L. (2003), 'The moderating effect of a firm's internal climate for innovation on the impact of public R&D support programmes', *International Journal of Entrepreneurship and Innovation Management*, Vol. 3, No. 5-6, pp. 525-545.

Yang, C. H., and Huang, C. H. (2005) 'R&D, size and firm growth in Taiwan's electronics industry', *Small Business Economics*, Vol. 25, No. 5, pp. 477-487.

Yin, R. K. (2018). *Case study research and applications: Design and methods*. (6th ed.). Los Angeles, CA: SAGE.

Zerenler, M. and Karakuş, G. (2017) 'Ürün ve süreç yeniliğinin işletme performansına etkisi: Bir vaka çalışması', *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, Vol. 19, No. 2, pp. 305-331.

Zhu, Pingfang, Xu, Weimin and Lundin, N. (2006) 'The impact of government's fundings and tax incentives on industrial R&D investments—Empirical evidences from industrial sectors in Shanghai', *China Economic Review*, Vol. 17, No. 1, p. 51-69.

http://www.oecd.org/sti/msti.htm (Accesed Date: 19.10.2020).