

The impact of future technologies on the productivity of Turkish exporters

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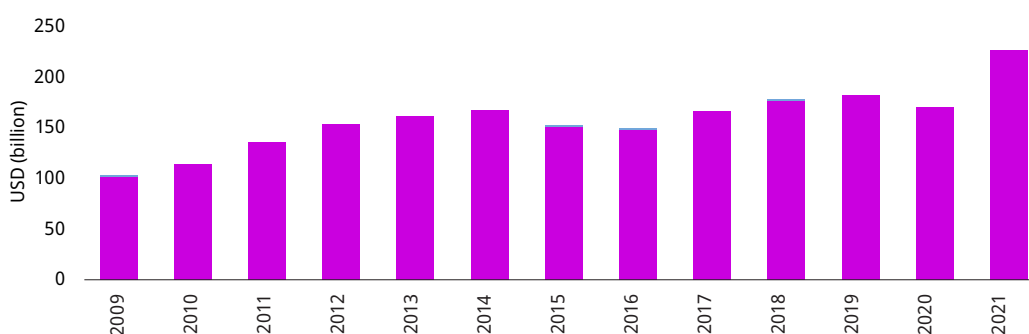
Introduction

Global productivity growth stagnation since the mid-2000s has been a widespread subject of debate. Pessimists argue that the ICT Revolution will disappear without having left any significant benefits; optimists argue that current productivity stagnation is temporary and growth will return, once the transitional period is over (see GII 2022 Expert Contribution from Petropoulos). The lessons of similar transitional phases over the past two centuries give cause for optimism. As Erik Brynjolfsson and Andrew McAfee argue persuasively, the digital revolution is not only likely to accelerate innovation, but also increase productivity and irreversibly change the workforce and economy.¹

There are several approaches that can be taken to the concept of productivity. In the literature, productivity refers to the relationship between inputs into the manufacturing process (labor, capital and so on) and outputs (the products obtained at the end of this process). It is understood that higher productivity increases resource efficiency, allowing for more outputs to be produced from the same amount of inputs. Technologies play a key role in this reciprocal relationship, and in productivity growth in general. Although companies regard productivity as running parallel to profitability, productivity growth is a more complex phenomenon. In socioeconomic terms, productivity growth contributes to combating the global climate crisis by preventing the waste of resources and reducing income inequality, by generating greater production and income. It also enables people to live in more comfortable conditions, supported by technological developments. The United Nations Sustainable Development Goals emphasize this positive aspect of productivity. Innovation and research and development (R&D) have been shown to reinforce the positive aspect of productivity growth, and a revival from productivity stagnation is seen as important in bringing about such a positive change.

In this paper, the concept of productivity will be discussed in the context of production and export. The “learning by experience” model encourages the use of many innovative technologies at company level and ensures the production of high value-added products. In this respect, it is observed that exporting companies effectively contribute toward increasing productivity by developing innovation and R&D studies, as well as the efficient use of resources. Türkiye’s export structure supports this hypothesis. Exports from Türkiye reached USD 225 billion in 2021, increasing by 32.8 percent on the previous year (Figure 6.1).

Figure 6.1 Export volume of Türkiye, 2009–2021



This paper aims to understand how successful future technologies are increasing export efficiency and in which areas they show promising results for export sectors. A survey was conducted for this purpose investigating what are the current perspectives of exporting companies with respect to future technologies, as part of preparing a new strategy for Turkish exporters.



The first section of this paper shares survey results on the sectoral and regional projections of Turkish exporting companies with regard to future technologies and the opportunities they offer. After discussing the companies' general perspectives on future technologies, an overview of innovation-oriented programs is presented, together with good practice examples carried out by the Turkish Exporters Assembly (TİM). This paper then moves on to a discussion of current and future projects, as well as those business and policy actions that might provide productivity growth, based on the survey results.

Survey of Turkish exporters on future technologies and productivity growth

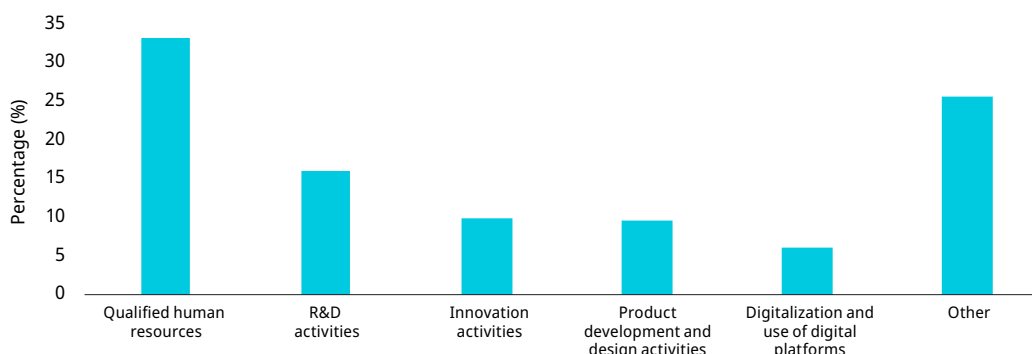
More than 500 exporters (firms and entrepreneurs) from 27 different sectors participated in the survey, created with contributions from TİM consultants, project teams and sector representatives. The firms that participated in the survey are concentrated in the services, electrical and electronics, machinery and machinery accessories, automotive, textile and raw materials sectors. The top five sectors accounted for one-third of Türkiye's total exports in 2021 (Table 6.1).

Table 6.1 Percentage shares of Türkiye's top 10 export sectors, 2021

Sector	Percentage
Services	13.3
Electrical and electronics	12.6
Machinery and machinery accessories	11.6
Automotive	8.8
Textile and raw materials	8
Chemical substances and products	6
Other industrial products	6
Apparel	4.8
Ferrous and non-ferrous metals	4.6
Wood and forestry products	4.6

The survey asked exporting companies to name the most important tools supporting productivity in their particular firm and industry (see Figure 6.2). Companies valued the quality of human resources as important in increasing productivity. A total of 199,371 people (full-time equivalents, FTE) were employed as R&D personnel in 2020.² A total of 33.1 percent of R&D personnel had a bachelor's degree, 32.1 percent a doctorate or equivalent, 24.6 percent had achieved a master's degree, 5.1 percent had finished vocational school, and 5.1 percent had attained an educational level equivalent to high school or below.³

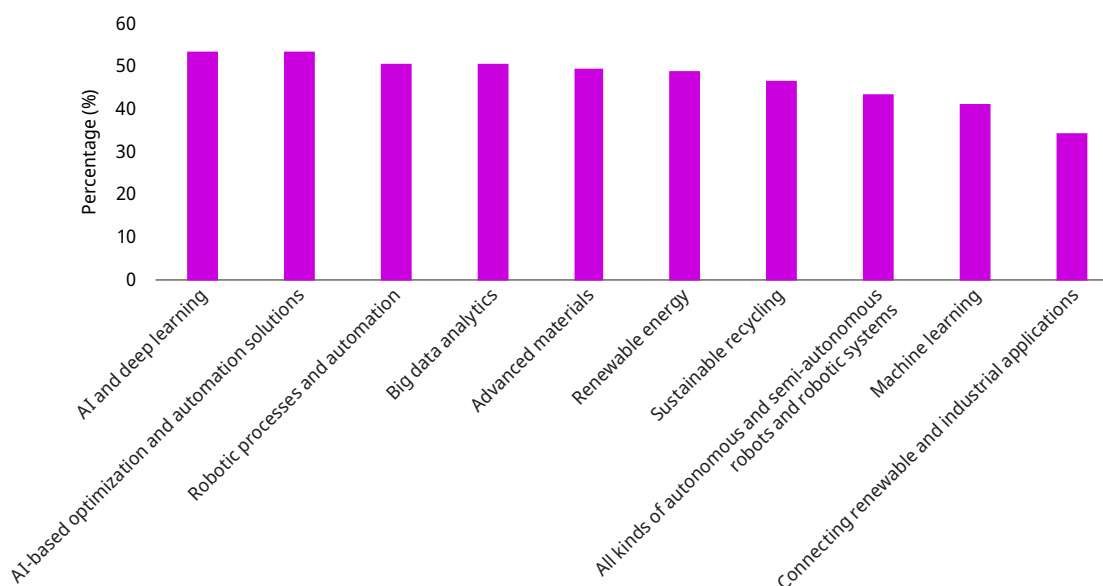
Figure 6.2 Tools for productivity, 2021



Companies also valued R&D as a means of ensuring increased productivity. There were 1,254 active R&D centers in Türkiye, as of 2021.⁴ Manufacturing machinery and equipment (174) accounts for the largest share of R&D centers, followed by the automotive subsidiary industry (131), software (116), computer and communication technologies (84), textiles (80) and electrical and electronics (77) sectors.

Second, companies were asked which technologies were most likely to shape the future of their company, sector and region (Figure 6.3).

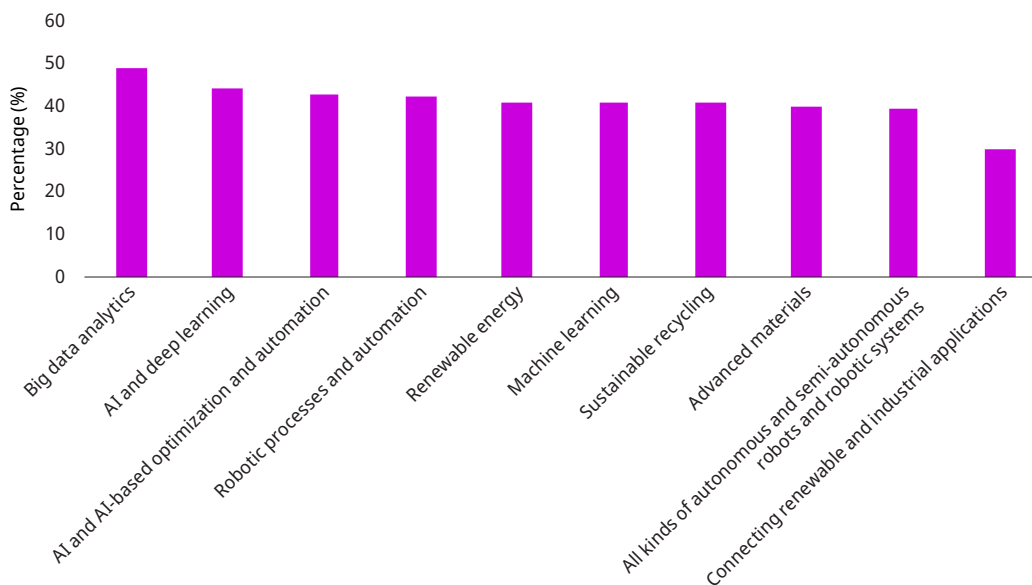
Figure 6.3 Technologies shaping the future of companies, sectors and regions in Türkiye, 2021



Companies considered artificial intelligence (AI) and AI-based deep learning the technologies most likely to change the future of their respective sectors and regions. At the same time, AI-based optimization and automation solutions, big data analytics, robotic processes and advanced material technologies emerge as other technologies of the future that firms consider important. Commercial drones and driver assistance and safety technologies ranked bottom.

For the next question, companies were asked which technologies they considered important for the future and plan to invest in for increased productivity (Figure 6.4).

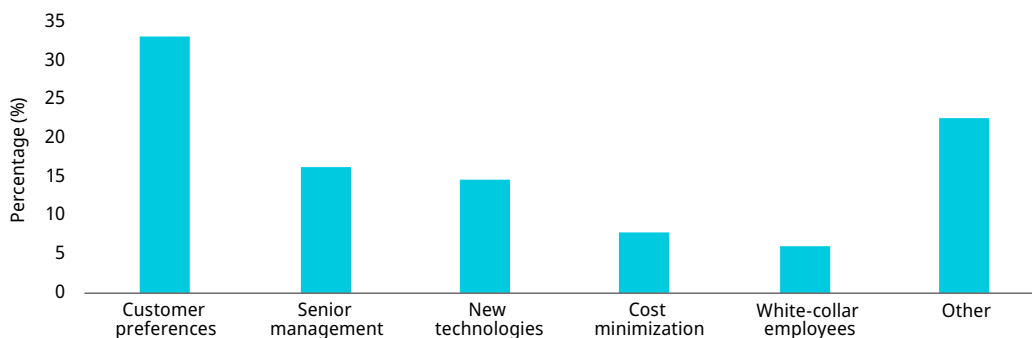
Figure 6.4 Future technologies most likely to attract (planned) investment to boost productivity



There appears to be a correlation between those technologies of the future that companies considered important and the areas in which they planned to invest. Almost a half (48.7 percent) of the companies participating in the survey planned to invest in big data analysis, 43.7 percent in technologies based on AI and deep learning, 42.5 percent in AI and AI-based optimization and automation solutions, 41.7 percent in robotic processes and automation, and 40.7 percent in renewable energy technologies. The least popular technologies for investment were microenergy technologies, bio-fuels, and driver assistance and safety technologies. Finally, 7.5 percent of firms did not plan to invest in future technologies at all.

Next, companies were asked which productivity-enhancing factors trigger innovation (Figure 6.5).

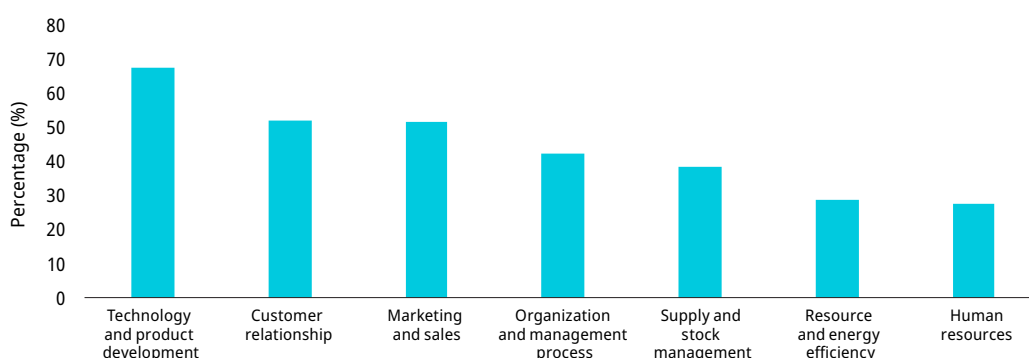
Figure 6.5 Productivity-enhancing factors



In reviewing which internal or external factors triggered the innovation activity of the companies, it can be seen that among the companies surveyed, customer preferences, senior management and new technologies were considered the most crucial. In addition, companies viewed innovation as a driving force. Special emphasis was placed on top management encouraging innovation, as well as the inclusion of white-collar employees in the innovation process. Government support, blue-collar workers and new legal regulations did not rank as high in terms of encouraging innovation at firms.

Finally, companies were asked in which areas productivity has increased through innovation in the previous three years (Figure 6.6).

Figure 6.6 Productivity growth areas in the previous three years



The survey found a connection between the innovative work undertaken by firms, the areas where productivity gains were achieved and the factors that triggered innovation. In order to respond to customers' changing preferences, companies reported relying on technology to provide efficient product development. Two areas where productivity gains were achieved through innovative studies were customer relations and marketing and sales. This clearly demonstrates the important effect external environment has on the innovation and adoption of future technologies by firms. In addition, the external environment stimulated enhanced productivity in companies' internal organization and management, for example, in processes such as supply and stock management. Survey responses showed that companies' innovative work on green transformation and logistics and distribution had provided the least productivity gains over the previous three years.

Exporters, entrepreneurs and manufacturing companies are vital to any sectoral and regional increase in productivity. In the light of the survey results reported, the following policy recommendations are proposed as having the potential to increase productivity among all actors.

Policy recommendations

- The implementation of processes and mechanisms that expedite decision-making at all levels will enable rapid action, and consequently a timely response to technological transformation. In this context, it is important to approach the adoption of new technologies proactively.
- The strengthening of financial support mechanisms for a twin-track transformation (a green and a technological transformation) and increased investment, especially in energy efficiency and renewable energy resources, will ensure that productivity increases through a green transformation.
- Enhanced investment in and better incentive mechanisms for the human resource sector are recognized as crucial for increased productivity. To improve the quality of human resources, providing employment support will be beneficial for increasing the number of graduates and post-graduates.
- Industrial symbiosis practices should be diversified and expanded through the identification of industrial co-living opportunities; the creation of pilot projects; the strengthening of institutional capacity on the subject by way of training and awareness-raising activities; and improving communication opportunities between stakeholders.
- Industry and production sectors are among the most intensive sectors when it comes to energy consumption. Digitalization has a key role to play in improving energy efficiency in industry. As part of the digitalization of the industry, studies to eliminate intermediaries between energy producers and energy consumers will help to ensure the effective use of resources.

TİM's innovation-oriented programs and best practice

Türkiye is directing R&D expenditure toward those areas that support digitalization and the establishment of a sustainable innovation ecosystem vital to increasing productivity. In this direction, TİM is responsible for the innovation-oriented Focused InoSUIT Program; the InovaTİM programs under the umbrella of the Innovation and Entrepreneurship Academy; the InovaLEAGUE; and the TİM-TEB Startup House. This section is an overview of the achievements and best practices that have stemmed from these four programs.

Academia–industry partnership: Focused InoSuit Program

The Focused InoSuit Program is a cooperative university–industry program with the aim of sustainably increasing innovation management competence, strengthening innovation management infrastructure, and designing and adopting institutional innovation systems at firm level.

The Program has four tracks, each offering a special operational process, depending on firm innovation management competence. These tracks are InoSuit Foundation, InoSuit 360, InoSuit High Added Value Focused and InoSuit Export Champions. Since the program began in November 2016, 1,233 mentor applications from 144 universities located in 63 different provinces and 612 company applications from 48 different provinces have so far been received. A total of 25,520 hours of mentoring services have been provided to the 166 companies that signed contracts within the scope of the 12 completed periods.

Thanks to the Program, numerous companies have turned innovative ideas into successful projects and increased sales of new products, as well as the number of registered patents. Certain companies have been able to increase the budget ratio from grants to 50 percent of total innovation spending; double the number of employees actively participating in innovation projects to 300; and double the number of product development projects carried out jointly with external stakeholders.

Fostering the innovation ecosystem: InovaTİM

Türkiye's youngest and most innovative family, InovaTİM, has operated effectively since 2015. It has created an innovation ecosystem comprising 5,955 university students drawn from 72 provinces and 176 universities throughout Türkiye. In 2018–2019, the company carried out its "Artificial Intelligence and Innovation Training in High Schools" project, whereby 9,284 high school students underwent training in 207 different schools in 32 provinces. A total of 15,799 university and high school students have participated in the InovaTİM projects to date.

Among InovaTİM's activities and projects are 150 meet-ups; the organization of 35 events in 27 countries; hosting of 34 students and joining overseas business delegations; 42 rectorates and 59 deans' meetings; 64 workshops; two R&D projects; 11 project teams; eight international competitions; and four international innovation center visits (NASA, Silicon Valley, Maker Faire, Trinity College Dublin).

InovaTİM's first R&D project was the "Nano, Micro, Multifunction Solar Panel R&D Project in Cube Satellites" which directly coincides with three of the 10 visionary targets set by Türkiye's first National Space Program announced by the country's president. Its aim is to acquire capability in economic production techniques and development processes for solar panels.

InovaTİM also prepares research papers and reports. In research focused on the effects of future technologies, InovaTİM has highlighted AI, data-oriented technologies, the internet of things (IoT), advanced materials and cloud computing technologies as tools for increasing company efficiency. Other technologies not included in the priority list but nevertheless considered as part of the research were cyber security-oriented technologies emerging as quantum computers/quantum technologies; additive manufacturing; mobile technologies; 5G; digitalization robotics; automation; human–machine interface; UI/UX design; software technologies; and biomimicry.

Measuring innovation: InnoVALEAGUE

Created by TİM in 2014, InnoVALEAGUE is the first innovation development program in Türkiye. InnoVALEAGUE allows companies to measure their innovation competencies using an interactive platform. Following the completion of its first phase, a comprehensive 100-page innovation assessment and benchmark analysis report is being prepared for each of the companies that participated. A total of 25 companies from five different categories were eligible to participate in the semi-finals, based on IMP³rove Academy benchmark reports, with the top three firms each receiving an award during Türkiye Innovation Week.

Within the scope of the InnovalEAGUE program, 6,639 company applications from 74 provinces plus the Turkish Republic of Northern Cyprus were submitted and 85 companies received a Türkiye Innovation Week award. Through InnovalEAGUE, a significant amount of intellectual capital has been transferred to Türkiye. When analyzing successful companies from within the InnovalEAGUE program, innovation is seen as a key factor determining success, especially in the fields of organization and culture. It is notable that successful companies within the InnovalEAGUE program value customer feedback, when creating innovation strategies, and approach incremental and radical innovations accordingly.

Supporting tech startups: TİM-TEB Startup House

TİM-TEB Startup House is responsible for one-fifth of all tech startups in Türkiye, and has become a leading brand, offering the widest range of entrepreneurship services with a variety of innovative and sustainable programs in different cities of Türkiye. TİM-TEB Startup House operates in seven cities, namely, İstanbul, İzmir, Ankara, Denizli, Gaziantep, Bursa and Mersin, while a separate TİM Startup House is active in two additional cities, Trabzon and Erzurum.

TİM-TEB Startup House is Türkiye's most comprehensive and widespread entrepreneurial family, raising more than 1,600 entrepreneurs in six years in different segments and provinces of Türkiye. Currently, these startup houses have 10,684 employees.

TİM-TEB Startup House serves as an incubation center for aspiring entrepreneurs, as well as existing technology companies. TİM-TEB Startup House is continuously developing its business model through the most appropriate consultancy and training applications for the needs of Türkiye. It has an important mission of transforming technology companies established through state aid into sustainable enterprises.

Entrepreneurs participating in TİM-TEB Startup House get the opportunity to benefit from strategic management consultancy; work with experienced mentors in the sector; collaborate with corporate companies; meet with investment fund managers; take part in national and international events; access global markets and the Global Accelerator Network (GAN) covering 94 countries; promote their products and services through online and offline channels; take part in Startup to Corporate (S2C) collaboration programs; attend speed-mentoring events, webinars and training events specially organized for TİM-TEB entrepreneurs; and participate in TİM trade delegations.

TİM-TEB Startup House won a special award on behalf of Türkiye at the European Enterprise Promotion Awards from among 29 countries. Additionally, it is the first and only accelerator from Türkiye to join GAN, which operates in 94 countries with 120 members and offers the world's largest network.

There are various examples of productivity-enhancing practices established by the companies participating in TİM-TEB Startup House programs. Among some of the technologies developed are quality control systems based on image processing in mass production lines designed to reduce error rate and bring down fixed costs. Others are drones, software and heat maps intended to solve the problem of efficient warehouse management, one of the biggest problems facing the country's enterprises.

Modern technologies provide added value to businesses. Using the R&D-based materials developed with know-how can ensure import substitution and minimize supply issues. Intra-building logistics services, route optimization and international platforms for transporting goods together support the efficient management of logistics and are beneficial for those companies wanting to reduce costs and navigate global trade. This is even more the case in industrial transformation projects, where robotic technologies give a competitive advantage to companies, by reducing human-based error and increasing production capacity. Technology initiatives that enhance production and provide effective marketing and financing solutions by interpreting data created for the end-to-end management of business contribute to the digital transformation of businesses.

Finally, we should give a brief mention to TİM-TEB Entrepreneurs, which provides occupational safety through wearable technologies, efficient management through IoT systems and the digitalization of human resource processes via software, thus contributing both to Türkiye's economy and to effective resource use.

Conclusion

We believe that productivity growth achieved through the widespread use of future technologies will increase the competitiveness of Turkish exporting companies and create higher socioeconomic outputs. The benefits of future technologies for industry can be summarized as an increase in the quality and efficiency of production, a reduction or elimination of logistical costs, a saving in energy and better equipment maintenance. Being able to utilize these technologies will enable small and medium-sized enterprises (SMEs) to boost their competitiveness and find a stronger place in the market.

Moreover, the use of future technologies creates novel business opportunities. Companies with a better understanding of their customers, competitors and their environment will be able to strengthen their market position inside Türkiye and beyond thanks to the digital transformation.

Recently, digital transformation technologies have become more accessible and applicable to industry. Sensors and processors, which could be called the infrastructure of digital transformation, have, over the years, become smaller and cheaper. That said, the initial investment costs of digital transformation remain an obstacle, especially for SMEs. In the context of R&D and technology development, focusing on priority areas rather than operating in every field is likely to result in a more effective use of resources and a reduction in transformation costs.

Notes

- 1 Brynjolfsson and McAfee, 2011.
- 2 Ministry of Industry and Technology of Türkiye, 2021.
- 3 Turkish Statistical Institute (Turkstat), 2020.
- 4 Ministry of Industry and Technology of Türkiye, 2021.

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