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Market Trends of Türkiye Textile and Composite Industries: A Regional-Global Case Study

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Abstract
The demand for high-value products, including technological textiles, has recently increased on global marketplaces. In an attempt to improve their economic position and compete on a global basis, numerous nations have turned their manufacturing attention to these items in the past ten years. The current status of Türkiye's textile sector and its transition towards technology textiles with better value additions will be illuminated by this research, which will use Bursa as an example. With the use of import-export statistics, this article analyses Türkiye's position in the present state of global trade volumes of items. The current status of the technical textiles market and the most recent innovations in the field are also discussed. Technical textiles saw a 3.38 percent increase in sales to about $118 billion on a global scale. At 2.413 billion dollars, Türkiye's exports in 2021 were down 12.91 percent from the previous year. Trade within Türkiye's technical textile industry is bidirectional, according to the Grubel-Lloyd Index analysis, with a few exceptions. An average index value of 0.7968 was recorded for all technical textile items. There are twelve main categories of technical textiles classified by their function. Trade products are projected to be particularly prominent in the Mobiltech, Indutech, and Packtech subcategories of technical textiles by the year 2028.

Keywords
technical textiles, market analysis, high-value-added, Grubel-Lloyd Index, Bursa

1. Introduction

The demand for technical textile products, which stand out with their specific physical and functional properties and performances in global markets, is increasing day by day [1–10], unlike products such as ready-made clothing, upholstery, and home textiles conventionally produced by the textile industry. The market continues to expand as technical textiles are used by an increasing number of end users in various industries such as agriculture, construction, healthcare, transportation, packaging, sports, environmental protection, and protective clothing [11]. Türkiye maintains its place among all the countries in the world, especially in the production and export of technical textiles and its export rates are increasing gradually [12–14]. It is predicted that the competitive power in global markets will increase as new technologies are developed in the production processes of technical textiles, which have higher added value compared to conventional textile products [15], and the increase in qualified personnel accompanies this. It is thought that the expectations that the fluctuations created by the COVID-19 pandemic in demand and supply will end as of the current year and the nature of the transformations brought about by the international agreements that are closely related to Türkiye, such as the European Green Deal [16], will become clearer and increase the search for new markets by the manufacturers. Market research and export potential analysis, tries to produce answers to a few key issues from a specific methodological framework. This methodology that is called as “Data Triangulation” [17] is based on bringing three different approaches. Of these, the ‘Top-Down Approach' [18] requires first of all to present the market share and market volume of technical textiles [19–21] in Türkiye and in the world, with current numbers and ratios. Thus, a general view of the market will be obtained and a clearer image of the sector will be created for exporters. The 'Bottom-Up Approach', on the other hand, includes identifying Türkiye's potential export markets for each of them by considering

high value-added technical textiles one by one with their six-digit codes (GTİP) defined in the Harmonized System. The backbone of this study is to reveal these markets. The Qualitative Data approach, on the other hand, refers to the blending of insights obtained from 50 deep interviews conducted with key factors such as manufacturers, unit directors, development agencies and academicians operating in the sector for market research, with the numerical data revealed in other approaches. In the deep interviews, various questions were asked to the key actors interviewed, such as how they perceive the future of the technical textiles industry, which technological trends they think will come to the fore, what the manufacturers in Türkiye should aim for in competition with other competitors in the world, and the answers received were interpreted together with numerical data. In addition, the market trends that will reveal which product groups the market is heading towards in technical textiles are emphasized by making use of the analysis reports of international organizations. At the same time, a SWOT analysis [22] has been made in which the strong-weak sides of Türkiye in these areas and the threats and opportunities will be discussed. In accordance with our methodology, this analysis is also evaluated together with the insights obtained from the qualitative data. Finally, the Grubel-Lloyd index [23, 24], which measures Türkiye's intra-industry trade balance in technical textiles, was calculated for 6-digit sub-product groups one by one. As will be explained in detail below, this index, which takes a value between 0 and 1, reveals whether the country is engaged in one-way or two-way trade in product groups. To put it more clearly, when the index value approaches 0 in a product group, it means that trade is carried out unidirectionally in terms of imports or exports, and close to 1 means that both the import and export of the same product are carried out in nearly equal amounts. As the index value approaches 1, it is concluded that the trade in the product group in question is healthier in terms of economic theory. In the study, the Grubel-Lloyd index was also used to determine potential export markets. In technical textiles product groups, the countries with more imports than exports (that is, the index value is close to 0 in terms of imports) were determined and considered as an analysis criterion in determining the countries with export potential.

A comprehensive analysis of added value has been undertaken through regional and global market research on technical textiles [25] and composite [26] materials. Our analysis demonstrates an increasing demand in international markets for high-value-added products such as technology textiles. Over the past decade, numerous countries have restructured their production systems to give priority to the creation of these goods, with the aim of improving their economic competitiveness on a global scale. The global exports of technical textiles reached a total value of 118 billion dollars, indicating a growth rate of 3.38 percent compared to the preceding year. In 2021, Türkiye's exports amounted to $2.413 billion, representing a decline of 12.91% compared to the previous year. With the exception of a few cases, the calculation of the Grubel-Lloyd Index for technical textile product categories in Türkiye demonstrates a predominantly bilateral intra-industry trading pattern. The calculated average index value for all technical textile goods was 0.7968. The commercial market is projected to be dominated by the Mobiltech, Indutech, and Packtech subcategories of technical textiles by 2028 [27]. The contemporary global markets are witnessing an increasing demand for high-value composite products, specifically technical textiles. In the past decade, numerous nations have shifted their manufacturing processes towards prioritizing these specific commodities, with the aim of augmenting their competitiveness within the global economy. In 2021, Türkiye experienced a 19.48% increase in its exports of composite materials, reaching a total of 2.7 billion lira (TRY) compared to the previous year. According to the Grubel-Lloyd Index calculation, the study concludes that intra-industry trade in Türkiye's composite material product categories is predominantly bilateral, with only a few minor deviations. The composite materials' mean index value was computed as 0.6890.The competitive pressures in the technical textiles and composite sectors were analyzed by the authors [36]. This study indicates that the technical textiles and composites business significantly influences the global economy through factors such as production costs, technology, product excellence, innovation, and sustainability. The growth and profitability of the technical textiles and composites industries depend on their ability to transform these competitive characteristics into products that provide additional value. Value-added items are distinguished from commodity goods by their distinct characteristics, functions, and advantages. This facilitates businesses in raising prices and generating higher profits.

This research intends to provide a strategic plan for technical textiles makers to identify new markets and pinpoint prospective market opportunities. The discussion focuses on the technical textiles groups in which Türkiye has more export potential and the countries to which exports may be increased in these sectors. This study also highlights Türkiye's capacity in technological textiles. The goal is to identify new product categories by analysing technology and market developments within these groupings.

2. Methodology

The comprehensive investigation of the requirements of the operational enterprises within the textiles and composites sector included two distinct stages. The initial stage involved visiting 140 companies to administer a questionnaire. In the second phase, we used two objective scoring tools to select a subset of 50 companies from the same pool of 140 companies. These selected companies were then subjected to in-depth diagnostic interviews conducted by specialists specializing in technical textiles and composites. The first step involved preparing a preliminary questionnaire. The pilot phase involved conducting trials with prominent companies in the textile and composite industries. We refined the questionnaire to ensure efficient data gathering. The comprehensive screening phase questionnaire comprises nine modules, encompassing a total of 91 questions.

• Industry/Manufacturing (8 questions) • Distribution/Sales (17 questions) • Personnel management (10 inquiries) • Investigation and Advancement (R&D) (24 inquiries) • Excellence (5 inquiries) • Sustainability (2 inquiries) • Value chain (8 inquiries) • Transformation (7 questions) • Clustering (10 questions)

Given the time constraints, the extensive iteration of 73 inquiries yielded a condensed rendition. The selection of companies for the initial phase of the study was conducted using logical sample procedures. The Bursa Chamber of Commerce and Industry (BTSO) maintained a company registry, which provided the database of 2734 companies for this purpose. The establishment of the companies took place on Bursa, with a minimum of one employee listed on the payroll. The construction of the database involved the utilization of NACE codes to capture the operations of companies. A preliminary sample, including 20 companies, was chosen to conduct a trial of the questionnaire. The selection exhibited a bias towards larger corporations, as they are more inclined to participate in the manufacture of technical textiles and composites. We used a stratified technique to randomly select an initial sample of 175 companies. However, when the rate of non-response exceeded initial expectations, we selected a further sample of 144 enterprises and a third sample of 80 companies, implementing a turnover threshold. The initial sample's high nonresponse rate was primarily due to the demanding schedules of company owners or high-level managers, and the inclusion of a larger number of smaller companies. These companies had either ceased their operations or displayed no inclination towards transformation and engagement in the project activities. Smaller enterprises with low turnover were excluded from the second and third samples. We utilized a semi-structured questionnaire in the second phase, which comprises inquiries aimed at identifying the constraints and obstacles organizations face in prototyping and the development of new products. This study examines the requirements and strategies of companies in relation to prototyping and new product development, taking into account their technological capabilities, decision-making processes for new product development, barriers to generating innovative ideas, challenges encountered in research and development processes, new product development initiatives, the needs of project teams, their gaps in skills and knowledge, marketing strategies, the transition to technical textiles and composites, and the perceptions of clustering. The questionnaire serves as a means to investigate the requirements of the companies.

3. Production technologies and machinery

When the technologies utilized in company production are evaluated, it is evident from Figure 1 that weaving technologies predominate in the Bursa textile industry. Following these technologies are those for weaving preparation, finishing, and dyeing. In companies that claim to only produce traditional textiles, weaving technologies, and weaving preparation technologies rank first and second, respectively, while companies that produce technical textiles prioritize finishing and dying technologies.

Although there aren't many companies that use knitting technology, it is clear that these companies generally focus on technical textiles. Most of these businesses produce for the automotive industry. It has been reported that weavers also manufacture technical textiles, as shown in the figure. Dyeing and finishing relationships with technical textiles are assumed to be limited to functional textiles. Despite the fact that companies using coating technologies also make technical textiles, it is thought that the majority of them produce fabrics for roller blinds or upholstery.

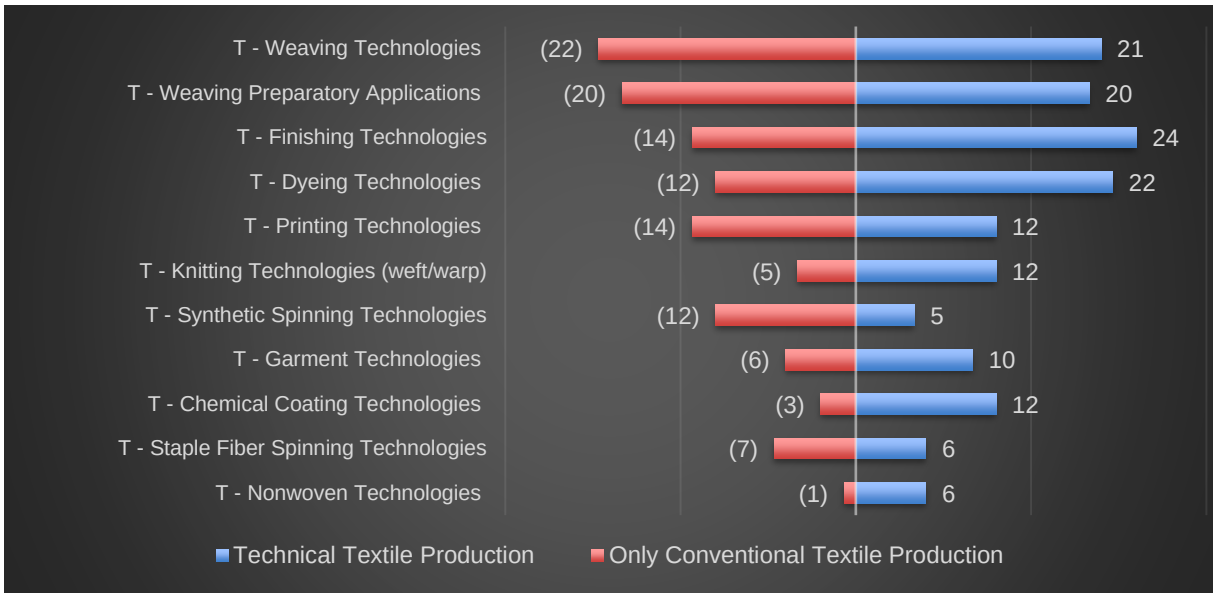

Fig. 1. Production technologies used in textile companies (%)

Table 1 displays the total technology usage in textile-related companies taking part in diagnostic research in Bursa. The main textile industry in Bursa is weaving. Companies that integrate weaving processes, weaving preparation, finishing, dyeing, and printing technologies are one such example.

Table 1. Technologies used (Textile)

	Synthetic spinning technologies	Staple fiber spinning technologies	Weaving preparation technologies	Weaving technologies	Knitting technologies (weft, warp)	Non-woven fabric technologies	Painting technologies	Printing technologies	Finishing technologies	Garment (cutting) technologies	Chemical (Removable) coating technologies
Synthetic spinning technologies	16	9	13	12	3	2	9	9	10	2	3
Staple fiber spinning technologies		12	10	9	3	2	9	8	10	3	3
Weaving preparation technologies			39	36	11	5	27	19	29	10	10
Weaving technologies				42	12	5	27	22	29	12	10
Knitting technologies (weft, warp)					16	2	13	10	13	4	6
Non-woven fabric technologies						7	4	3	6	3	3
Painting technologies							32	22	30	9	10
Printing technologies								26	23	8	7
Finishing technologies									37	11	15
Garment (cutting) technologies										15	2
Chemical (removable) coating technologies											15

Technology for pressing moulding is increasingly used by companies that produce composite materials (Figure 2). Injection moulding, RTM, and hand lay-up technologies are placed after that.

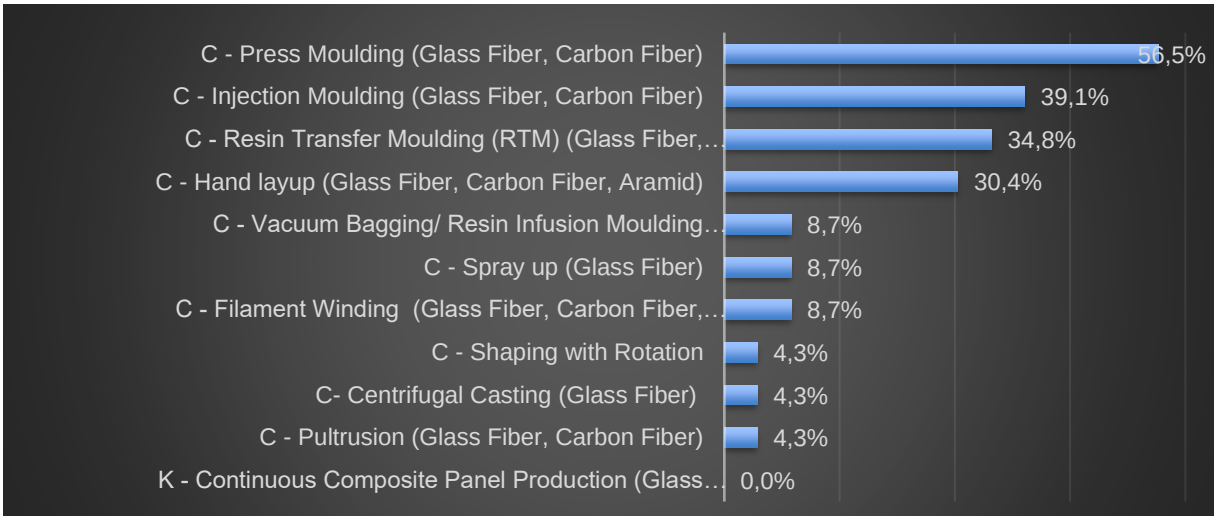

Fig. 2. Production technologies used in companies producing composite materials (%)

Compression moulding, pultrusion, hand lay-up, and RTM processes are frequently used by companies that produce composite materials. In

Table 2, further compositions are given.

Table 2. Technologies used (Composite)

	Hand lay-up (glass fiber, carbon fiber, aramid)	Filament winding (glass fiber, carbon fiber, aramid)	Spraying (fiberglass)	Pultrusion (glass fiber, carbon fiber)	Injection molding (glass fiber, carbon fiber)	Press molding (glass fiber, carbon fiber)	Centrifugal casting (glass fiber)	Vacuum bagging/ Resin infusion molding (RIM) (glass fiber, carbon fiber, aramid)	Continuous composite board production (glass fiber)	Resin Transfer Molding (RTM) (glass fiber, carbon	Shaping by rotation
Hand lay-up (glass fiber, carbon fiber, aramid)	7	1	1	1	2	4	0	2	0	4	0
Filament winding (glass fiber, carbon fiber, aramid)		2	0	1	0	2	0	0	0	0	0
Spraying (fiberglass)			2	0	0	1	0	0	0	0	0
Pultrusion (glass fiber, carbon fiber)				1	0	1	0	0	0	0	0
Injection molding (glass fiber, carbon fiber)					9	6	1	1	0	2	0
Press molding (glass fiber, carbon fiber)						13	1	2	0	4	0
Centrifugal casting (glass fiber)							1	0	0	0	0
Vacuum bagging/ Resin infusion molding (RIM) (glass fiber, carbon fiber, aramid)								2	0	2	0
Continuous composite board production (glass fiber)									0	0	0
Resin Transfer Molding (RTM) (glass fiber, carbon fiber, aramid)										9	0
Shaping by rotation											1

Table 3 compares the companies' machine parks to the technologies in this field in Türkiye and around the world, based on their age, technology, and need for innovation. The company authorities' information indicates that the machinery park's age and technology are comparable to new in both sectors. The proximity to the new is slightly less, though, according to world technology.

Although it may seem that traditional textiles are more advanced than the average technology in the world, it is known that technical textiles use relatively similar technologies. Companies producing technical textiles claim to be more technologically advanced and innovative than their Türkiye competitors. Companies that produce composite materials, on the other hand, claim that the technology and innovation in their machinery parks are more contemporary than those in their respective sectors in Türkiye, but they are comparable to those in other countries. In comparison to traditional textiles,

companies producing technical textiles and composites anticipate that their machinery parks may need to be renewed in the next 2 years more than others (Figure 3).

Table 3. Machine Park technology, age comparisons and need for innovation

	Only Traditional Textile production is available	Technical textile production is available, but less than 50% in total production	Technical textile production is available and more than 50% in total production	Companies producing composite materials
The machine park's age and technology score in comparison to other companies in Türkiye engaged in the same industry (1=very old, 5=very new)	3.57	3.81	3.72	3.67
The machine park's age and technology score in comparison to other global companies engaged in the same industry (1=very old, 5=very new)	3.48	3.39	3.42	3.09

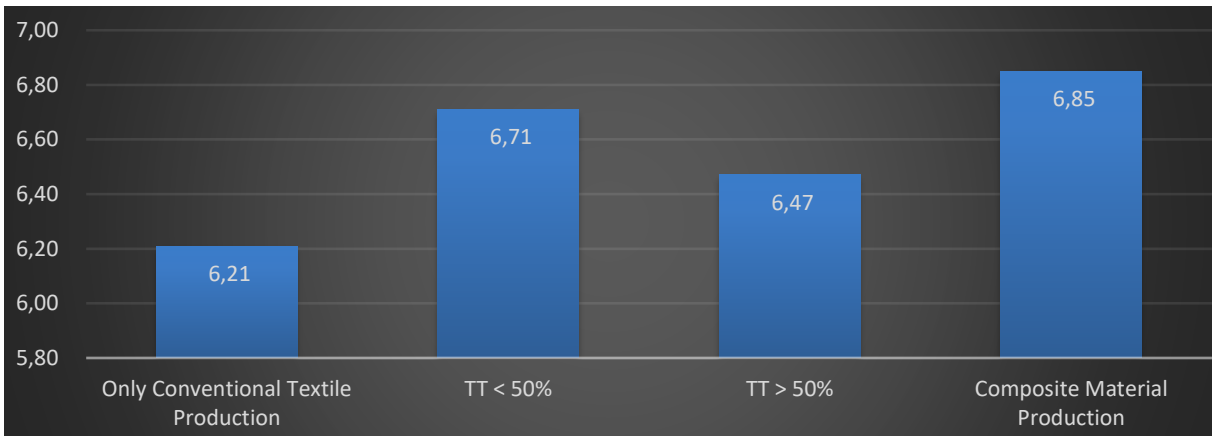

Fig. 3. Necessity for renewal of machinery in the next 2 years (out of 10)

Although there is no significant difference with other sectors in terms of machinery park technologies and ages in companies producing technical textiles, a difference is observed in the prediction of renewing the machinery park compared to those producing only traditional textiles. Especially technical textile manufacturers and composite companies believe there is a greater chance than others that their machinery park will need to be renewed within two years.

Figure 4 displays the primary raw materials used in the manufacture of textiles. Companies that make technical textiles claimed to use a greater variety of raw materials. Nonwoven fabric, high-performance yarns, and polymer granules are prominent in addition to chemicals and woven fabric.

Figure 5 displays the countries from which solely traditional textile-producing companies import raw materials. It is understood that the raw materials used in traditional textile production in Bursa companies are primarily imported from China, India, and South Korea. Even though some companies claimed to have purchased the raw materials from Türkiye enterprises, they insisted that the materials originated from abroad but could not specify where.

Companies producing technical textiles get raw materials from European countries such as Spain, Italy, and France, particularly Germany (Figure 6). Companies with technical textile output lower or more than 50% do not significantly alter the raw material purchasing profile. China stands out within this category as the country where most of the raw resources are acquired.

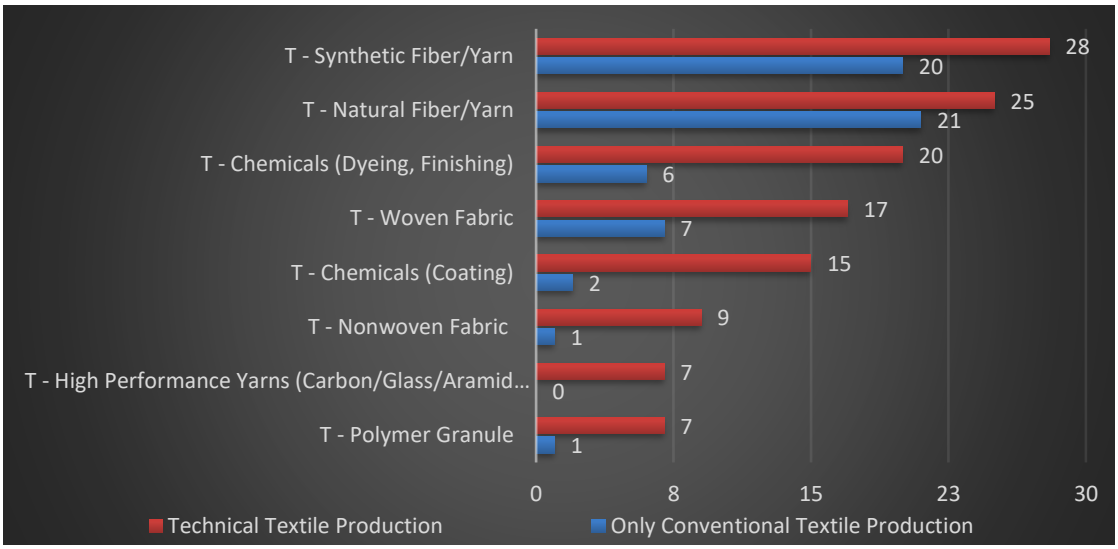

Fig. 4. Raw materials used in textile producing companies (%)

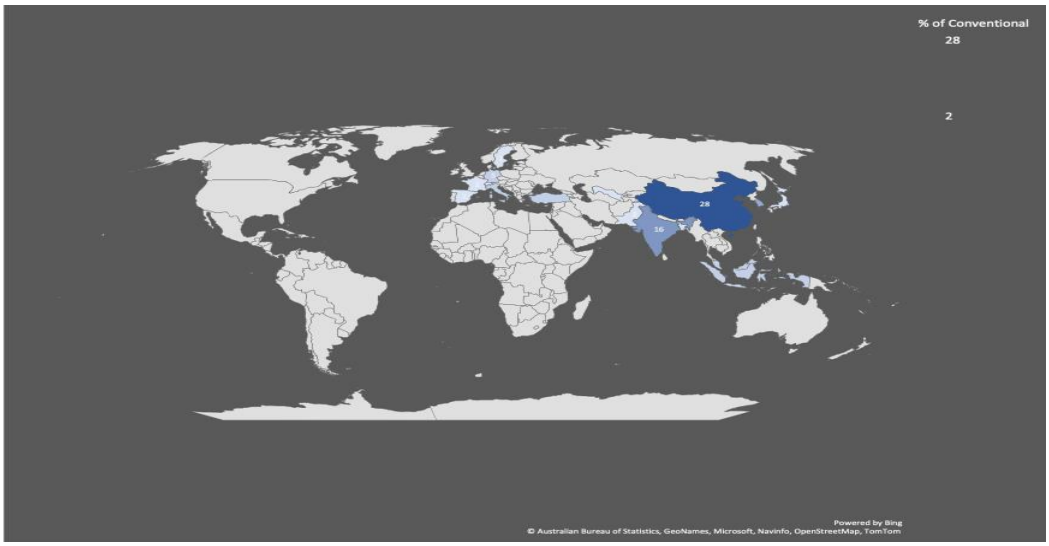

Fig. 5. Countries where raw materials used in traditional textile producing companies are imported (%)

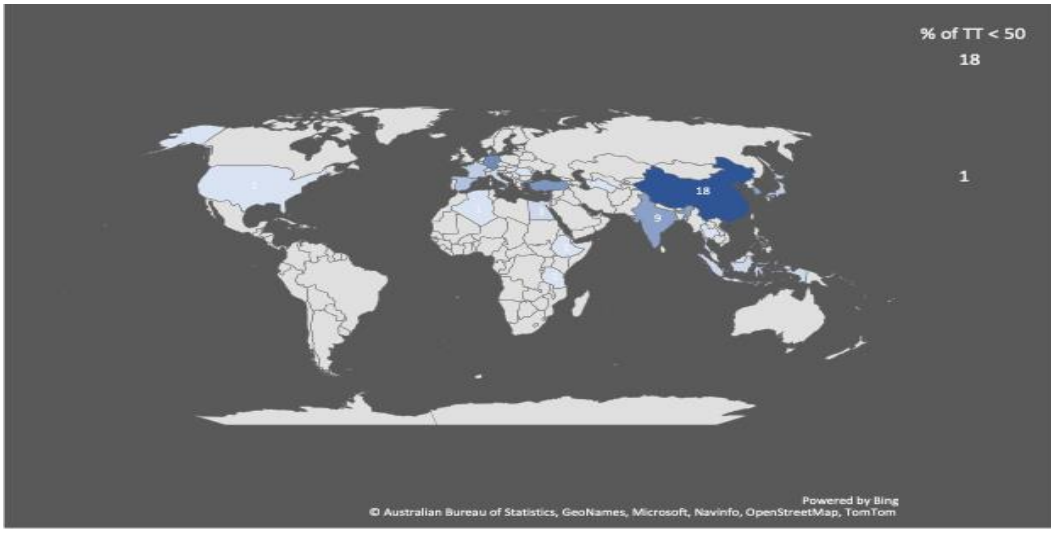

Fig. 6. Countries from which raw materials used in technical textile manufacturing companies are imported (%)

The main problems influencing the supply of raw materials in technical textile companies were listed as the global raw material crisis, continuous exchange rate fluctuations, and high transportation costs. The most significant issues in obtaining raw materials are also their unavailability and variations in quantity or quality.

The countries where the companies that produce composite materials or use composite materials in final production obtain their raw materials are depicted in Figure 7. These businesses claimed that the raw materials used in final products are generally imported from European countries. Among these countries, Germany comes first. Companies, however, claimed that they also buy raw materials from China as well as European countries.

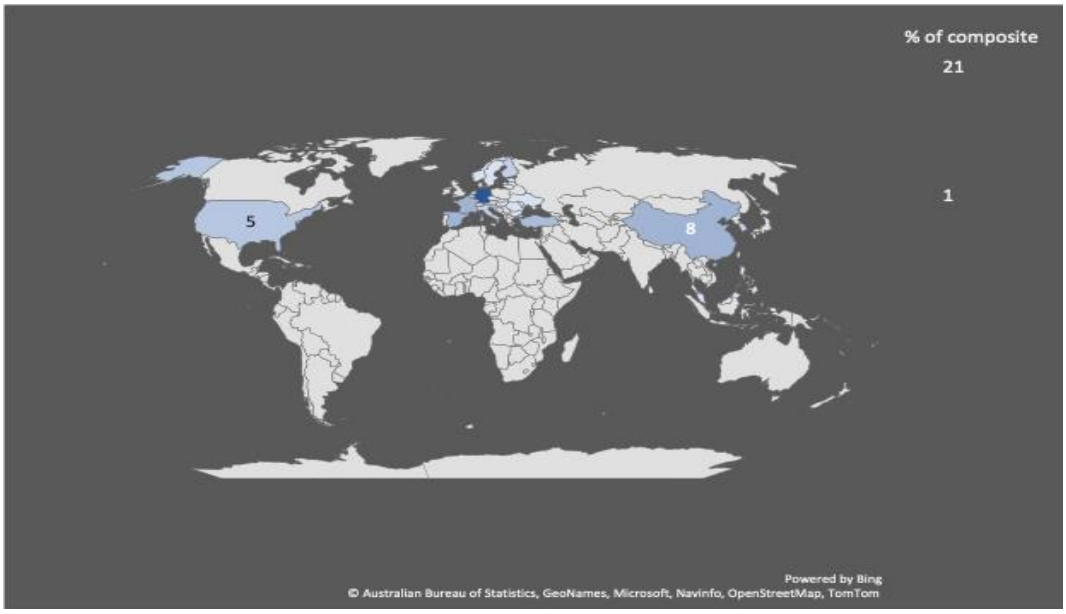

Fig. 7. Countries where raw materials used in companies producing composite materials are imported (%)

Glass fibre is the most often utilised material in composite material manufacturing companies, followed by carbon fibre. Additionally, some businesses claim to produce goods using both carbon and glass fibre. This instance demonstrates that businesses can develop products in response to customer demand or have a choice of products.

Table 4 Problems encountered in raw material supply (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Global raw material crisis	84.0%	70.8%	83.3%	71.0%
Confusion in the procurement process	40.0%	29.2%	38.9%	35.5%
High transportation costs	80.0%	66.7%	72.2%	51.6%
Low transport capacities	16.0%	8.3%	11.1%	12.9%
Unavailability of raw material	40.0%	54.2%	55.6%	51.6%
Lack of continuity in the amount of raw materials	40.0%	33.3%	44.4%	25.8%
Lack of continuity in raw material quality	36.0%	25.0%	38.9%	22.6%
Pandemic conditions	88.0%	66.7%	38.9%	64.5%
Continuous fluctuations in exchange rates	72.0%	87.5%	77.8%	74.2%

Most of the companies visited conducted raw material input control (Figure 8). This percentage is higher in companies that manufacture more than 50% of their output as technical textiles and composite materials.

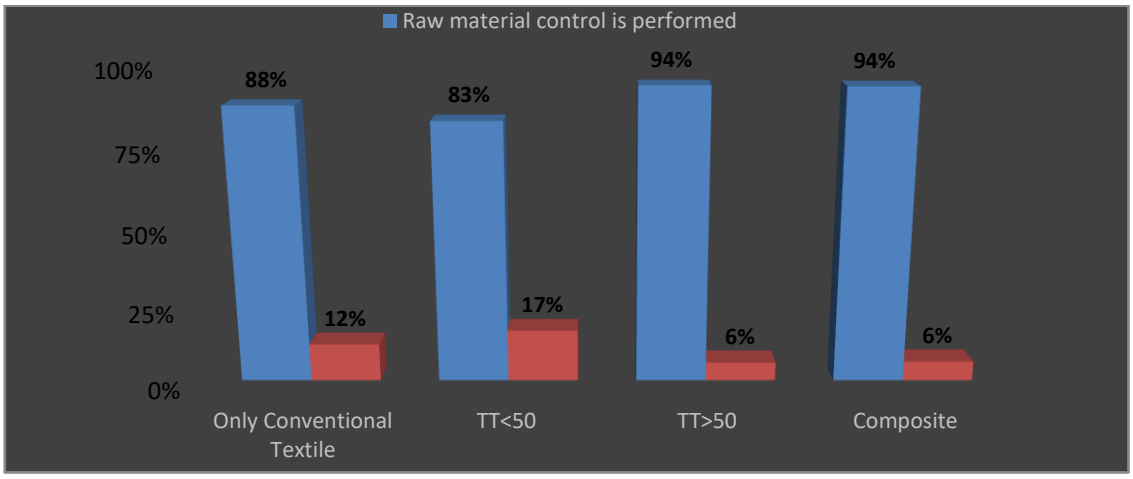

Fig. 8. Raw material input control (%)

4. Export

Nearly all companies that manufacture technical textiles and composite materials claim to export, and they typically do so directly. Companies who solely produce traditional textiles and produce technical textiles for less than 50 percent of their output reported exporting through intermediaries more frequently than other companies.

Table 5. Whether the companies export and the way they export

	Traditional Textile Only	TT<50	TT>50	Composite
Yes, directly	58.3%	78.3%	72.2%	84.4%
Yes, through intermediaries	62.5%	39.1%	66.7%	40.6%
No	25.0%	8.7%	5.6%	3.1%

The countries that solely traditional textile production companies export to are shown in Figure 9. They claimed that Germany and Russia account for the majority of exports. Italy, Spain, and France follow these countries in this order.

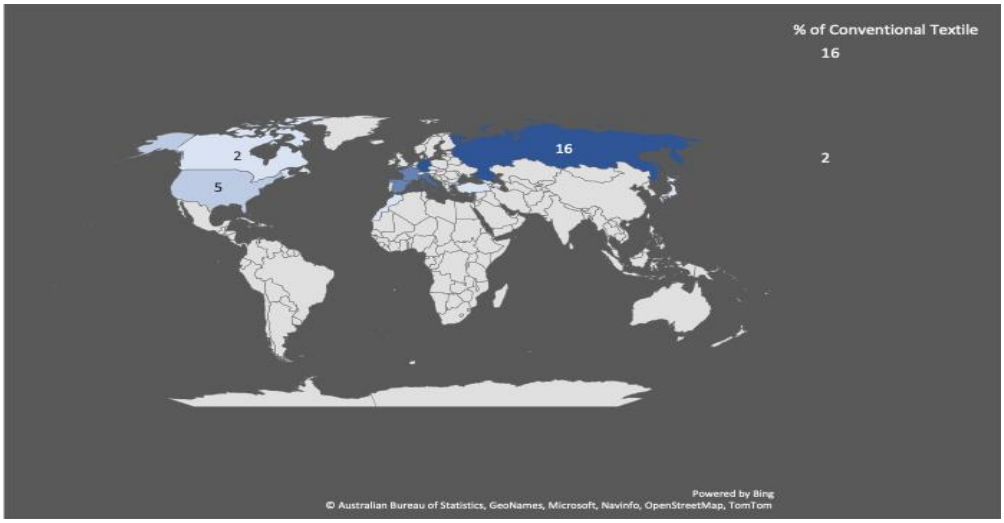

Fig. 9. Countries that traditional textile production companies export to

The export ranges of companies producing technical textiles have expanded, as seen in Figure 10.

Although Germany and the United States are the main export destination countries, exports are made to many other countries throughout the world. European, Balkan, Asian, and African countries are also among the export countries.

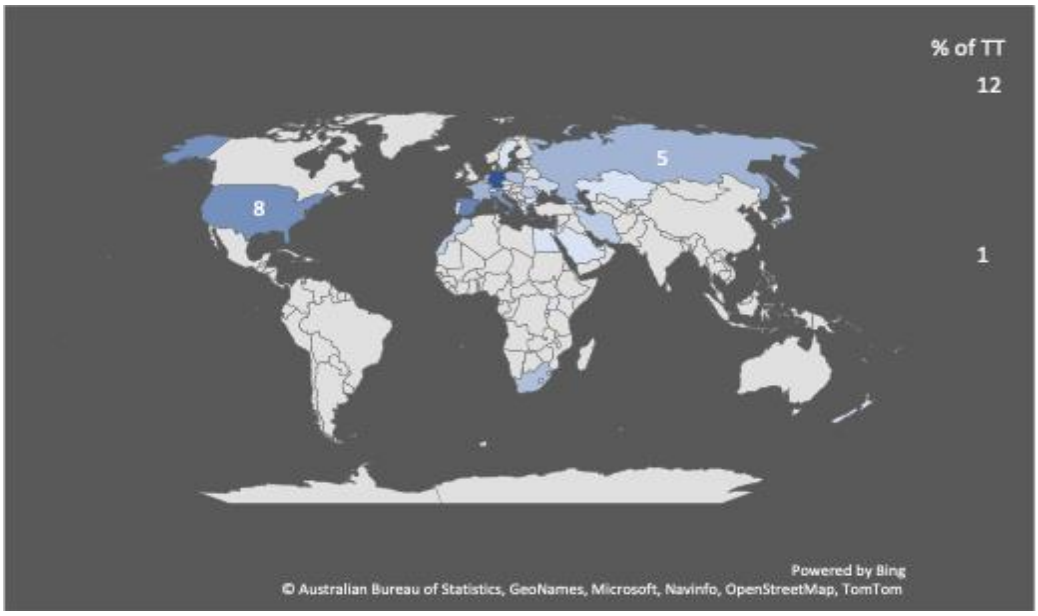

Fig. 10. Countries that companies producing technical textiles export to

According to Figure 11, businesses that produce more technical textiles than 50% of their total output claim to export mostly to European nations. Additionally, some businesses export to Russia and the USA.

Fig. 11. Countries where companies with technical textile production more than 50% of their total production export to

The export countries for companies that use composite materials in their manufacturing are shown in Fig. 12. The most popular destination for these companies' exports is Germany. Following are other European nations. Romania has a certain weight among these countries.

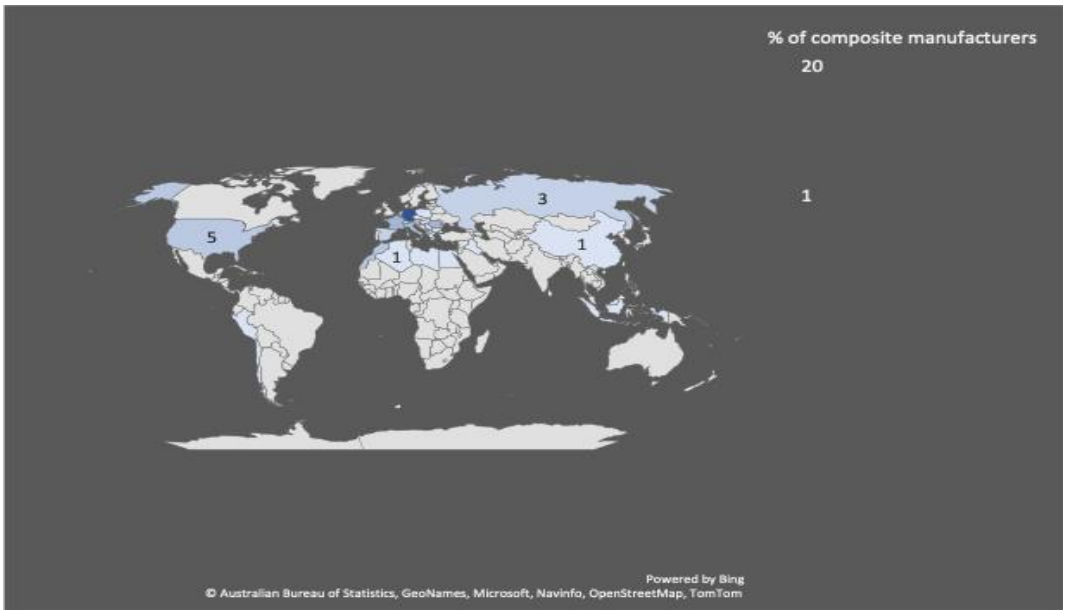

Fig. 12. Countries that companies using composite materials in their production export to

Production costs and the level of competition were cited as the two biggest issues by companies that exclusively make traditional textiles and by those where less than half of their output is technical textiles (Table 6).

Table 6 Problems encountered while exporting (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Technology and R&D	20.0%	5.6%	6.7%	0.0%
Trained qualified personnel and language problem	20.0%	33.3%	20.0%	0.0%
Production costs	86.7%	83.3%	53.3%	40.0%
Problems related to transportation, storage and distribution	40.0%	11.1%	20.0%	60.0%
Standardization	20.0%	22.2%	0.0%	0.0%
Export controls	6.7%	0.0%	20.0%	20.0%
Competitors and the intensity of competition	60.0%	88.9%	60.0%	60.0%
Environment: Considerations related to ISO 14000	0.0%	5.6%	0.0%	0.0%
Quality: Considerations related to ISO 9000	0.0%	5.6%	0.0%	0.0%
Implementations and quotas	6.7%	16.7%	20.0%	0.0%
Country and company image	20.0%	11.1%	6.7%	20.0%
Counterfeit products	46.7%	27.8%	26.7%	20.0%
Other (please specify)	6.7%	11.1%	20.0%	40.0%

There is a statistically significant difference even though these problems are prevalent in businesses that produce composite materials and produce technical textiles at a rate of more than 50 percent of total production. Production costs are less expressed by the companies that generate composite materials and whose technical textile production accounts for more than half of their output. Companies that make composite materials claim that issues with transportation, storage, and transportation also have an impact on exports. Particularly composite material producers mention the high cost of raw materials. In addition to these, one of the issues experienced when exporting has been cited as the continuing Ukraine situation at our borders.

Companies that only produce traditional textiles did not specify many competitor nations (Fig. 13). Nearly half (46.3%) of the companies that manufacture technical textiles admitted that they are unaware of the countries where their rivals are based. The most significant competitors in this field, according to those who are familiar with the locations of the competitors, are Germany, China, England,

Italy, and the USA, as shown in the figure below. Some of these companies claimed to have significant Türkiye competitors.

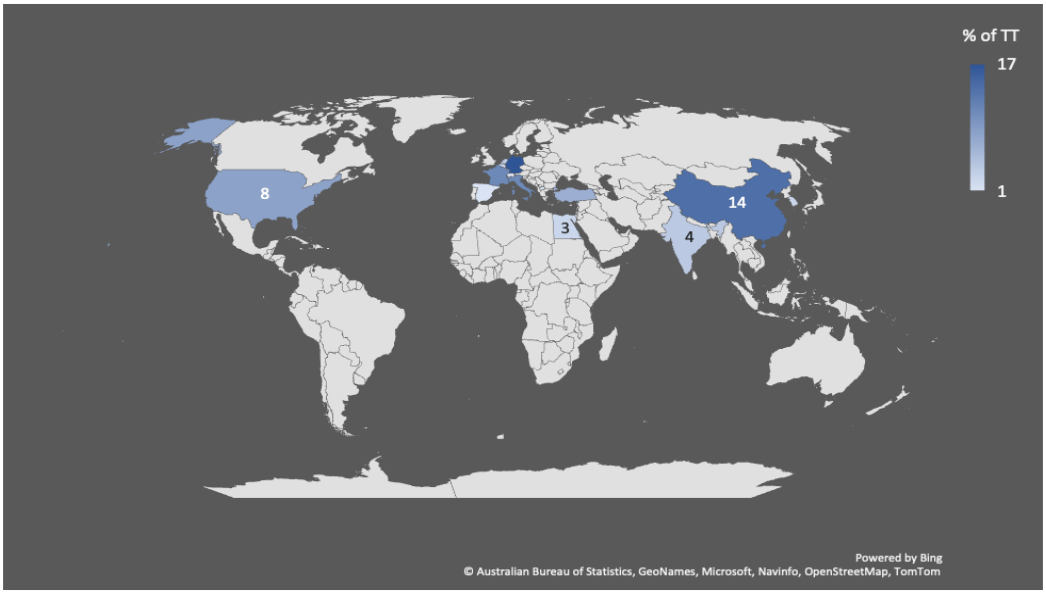

Fig. 13. Countries of which companies know their competitors are located

E-commerce is claimed to be conducted by 16.7 percent of the visited companies (Figure 14). Companies that produce only conventional textiles have the highest rate. One-third of the companies stated that their systems are unsuitable for e-commerce, while one-fourth indicated that their sales are B2B and that B2B is unsuitable for e-commerce. Aside from this, the personal interaction with the consumer and the fact that the products are not suitable for sale over the internet are commonly noted difficulties.

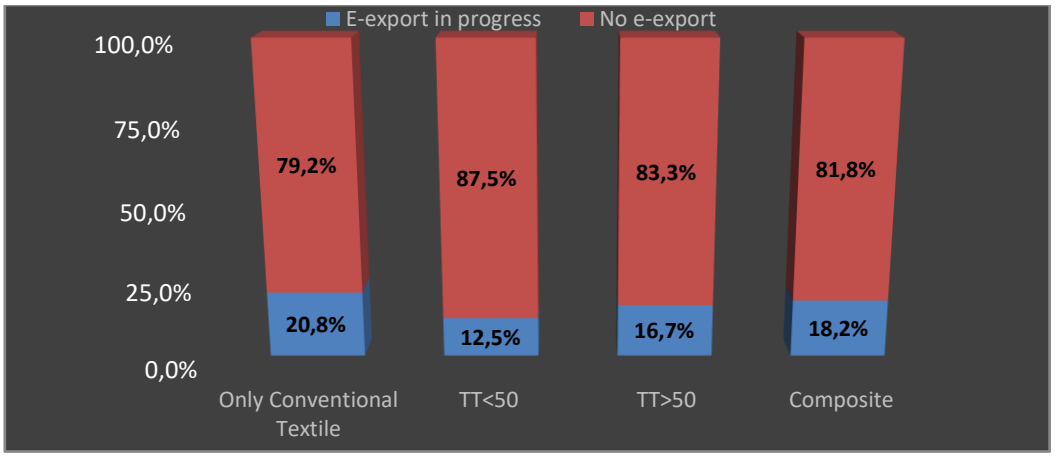

Fig. 14. E-export (%)

According to two-thirds of the companies, they attended significant fairs in their industries as guests, and half of them opened stands (Table 7). Composite material producers had the highest visitor involvement, while two-thirds of companies with more than 50 percent of their products in technical textiles said they had opened stands at significant fairs. Companies who set up stands have a great chance of displaying new products. 94.3 percent of these companies claimed to have exhibited their new products at the stands they established. A high rate of fair participation indicates a market-ready industry. The high rate of new product introduction at fairs demonstrates the sector's strong product development capability.

Table 7. Participation in important fairs (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Yes, as a visitor	60.0%	75.0%	61.1%	78.8%
Yes, by opening a stand	40.0%	62.5%	66.7%	45.5%
No	28.0%	16.7%	11.1%	15.2%

5. Conclusions

The following results were obtained within the scope of this study:

It is seen that weaving technologies are dominant in the Bursa textile industry. After these technologies, weaving preparation, finishing, and dyeing technologies come. Additionally, press molding technology is increasingly being used by companies producing composite materials. Next are injection molding, RTM, and hand lay-up technologies. Although traditional textiles seem to be more advanced than the average technology in the world, it is known that technical textiles use relatively similar technologies.

Companies producing technical textiles purchase their raw materials from European countries such as Germany, Spain, Italy, and France (Figure 6). Companies with technical textile production levels below or above 50% do not significantly alter their raw material purchasing profile. China stands out in this category as the country that obtains the rawest resources. It claims that European countries generally import the raw materials used in the final products. Among these countries, Germany ranks first. However, the companies claimed that they received raw materials from both China and European countries.

Glass fiber is the most frequently used material in companies producing composite materials, followed by carbon fiber. Additionally, some businesses claim to produce products using both carbon and glass fiber.

Almost all companies that produce technical textiles and composite materials claim to export, and they usually do so directly. They claimed that Germany and Russia accounted for the majority of exports. These countries are followed by Italy, Spain, and France, respectively. Companies that produce only traditional textile products did not specify many competing countries. Almost half of the companies producing technical textiles (46.3%) admitted that they do not know the countries where their competitors are located. According to those who know the locations of the competitors, the most important competitors in this field are Germany, China, England, Italy, and the USA, as seen in the figure below. Some of these companies claimed to have significant Türkiye competition.

One-third of the companies stated that their systems were not suitable for e-commerce, while one-quarter stated that their sales were B2B, and B2B was not suitable for e-commerce. In addition, personal interaction with the consumer and the fact that the products are not suitable for sale over the internet are among the frequently mentioned difficulties.

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