

Examination of R&D Capacity in the Technical Textile Sector: A Regio-Global Case Study

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Abstract

As a well-established industry in many countries, textiles and composites have a substantial influence on global economies. Sustainability, innovation, product quality, production costs, and technology are just a few of the factors that impact the level of competition in this sector. Converting these inputs into value-added products is a key driver of industry expansion. In the textile and composites industry, production cost is an important factor in competitiveness. Production costs can be reduced by increasing efficiency, minimizing waste, and streamlining the supply chain, since the sector requires a lot of people. Another crucial element is technology, which enables the production of high-quality goods with enhanced performance and functionality. Businesses can't stay competitive without innovation, which helps them differentiate their products from competitors' and meet changing customer needs. Because of the growing demand for eco-friendly products, sustainability has emerged as an essential feature. Sustainable practices allow businesses to save money, increase output, and appeal to environmentally conscious consumers. Adding value to textiles and composites using these competitiveness traits is key to the industry's continued growth and prosperity. The unique qualities, capabilities, and benefits that value-added goods provide set them apart from commodity items. Consequently, companies are able to increase their pricing and generate larger profits.

Keywords

technical textiles, process development, quality, value chain, market analysis, Grubel-Lloyd index, Bursa

1. Introduction

The textile sector has an important role in the economic growth and development of countries. With the earliest days of hand weaving and continuing into today's highly mechanized and technologically advanced industry, the textile industry has continuously developed and adapted to meet shifting customer demands and market situations. In recent years, the industry has become more competitive than ever, and businesses are under more and more pressure to set themselves apart from their rivals, save costs, and offer high-quality goods that fulfil the requests and expectations of their customers [1–3]. One of the key competitive elements in the textile sector is innovation. In a market that is competitive, businesses who can develop and introduce innovative new items that meet or surpass consumer expectations are more likely to prosper. Funding R&D, working with designers and other professionals in the field, or highlighting the newest trends and technologies are all examples of innovations. By placing an emphasis on innovation, businesses can set themselves apart from their rivals and occupy a special market niche. New materials and fibers, state-of-the-art manufacturing processes, and advanced digital technologies are all examples of innovations in the textile sector. For instance, new fibers like Tencel and recycled polyester have been developed recently and offer better sustainability and performance qualities. Similar technological developments in digital printing have made it possible for designers to produce intricate and highly detailed patterns and designs, and advancements in automation and robotics are revolutionizing manufacturing processes by making them quicker, more effective, and more affordable [4–8].

Speed-to-market is another essential element of competitiveness in the textiles sector. Companies that can launch products swiftly and effectively have a higher chance of success as consumer preferences

and market conditions change quickly. Investments in supply chain optimization, rapid product development techniques, and efficient manufacturing procedures may be necessary to achieve this. Businesses are better positioned to gain market share and maintain an advantage over rivals if they can act swiftly and adapt to changes in demand and market conditions [9–11]. A crucial element in the textiles sector is cost competitiveness. Due to the squeeze on margins and escalating competition, businesses must discover ways to cut expenses without compromising product quality or client expectations. This could entail investing in automation, streamlining the supply chain, or carefully choosing where to get the materials and components. Companies can sustain profitability and provide competitive pricing to customers by cutting costs [12–15]. In the textiles sector, product quality continues to be a critical competitiveness driver. Customers now expect high-quality, long-lasting products, therefore businesses who can reliably fulfill or exceed these demands will have a substantial competitive edge. This may entail making investments in quality assurance procedures, staff training and development, or a supply chain improvement focus [16–19]. Furthermore, crucial competitiveness elements in the textiles sector are branding and marketing. Businesses with strong brand identities and excellent consumer marketing strategies are more likely to prosper in a crowded market. A strong brand may help a business stand out from rivals, increase customer retention, and foster a sense of dependability. Companies can express their unique value propositions, reach new customers, and increase brand recognition with the use of efficient marketing methods [20–22].

The textiles sector has recently recognized sustainability as a crucial competitiveness component. Customers are requesting more and more products that are made ethically and sustainably as knowledge of environmental difficulties and social problems grows. Businesses who can provide environmentally friendly goods and services will have a big advantage over rivals in the market [23–25].

Another crucial competitiveness component in the textiles sector is social responsibility. Customers are increasingly demanding goods that are produced in an ethical and responsible manner as consumer knowledge of labor and human rights issues grows. Businesses with a track record of social responsibility will be at a distinct advantage in the marketplace [26–29]. The textile industry is facing a digital revolution. The product design, R&D, and supply chain processes are going through digitalization. To improve customer relationships, some companies have embraced multi-channel and e-commerce strategies [30–32]. In the textiles sector, talent management can take on a variety of forms, from providing chances for professional development and progress to fostering an empowering and welcoming workplace environment. In a similar vein, several organizations have established flexible work schedules and other rules to foster work-life balance and improve employee wellbeing [33, 34].

We have conducted regional and global market research on technical textiles [35] and composite [36] materials, including an analysis of added value. Our study indicates that there is a growing demand in global marketplaces for high-value-added items like technology textiles. Many countries have reorganized their production systems in the past decade to prioritize the manufacturing of these items in order to enhance their economic competitiveness internationally. Global exports of technical textiles amounted to over \$118 billion dollars, showing 3.38 percent growth from the previous year. Türkiye's exports in 2021 totaled \$2.413 billion dollars, marking a 12.91% reduction from the previous year. With only a few exceptions, the Grubel-Lloyd Index calculation for technical textile product groups in Türkiye shows bilateral intra-industry trade, with only a few exceptions. The mean index value for all technical textile items was determined to be 0.7968. By 2028, Mobiltech, Indutech, and Packtech subcategories of technical textiles are expected to be the leading sectors in the commercial market [37].

The need for high-value composite products, such as technological textiles, is rising in today's global markets. Many countries have transitioned their manufacturing processes to focus on these items in the past decade to enhance their competitiveness in the global economy. Türkiye's composite material exports grew by 19.48% in 2021 compared to the previous year, totaling 2.7 billion lira (TRY). The study determines that intra-industry trade in Türkiye's composite material product categories is mainly bilateral according to the Grubel-Lloyd Index calculation, with only a few minor exceptions. The mean index value for composite materials was calculated as 0.6890.

The authors examined the competitive forces in the technical textiles and composite industries [36]. The technical textiles and composites industry has a considerable impact on the global economy due to

aspects including production prices, technology, product quality, innovation, and sustainability, as indicated by this study. The technical textiles and composites industries' growth and success rely on their capacity to convert these competitive attributes into products that offer added value. Value-added goods differentiate themselves from commodity goods through unique features, functionalities, and benefits. This enables enterprises to increase prices and generate greater profits.

To improve the textile and composites industry's growth and success, this research aims to identify, analyze, and investigate the primary competitive features and how they may be turned into value-added items.

2. Methodology

The diagnostic study over the needs of the active companies in the fields of textiles and composites industry consisted of two phases. In the first phase, 140 companies were visited to fill out a questionnaire, while in the second phase, 50 companies selected among the 140 using two objective scoring tools were visited for deep diagnostic interviews by experts in Technical Textiles and Composites. A draft questionnaire was prepared first. It was tried out during a pilot phase with leading companies of the textile and composite sectors. The questionnaire was then fine-tuned for effective data collection. The long questionnaire for the screening phase consists of nine modules with a total of 91 questions:

- Activity/Production (8 questions)
- Supply/Sales (17 questions)
- Human resources (10 questions)
- Research and Development (R&D) (24 question)
- Quality (5 questions)
- Sustainability (2 questions)
- Value chain (8 questions)
- Transformation (7 questions)
- Clustering (10 questions)

Due to time limitations, a shortened version was adapted from the long version with 73 questions. The companies to be visited for the first phase study were selected using rational sampling strategies from a database of 2734 companies from the company register provided by Bursa Chamber of Commerce and Industry (BTSO). The companies were established in Bursa, with at least one staff on the payroll. The database was constructed from companies' activities using their NACE codes. A pilot sample of 20 companies were selected in order to try out the questionnaire. This selection was skewed towards larger companies, as those are more likely to engage in technical textile (TT) and composite production. A first sample of 175 companies was then randomly selected using a stratified method. However, when it was found that the non-response rate was much higher than expected, a second (144 companies) and third (80 companies) sample were taken to which a turnover threshold was applied. The high nonresponse rate of the first sample was attributed to the busy schedules of company owners or related high-level managers and the larger number of companies of smaller sizes included in the first sample that had already ceased their activities or showed no interest in transformation and participation in the project activities. In the second and third samples, smaller companies with a low turnover were not included. The semi-structured questionnaire for the second phase is made up of questions to diagnose companies' limitations and challenges regarding prototyping and new product development. It focuses on companies' needs and plans for prototyping and new product development considering their technology levels, decision-making process for new product development, obstacles for developing new ideas and challenges in R&D processes, new product development projects, project teams' needs, their skill and knowledge gaps and needs, marketing strategies, transforming to technical textile and composites, clustering perceptions, etc. The questionnaire is a tool to explore the companies' needs.

3. New product and process development, R&D

According to companies, 90 percent of new product ideas come from customers (Table 1). This demonstrates that companies are attentive to customer feedback, cooperative with clients, and

empathic. In other words, companies aim to make things that they can sell. They later asserted that they use the sector follow-up processes. However, these demonstrate that enterprises continue to exist by engaging in new production development activities such as generating items that customers want, that are produced by the sector, and that have low market or profitability risk. It is acknowledged that the company's employees contribute significantly to the creation of fresh ideas. Although this situation demonstrates the employees' ability to innovate, innovation actually occurs as a result of the core sales and technical production staff's experience in the industry, in which they have worked for many years, as well as their ability to closely observe the market. In addition to all of these, competition monitoring emerges as one of the crucial components in the development of new products. The market is poor when it comes to cooperation, as evidenced by the 30 percentage ratio of outsourced services and project partnerships. However, there is also a chance that this element will help the Butexcomp project succeed. Companies that form the most project collaborations are those that produce less than half of their output in technical textiles and those in composite materials.

Table 1. Sources of new product ideas (%) (TT: Technical Textile)

	Traditional Textile Only	TT<50	TT>50	Composite
By our employees	65.2%	62.5%	61.1%	45.5%
We receive external advice/service	30.4%	41.7%	22.2%	18.2%
With project partners	21.7%	41.7%	22.2%	45.5%
We follow our competitors	34.8%	66.7%	38.9%	30.3%
Customers demand	91.3%	91.7%	88.9%	90.9%
We follow the sector	65.2%	83.3%	72.2%	75.8%
Other (please specify)	0.0%	0.0%	16.7%	9.1%

Nearly three-quarters of the businesses whose interviews were conducted as part of the diagnosis study indicated conducting design studies, compared to more than three-quarters who said they conducted R&D and PD studies (Table 2). The rate is highest in companies whose production of technical textiles accounts for less than half of overall production. Companies making composite materials came in second, however, it was found that those making only traditional textiles had the lowest rate.

Table 2. Occurrence of R&D / PD and Design studies (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Yes, R&D studies are conducted	65.2%	83.3%	76.5%	82.4%
Yes, PD studies are conducted	73.9%	87.5%	58.8%	79.4%
Yes, Design studies are conducted	78.3%	70.8%	64.7%	76.5%
No, neither R&D, PD nor Design studies are conducted	17.4%	4.2%	11.8%	8.8%

There are ministry-approved R&D centres of companies especially at those whose output of technical textiles accounts for more than half of total production and produce composite materials among the companies visited (Fig.1). Approximately two-thirds (63.2 percent) of traditional textile companies claimed that their staff conducted R&D and PD studies. Companies with less than half of their products being technical textiles have R&D centres/units either approved by the ministry or not. It is acknowledged that such companies have a higher propensity for R&D than others. It has been shown that companies with more than half of their products being technical textiles are the only ones that collaborate with universities on R&D and PD.

Exactly half of the companies claimed to have personnel capable of networking and collaborating with independent R&D centres, universities, and research organisations (Table 3). When it comes to businesses that make technical textiles, this figure is close to 60 percent. Companies with technical textile production that makes up less than half of total production have a high rate. Additionally, companies that do not now employ such employees declare that they intend to do so. This shows that these companies have a strong propensity for transformation and development. Half of the companies

that make composite materials said they have qualified employees who can complete this activity, while some others said they intend to hire such people. Nearly one-third of traditional textile production companies acknowledged the availability of qualified employees to perform these tasks, and one-fifth stated that they intend to hire them.

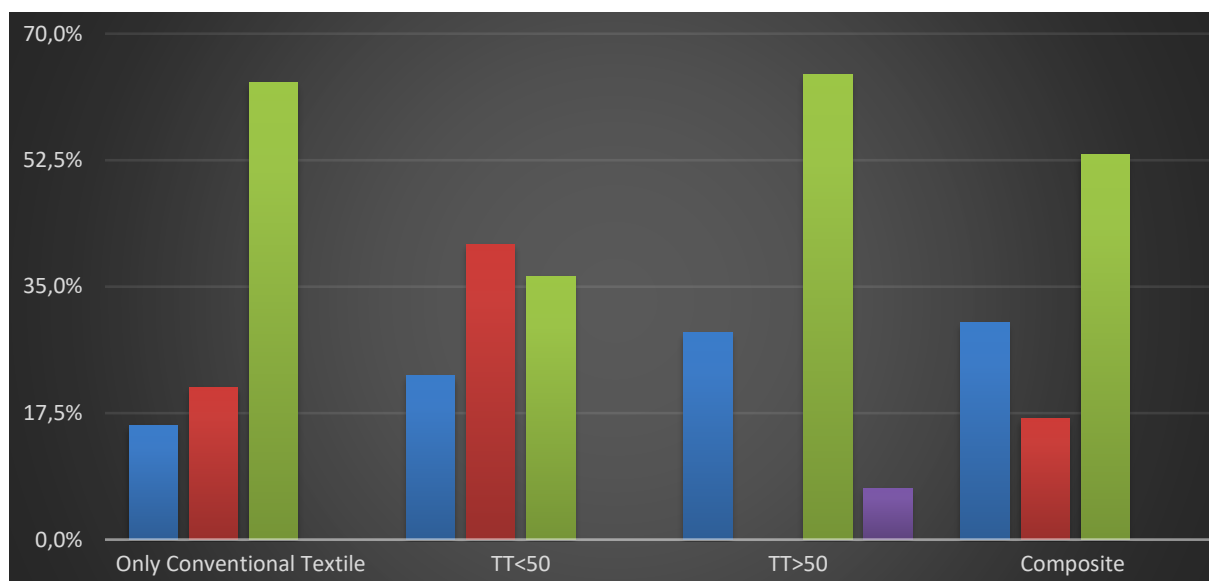


Fig. 1. Units where R&D / PD studies are carried out (%)

Table 3. Qualified personnel for networking (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Yes, there is	30.0%	61.9%	56.3%	51.5%
No, but we plan to employ	20.0%	19.0%	0.0%	9.1%
No, there is not	50.0%	19.0%	43.8%	39.4%

Companies claimed that their laboratory infrastructure was insufficient for the implemented R&D projects (Table 4). Although it is better than the infrastructure, it is acknowledged that in order to carry out R&D projects, the staff members of the R&D unit also require training and improving their skills. The demand is slightly higher than the others, particularly in technical textiles.

Table 4. Adequacy of laboratory infrastructure and R&D personnel skills (out of 10)

	Traditional Textile Only	TT<50	TT>50	Composite
Adequacy of laboratory infrastructure for R&D projects	5.9	5.4	5.4	5.9
Adequacy of the knowledge and skills of your R&D unit staff for the R&D projects	6.7	6.5	6.4	7.0

These findings indicate that the companies' laboratories have a medium degree of competency for R&D projects and that the Project has the potential to assist. Similar to this, improving the abilities of the company's R&D staff will improve the adequacy of R&D projects. As a result, it is anticipated that the training and test analysis services to be offered as part of the Project will significantly improve the quality of the companies' R&D projects.

Although the infrastructure of design centres and the competence of design people are superior to those of R&D, there is a dearth of knowledge and skills in this area (Table5). Notably, employees at companies that produce less than half of their output in technical textiles need design knowledge and skills.

Table 5. Adequacy of laboratory infrastructure and R&D personnel skills (out of 10)

	Traditional Textile Only	TT<50	TT>50	Composite
Adequacy of design centre infrastructure for design projects	6.8	7.1	6.9	7.0
Adequacy of the knowledge and skills of the personnel working in the design centre/unit for design projects	7.1	6.8	7.4	7.3

One-third of the companies responded that they have previously adopted or are now implementing R&D and/or PD projects (Table 6). It is acknowledged that composite material producers have greater project execution capabilities than others. However, it is understood that nearly two-thirds of the companies do not currently have an externally supported R&D or PD project.

Table 6. R&D and/or PD project experience (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Project implemented before	15.0%	9.5%	16.7%	51.6%
Currently being implemented	5.0%	14.3%	11.1%	29.0%
Project application has been made	5.0%	0.0%	11.1%	12.9%
Project preparation phase continues	15.0%	23.8%	22.2%	22.6%
No, there is not	60.0%	66.7%	66.7%	54.8%

Financial support funds are well-known among businesses. Nearly two-thirds of the businesses claimed to have requested or utilised financial support funds (Fig. 1). The highest rate is seen in companies where the production of technical textiles accounts for less than half of total production, while the lowest rate is seen in companies where the production of technical textiles accounts for more than half of total production.

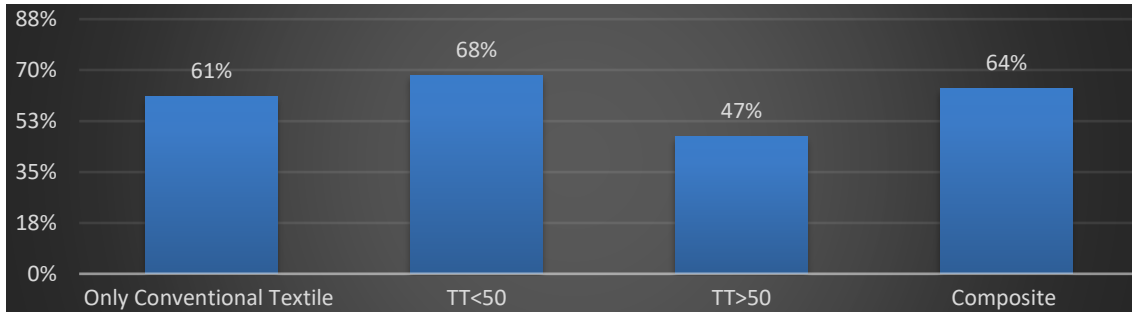


Fig. 1. Application or use of Financial Support funds (%)

Companies receiving financial support reported that they mostly benefit from KOSGEB incentives (Table 7). This is followed by financial assistance from TÜBİTAK TEYDEB, the Ministry of Industry and Technology, and the Ministry of Trade.

Table 7. Distribution of beneficiaries' financial support funds by sources and groups (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Ministry of Industry and Technology	33.3%	35.7%	11.1%	31.6%
Ministry of Trade	33.3%	21.4%	22.2%	26.3%
BEBKA	0.0%	14.3%	22.2%	10.5%
KOSGEB R&D Incentives	11.1%	28.6%	11.1%	5.3%
KOSGEB Other Incentives	55.6%	57.1%	77.8%	63.2%
TÜBİTAK TEYDEB	22.2%	35.7%	11.1%	42.1%
TUBITAK PhD program	11.1%	14.3%	11.1%	10.5%
HORIZON 2020, EU funds	22.2%	7.1%	11.1%	5.3%

Even though only one-fourth of companies did projects, the number of projects undertaken by these companies is high on average, particularly in companies where technical textiles account for more than half of their output (Fig. 3). Even though half of the companies that manufacture composite materials have done projects, their average number of projects is lower than compared to the others. The reason why the number of projects per company is low in companies producing composite materials is that most companies produce after customer orders, so they do not give priority to projects for such companies.

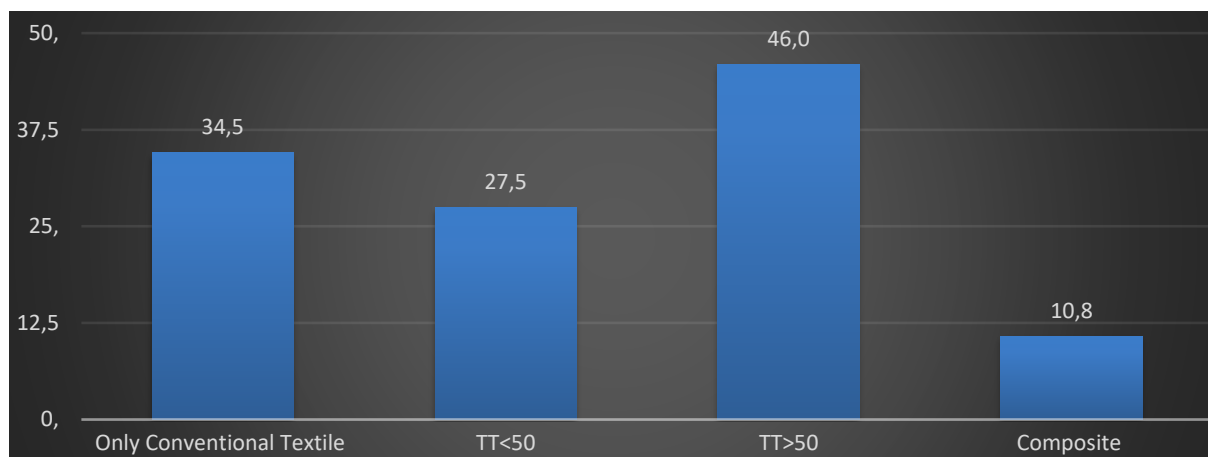


Fig. 3. Average Number of R&D and/or PD projects carried out in companies between 2016 and 2021

The commercialisation rate of completed projects for traditional textile companies is one-third, whereas the commercialisation rate for composite material companies is approximately two-thirds (Fig. 4). In companies that only make traditional textiles, this rate is the lowest. The rate of project commercialisation is higher in companies where technical textile production accounts for more than half of the output than others. As the commercialisation rate is the ratio of the number of successful commercialisations and the number of product development projects, this ratio is not only dependent on the competence of the companies for successful commercialisation, but also highly dependent on what the companies perceive as “successful commercialisation” and “project”, as well. Compared to the often-quoted 80-95% failure rate of innovation projects, the success rates reported here suggest that companies mostly reported low-risk product development projects.

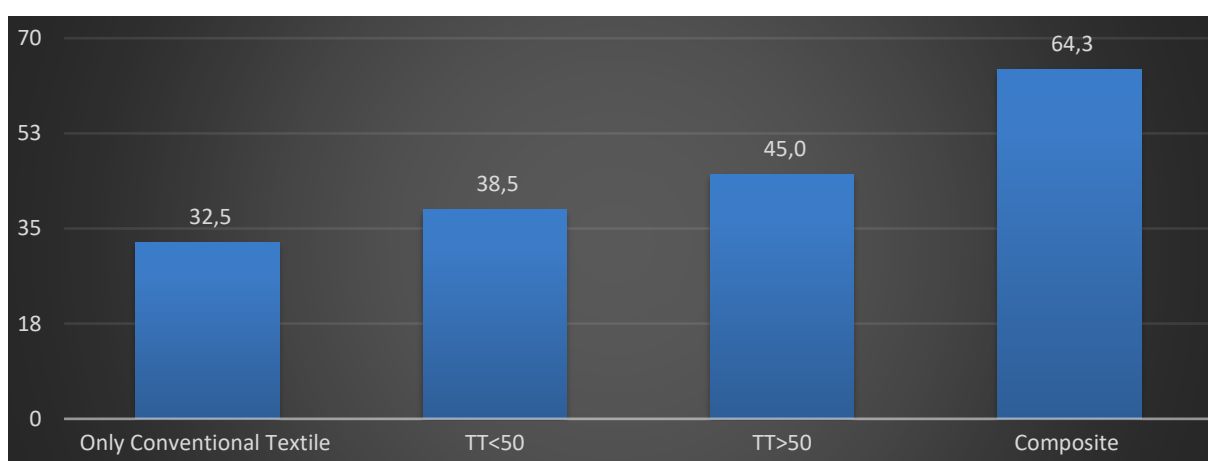


Fig. 4. Commercialization rate of projects (%)

The businesses assessed their capacity for innovation as moderate (Fig. 5). Companies that make traditional textile products assert that their ability to innovate is at a moderate level, but those that make composite materials assert that their ability to innovate is higher than others.

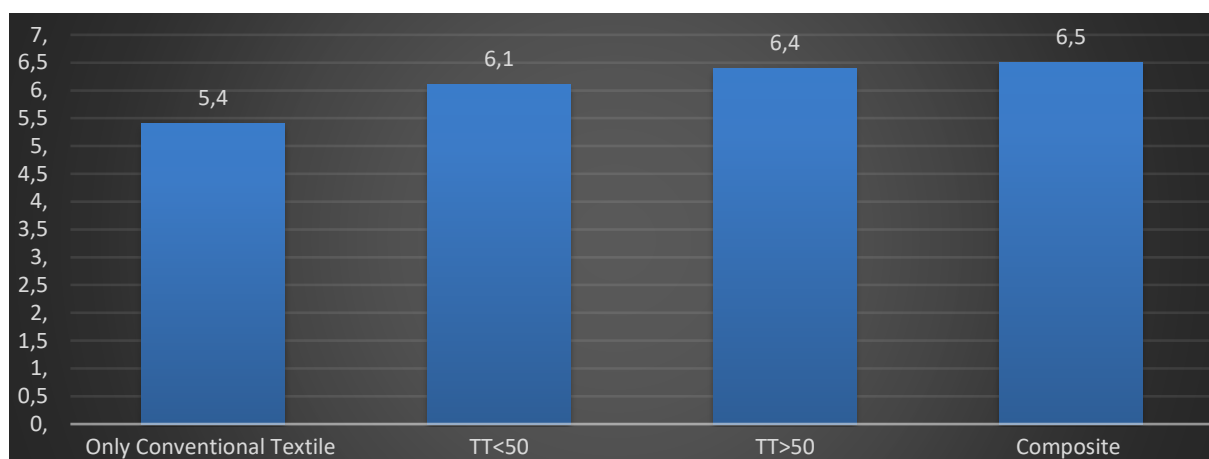


Fig. 5. Perception of innovation ability (out of 10)

Almost half of the companies (45.1 percent) claimed that they have medium-high technology products (Fig. 6). It has been observed that products with medium-high technological levels are primarily found in composite material manufacturing enterprises. As the percentage of technical textiles in production rises, so do the rates of the companies that produce them. As expected, those that only make traditional textiles have a low share of medium-high technology products.

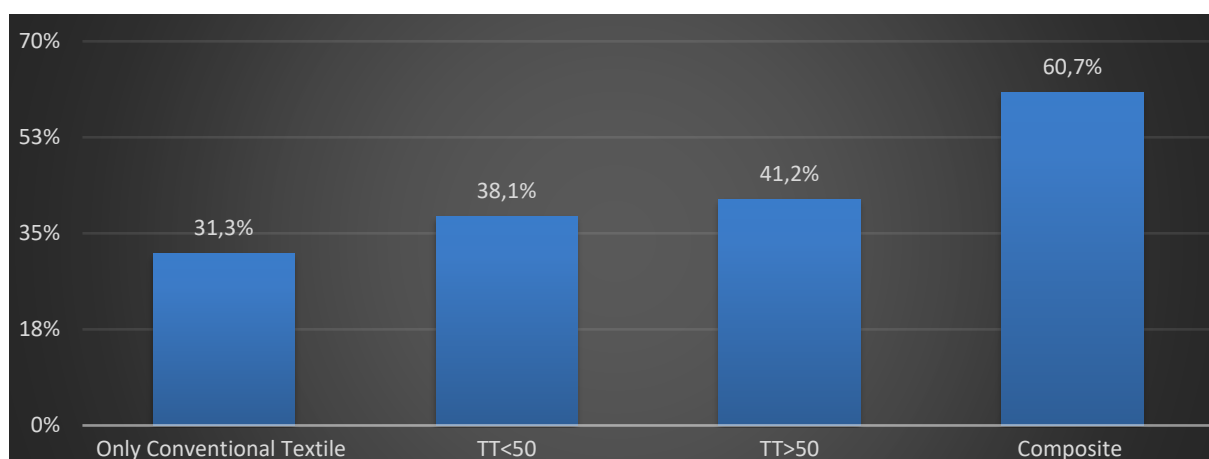


Fig. 6. Medium-high technology product availability (%)

It has been found that companies have an average of 10.5 registered national patents (Table 8). The companies with the most patents at the moment produce less technical textiles than half of their overall output. The high number of patent applications comes out of businesses where technical textiles make up more than 50% of overall production. Only businesses that produce more than 50% of their products as technical textiles and composite materials are known to hold international patents. While the average number of utility model registrations in companies is 4.5, it is expected that companies making composite materials will come forward with the acceptance of their applications. The average number of registered trademarks is 2, and the number of applications that are still pending is around 1.5. The average number of articles written in 12 companies claiming to have written articles on the subject of their occupation is roughly 7, with companies manufacturing technical textiles or composite materials having a higher average.

4. Quality

Companies reported having an average of 3 quality certificates (Fig.7). It has been found that the companies making traditional textiles have the most certificates, and the companies making composite materials have the fewest certificates.

Table 8. Patent and utility model registration and application averages

	Traditional Textile Only	TT<50	TT>50	Composite
The number of registered national patents in the company	1.0	30.5	12.5	4.5
The number of registered international patents in the company	.	.	1	1.9
Number of pending patents within the company	1.0	3	22	3.3
Number of utility model registrations within the company	6.0	4.5	2	4.5
Number of pending utility model registrations within the company	2.0	2.3	1	2.8
Number of registered trademarks in the company	1.8	3.1	1.9	2
Number of pending trademarks in the company	1.7	1	1	1
Number of articles written within the company	1.7	4.8	22	5.3

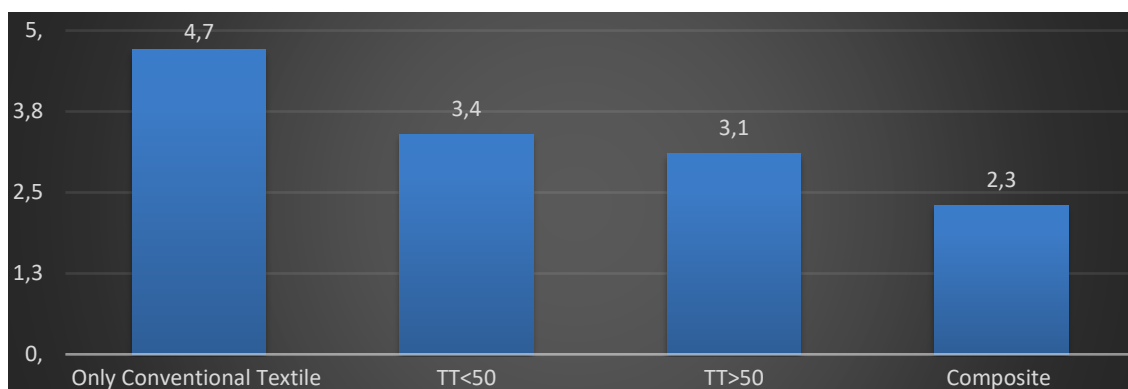


Fig. 7. Average number of certificates

Three-quarters of the companies stated that they had put their products through accreditation testing (Fig. 8). Nearly two thirds of the businesses claimed that they conducted some tests in Bursa and others in different Turkish cities. One-third of the companies disclosed having some of the tests performed abroad. Companies whose technical textile production made up less than half of their total production claimed to use Bursa's test centres the majority of the time, whereas companies whose technical textile production made up more than half of their production claimed to have their tests conducted more frequently in other Turkish cities. Even while businesses that solely make traditional textiles have tests conducted in Bursa, they claim to have more testing conducted in other Turkish towns. Companies that make technical textiles and/or composite materials reported using foreign testing facilities more frequently.

Only 6 percent of the companies reported that there had been no returns because of quality issues (Table 9). The group with the highest non-return rate is the group with less than half of the products in technical textiles. Nearly 40 percent of companies report a return more than five times per year. The companies that make composite materials are shown to have the lowest rate of return.

41 percent of the visited companies claimed to have sustainability reports (Fig. 9). The companies whose production of technical textiles accounts for more than half of total output are the group with the highest rate of this. One-third of traditional textile manufacturing enterprises have sustainability reports available. The rate hovers around 40 percent in other groups. Especially, customers abroad request annual reports from suppliers on sustainability activities. These customers are generally estimated to be EU and US companies.

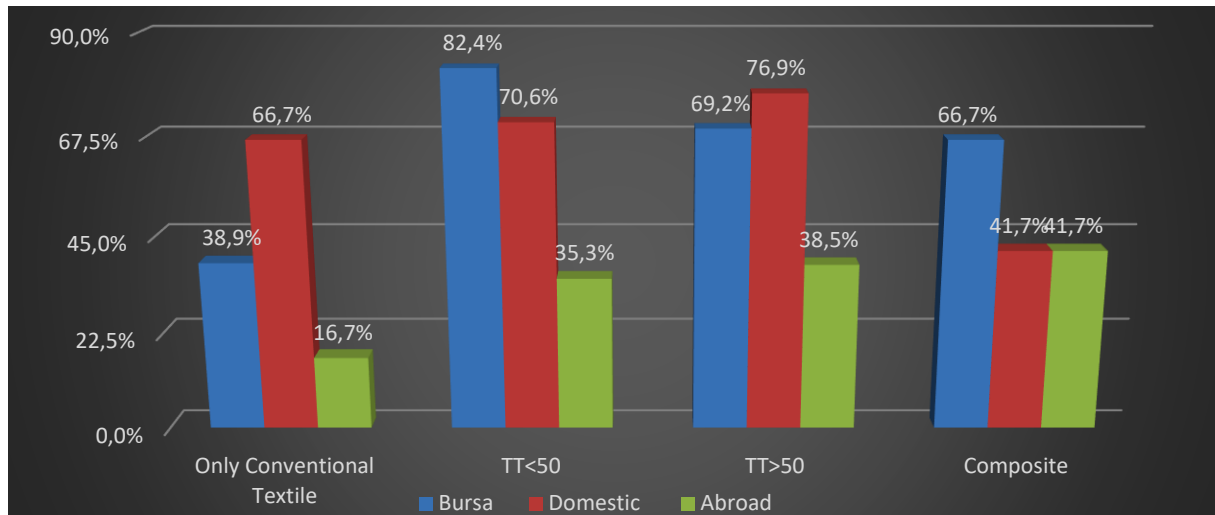


Fig. 8. Accreditation test locations (%)

Table 9. Return rates of products (%)

	Traditional Textile Only	TT<50	TT>50	Composite
There is no return	4.20%	10.50%	0.00%	6.90%
There is a return once a year	0.00%	5.30%	28.60%	13.80%
There are 2-3 returns per year	33.30%	21.10%	7.10%	27.60%
There are 4-5 returns per year	12.50%	21.10%	21.40%	17.20%
More than 5 returns per year	50.00%	42.10%	42.90%	34.50%

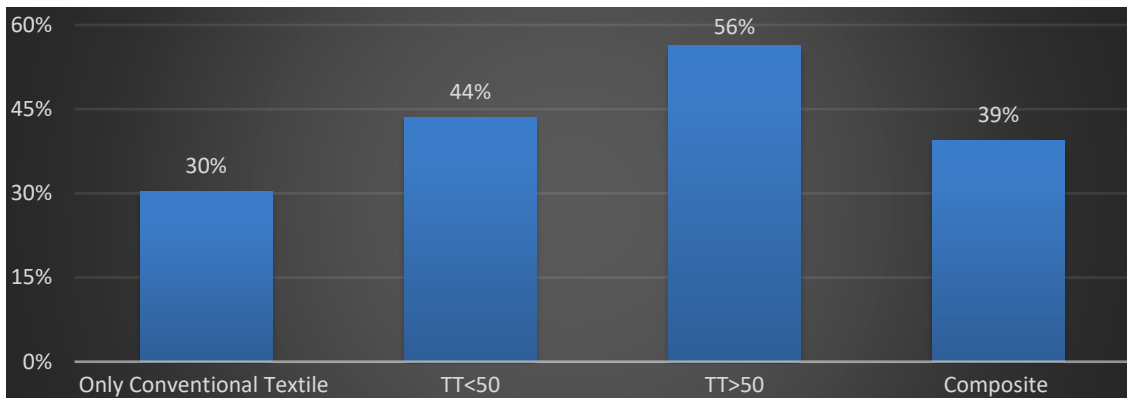


Fig. 9. Availability of sustainability reports

In businesses that produce traditional textiles, it has been noted that initiatives to convert to renewable energy sources and initiatives involving waste have gained prominence (Table 10). It has been claimed that in addition to waste management initiatives, energy conservation initiatives are carried out at companies that manufacture technical textiles. Waste, efficiency, and simplification projects have been reported to be carried out in composite material manufacturing businesses. Except for businesses with less than half the production of technical textiles, projects related to climate change, one of the most urgent challenges of today, are far behind. It has been noted that initiatives in companies that produce composite materials to convert to renewable energy sources and reduce water consumption do not draw attention. Since the amount of water used in the production of composite materials is very small, projects to reduce water consumption do not provide much benefit in terms of cost.

5. Value chain

General management, financial affairs, and strategic planning regarding the corporate infrastructure come in the first place when rating the administrative procedures in businesses (Table 11). Regarding

the relative importance of technology development and procurement procedures, companies were split into those that were most concerned about technology and those that were most concerned about supply procedures. Technology development-related concerns are more evident in companies that produce composite materials and whose technical textile manufacturing accounts for less than 50 percent of their overall production, whereas supply procedures are more noticeable in other companies. Human resource management is ranked as the last in all of them.

Table 10. Sustainability and environmental projects in companies (%)

	Traditional Textile Only	TT<50	TT>50	Composite
Projects related to reduce water consumption	40.0%	47.8%	38.5%	13.8%
Projects related to reduce energy consumption	50.0%	65.2%	69.2%	27.6%
Projects for conversion to renewable energy sources	60.0%	43.5%	46.2%	13.8%
Projects related to waste	65.0%	52.2%	84.6%	58.6%
Projects related to products	35.0%	56.5%	53.8%	27.6%
Projects related to climate change	20.0%	34.8%	7.7%	3.4%
Projects related to digitalization and automation	30.0%	39.1%	30.8%	37.9%
Projects related to efficiency and simplification	40.0%	39.1%	38.5%	41.4%
Other (please specify)	15.0%	26.1%	7.7%	20.7%

Table 11. Sequence of administrative processes in companies

	Traditional Textile Only	TT<50	TT>50	Composite
Company infrastructure (general management, financial affairs, strategic planning)	1	1	1	1
Technology development related issues (R&D, Design)	3	2	3	2
Human Resources Management	4	4	4	4
Supply processes	2	3	2	3

When the order of company processes is examined, companies barely make a distinction between marketing sales and production operations (Table 12). The most crucial process for all companies has been identified as production operations, closely followed by marketing and sales operations. Entry logistics, after-sales services, and exit logistics are mentioned as the following operational procedures.

Table 12. Sequence of business processes in companies

	Traditional Textile Only	TT<50	TT>50	Composite
Production operations	1	1	1	1
Marketing and sales	2	1	2	1
After-sales services	4	4	4	4
Entry logistics	3	3	3	3
Exit logistics	5	5	5	5

Table 13 shows how businesses rated the factors affecting their competitiveness. It has been claimed that the most significant challenge impacting competitiveness is availability of raw material supply and increasing raw material prices. The current market's competition and challenges finding a qualified workforce come next. Businesses also claimed that clients have strong negotiating power. The availability of raw materials and their costs are the most important factors for businesses producing

traditional textiles and composite materials, while access to a skilled workforce and market competition are crucial for businesses producing technical textiles, despite the fact that the issues affecting competitiveness are similar across the groups.

The quantity and proximity of suppliers for businesses that make technical textiles appear to be less of a disadvantage than other factors. Companies ranked proximity to the market and logistical opportunities as the last places in terms of competitiveness disadvantages. Companies that produce more than half of their entire output as technical textiles expressed confidence in their product's quality and technical proficiency.

Table 13. Issues affecting competitiveness (out of 10)

	Traditional Textile Only	TT<50	TT>50	Composite
Quality-technical competence	5.0	5.0	3.5	5.5
Market entry	6.0	5.1	5.1	5.1
The bargaining power of customers	7.0	6.1	5.3	5.8
Competition in the current market	7.2	6.3	6.8	6.1
Qualified workforce	6.2	7.1	6.2	6.5
Number and proximity of suppliers	5.1	4.9	4.9	5.3
Access to government incentives	5.9	5.5	5.0	6.3
Logistics possibilities	5.1	3.4	4.3	4.5
Proximity to market	4.7	4.3	3.5	4.6
R&D engineering opportunities	5.4	5.4	5.2	6.0
Raw material supply – raw material price	7.3	6.6	6.6	7.3
Foreign trade – marketing	6.5	5.6	5.4	6.2

The companies' specified medium- and long-term objectives are to increase sales and market shares first, followed by export growth (Table 14). Small variations appeared in the following rankings depending on the groups. Companies that produce textiles have indicated their goals are innovation and product development, whereas companies that make composite materials have stated their goal is to expand their capacities. Utilization of new technology and capacity expansion preferences came last for the companies. However, not focusing on new technologies in the medium and long term will reduce the competitiveness of companies even if they do not lose their market share.

Table 14. Ranking the medium and long-term goals of the companies

	Traditional Textile Only	TT<50	TT>50	Composite
Increasing sales / market share	1	1	1	1
Increasing exports	2	2	2	2
Increasing the capacity	5	4	4	3
Using new technologies	4	5	5	4
Innovation - Product development	3	3	3	5

Companies claimed that their preferred method of interacting with target customers was one-on-one client visits, followed by exhibition/fair participation (Table 15). Companies that produce only traditional textiles and less than half of their production in technical textiles made visits based on delegations, whereas businesses that produce composite materials or more than half of their production in technical textiles reported of wishing to reach their target customers through online advertising. Last on the list is the usage of written and visual media for reaching customers.

Companies sought to keep their current clients first, and then expand sales by attracting new ones (Table 16). While companies that solely produce traditional textiles and composite materials claimed that their goal is to grow by improving their profitability, companies that produce technical textiles stated that their goal is to expand into new and niche markets with their current products.

Table 15. Strategies of companies to reach their target customers

	Traditional Textile Only	TT<50	TT>50	Composite
One-to-one client visits	1	1	1	1
Participation in fairs	2	2	2	2
Delegation-based visits	3	3	5	5
Online advertising	4	3	3	3
Written and visual media	5	5	4	4

Table 16. Strategies of companies to reach their target customers

	Traditional Textile Only	TT<50	TT>50	Composite
Increasing sales to existing customers	1	1	1	2
Increasing sales to new customers	2	2	2	1
Accessing new, niche markets with existing products	4	3	3	4
Accessing new, niche markets by transforming	5	5	5	5
Growing by increasing profitability	3	4	4	3

6. Conclusions

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

Companies report that 90 percent of new product ideas originate from customers. This indicates that organizations value customer feedback and collaborate with customers. Almost 75% of the businesses interviewed in the diagnosis study reported undertaking design studies, while over 75% mentioned conducting R&D and PD studies. During the visits, ministry-approved R&D centers of enterprises specializing in composite materials were observed, particularly those with technical textile manufacturing accounting for over half of their overall output. Fully half of the companies have staff with the skills to network and collaborate with independent R&D centres, universities and research organisations. Companies claimed that their laboratory infrastructures were inadequate for the R&D projects they implemented. Design centers have greater infrastructure and skilled personnel compared to R&D, yet there is a wealth of information and expertise in this field. One-third of the companies stated that they had either adopted or are currently implementing Research and Development (R&D) and/or Product Development (PD) programs.

Businesses are familiar with financial support funds. Approximately 66% of the firms reported requesting or using financial support funds. Despite only a quarter of enterprises engaging in projects, those that do execute a large number of projects on average, especially in companies where technical textiles make up over half of their output. Traditional textile companies have a commercialization rate of 33%, while composite material companies have a commercialization rate of around 67%. 45.1 percent of enterprises reported having medium-high technology products. Companies, on average, possess 10.5 registered national patents. Currently, enterprises with the highest number of patents create less technical textiles than half of their total output. 75% of the companies reported that they have subjected their products to accreditation testing. Only 6% of the companies stated that no returns had occurred due to quality issues.

41% of the companies that were visited reported having sustainability reports. The enterprises that produce more than half of the total technical textiles have the greatest rate of production in this sector. Businesses in the traditional textile industry are increasingly focusing on transitioning to renewable energy sources and implementing waste management efforts. When evaluating administrative operations in enterprises, priority is given to general management, financial affairs, and strategic planning related to the corporate infrastructure. When analysing the sequence of firm operations, companies often fail to differentiate between marketing, sales, and production processes. The primary difficulty affecting competitiveness is said to be the availability of raw materials and the rising prices of raw materials. The companies' defined medium- and long-term goals are to prioritize increasing sales and market shares, with export growth to follow. Companies stated that their top choice for engaging

with target clients was through individual client visits, with involvement in exhibitions/fairs being a close second. Companies prioritized retaining existing clients before focusing on acquiring new ones to increase sales.

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