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Preliminary Analysis in Clustering and Supply Chain Creation: A Regional Case Study

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Abstract
Technical textiles and other high-value goods are seeing rising demand on international marketplaces. Many nations have shifted their manufacturing focus to these items in the last decade in an effort to boost their economic standing and compete on a global scale. This study seeks to shed light on the current state of the textile industry in Türkiye, specifically in Bursa, one of the textile hubs, and its shift towards technical textiles with higher value-added products. We take a look at the current product trade volumes around the world, import-export statistics, and Türkiye's standing in this field. Also covered are the latest developments in the industry as well as the state of the market for technical textiles. Technical textile exports to international markets reached almost $118 billion, up 3.38 percent from the previous year. The total value of Turkish exports in 2021 was 2,413 billion dollars, down 12.91 percent from the previous year. The results of the Grubel-Lloyd Index calculation for the technical textile product groups in Türkiye show that, with a few exceptions, intra-industry trade is bidirectional. All technical textile products had an average index value of 0.7968. The twelve main types of technical textiles are based on the many uses they serve. By 2028, the Mobiltech, Indutech, and Packtech subcategories of technical textiles are expected to have the most significant trade items.

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

1. Introduction

As compared to more traditional textile products like ready-made garments, upholstery, and home textiles, the demand for technical textiles is steadily rising [1–10]. These products stand out in global markets due to their unique physical and functional qualities and performances. A growing number of end users in sectors including agriculture, construction, healthcare, transportation, packaging, sports, environmental protection, protective apparel, and more are driving the technical textile market forward [11]. When it comes to the manufacturing and export of technical textiles, Türkiye continues to rank among the world's top nations, and its export rates are even going up [12–14]. Technical textiles have a higher added value than conventional textile products [15], and as new technologies are developed for their production, along with an increase in qualified personnel, the competitive power in global markets is expected to rise. Manufacturers are expected to ramp up their search for new markets as the expectations that the COVID-19 pandemic's impact on demand and supply will come to an end this year and the changes brought about by international agreements relevant to Türkiye, like the European Green Deal [16], become more apparent. The goal of conducting market research and analyzing export potential is to find solutions to a few critical questions using a predetermined set of methodologies. This strategy relies on combining three distinct methods; it is known as "Data Triangulation" [17]. To begin, according to the 'Top-Down Approach' [18], it is necessary to provide the current numbers and ratios for the technical textiles market share and volume [19–21] in Türkiye and globally. This will help exporters get a better picture of the industry while also providing a broad overview of the market. In contrast, the 'Bottom-Up Approach' involves finding the possible export markets for each of these high-value technical textiles in Türkiye by examining them individually with their six-digit codes (GTİP) as defined in the Harmonized System. The identification of these markets forms the basis of this research.

Contrarily, the qualitative data approach combines the numerical data shown by other methods with insights gained from fifty in-depth interviews with important stakeholders, including unit directors, academics, development agencies, and manufacturers involved in the sector for market research. During the in-depth interviews, we asked key players a range of questions about their predictions for the future of the technical textiles industry, the technological trends they think will be most prominent, and the goals that Turkish manufacturers should strive for in order to compete on a global scale. We then analyzed the responses with numerical data. The emphasis is also placed on market trends that, according to analysis reports from international organizations, will show which product groups the technical textiles market is heading towards. Concurrently, a SWOT analysis [22] has been prepared to examine the opportunities and threats facing Türkiye as well as its strengths and weaknesses in these domains. This analysis is also assessed alongside the insights derived from the qualitative data in line with our methodology. Lastly, Türkiye's intra-industry trade balance in technical textiles was measured for 6-digit sub-product groups one by one using the Grubel-Lloyd index [23, 24]. Whether a country is involved in one-way or two-way trade in product groups is revealed by this index, which takes a value between 0 and 1, as will be explained in detail below. A product group's index value approaching zero indicates unidirectional trade in terms of imports or exports, while an index value close to one indicates nearly equal amounts of imports and exports of the same product. Theoretically, the trade in that group of products is getting better as the index value gets closer to 1 [25-27]. The research also made use of the Grubel-Lloyd index to identify possible export destinations. To identify countries with export potential, we looked at technical textiles product groups and identified those with higher imports than exports (i.e., an index value close to 0 for imports). In order to help technical textiles manufacturers find new markets, this study will show them where those markets could be. We talk about the technical textiles groups where Türkiye has the most export potential and the countries where such exports can be realized to a higher level. Consequently, the study's contents also show how Türkiye can excel in technical textiles. Concurrently, it seeks to aid in the discovery of new product categories by revealing technological and commercial tendencies within these product groups.

2. Methodology

A comprehensive methodology for performing market analysis of technical textiles in Türkiye and globally, using data collection, GTIP codes, per kg prices, import-export balancing, and Grubel-Lloyd index had been carried out. Data was collected from various sources, such as industry reports, market research reports, trade publications, government agencies, and company websites. The collected data included information on the technical textiles market, such as production, consumption, trade volumes, and pricing. GTIP (Harmonized System) codes were used to classify technical textile products into specific categories. The codes were used to identify the specific products being traded, their origin, and destination. Prices/Kg for technical textiles products were collected from various sources, including customs data, industry reports, and trade publications. The prices were used to analyze the competitiveness of technical textiles products in the global market. The import and export data for technical textile products were collected from various sources, including customs data and trade publications. The data were used to determine the trade balance in technical textiles products between Türkiye and the rest of the world. The Grubel-Lloyd index was used to measure the intra-industry trade in technical textile products between Türkiye and the rest of the world. The index was used to determine the degree of specialization and competitiveness of Türkiye in the global technical textiles market.

Using these methods, a comprehensive market analysis of technical textiles in Türkiye and globally was conducted. The collected data was used to identify the major players, market size, and trends in the technical textiles market. The GTIP codes were used to classify technical textiles products, and per kg prices were used to evaluate the competitiveness of these products. The import-export balancing and Grubel-Lloyd index were used to analyze the balance of trade and the degree of competitiveness of Türkiye in the global technical textiles market.

3. Industry Trends and Highlights for Project Studies

Below is the information in interlinked areas based on the cluster and value chain analysis, segments are selected in relation with identified areas in which products and competences of Bursa Technical Textile and Composite Materials Cluster companies are related to.

3.1. Mobiltech Textiles

Mobiltech textiles refer to a specified area of technical textiles used in the automotive or transportation sector. Mobiltech means the Textiles Technology Integrated with Automobile, are known as Mobiltech textiles. Mobiltech is also known as Mobiltex. It includes a wide range of applications in automotive and its components (including aerospace, aircraft, railways, and marine vehicles). It covers not only the isolation and protection aspect! But also concentrate on style and comfort.

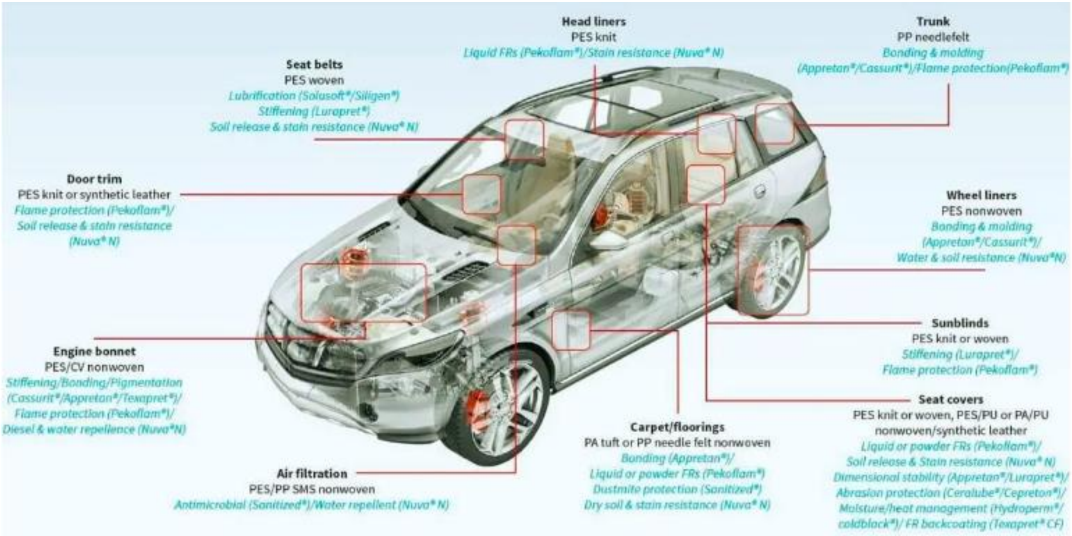

Fig. 1. Application in Automotive Industry [28]

Automobile textiles used in the car to ship, railway to the aerospace industry. Everywhere seems to play a vital role. Here, Mobiltech Applications in Automotive Industry are as follows [29]:

Table 9. Mobiltech Application in Car Industry

Application	Area of Uses	Textiles Integrated Technology
Seat	Back fabrics, bolster fabrics, Construction Reinforcements, Trim or Toe Kick, Decorative Fabrics	Hydro-entagled Needle Punch, Spunbonded, Natural fibers, and other sysnthetic fibers
Door	Lower facings, panel trim (door insert or bolster)	Needle punch, spunbonded
Insulation	Acoustic, thermal resistence	Needle punch, spunbonded
Headliners	Facing, backings (including mold release applications) Substrates	Needle punch, spunbonded
Hood Liners	Facing, backings (including mold release applications) Substrates	Spun bond, resign, needle punch
Rear Shelf	Facings or Backings	Needle punch
Trunk	Trunk liner, reinforcement, load floors, decliners, seatback fabric fold-down seat, under the package	Spun bond, Needle punch
Carpet	Carpet, primary backings, secondary backing	Spun bond, needle punch

3.2. Automotive Plastics Market

The global automotive plastics market was valued at USD 21.1 billion in 2021 and is projected to reach USD 30.8 billion by 2026, growing at a CAGR % 7.9 from 2021 to 2026. Maximum mass reduction potential, significant emission reduction, and enhanced vehicle design and aesthetics are some of the major factors contributing to the growth of the market for passenger cars.

By application; automotive plastics market is classified by interior, exterior, under bonnet and other (chassis and electric components).

By product type, the polypropylene (PP) segment accounted for the largest market share in 2020, in terms of volume. As a thermoplastic polymer, polypropylene can easily be formed into almost any shape. Polypropylene is extensively used in passenger cars for various applications, such as interior, exterior, and under bonnet components. Polypropylene, being a commodity plastic, is cheaper than other engineered plastics and, hence, preferred over other plastics by design engineers. The low-cost vehicle design requirement for engineers is usually met using polypropylene. These factors are responsible for the large share of PP in the automotive plastics market for passenger cars.

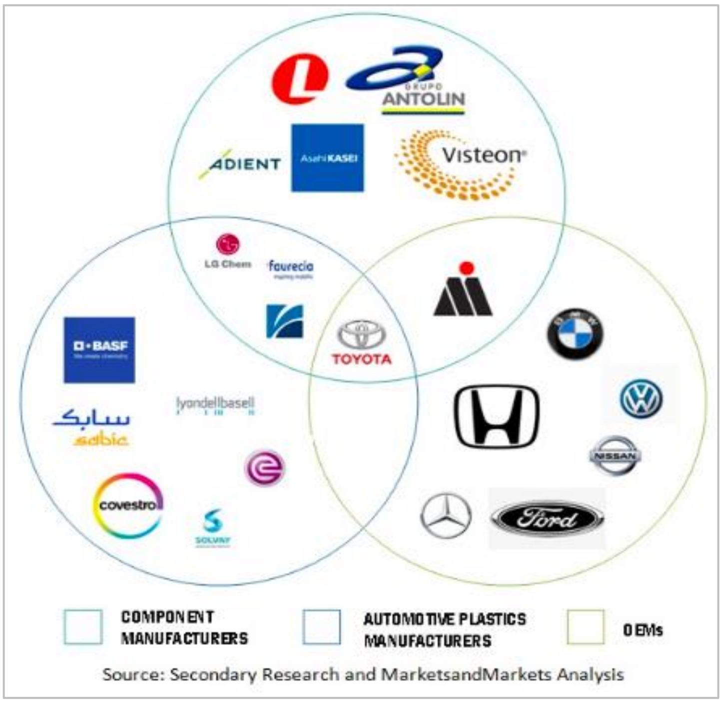

Fig. 2. Automotive Plastics Ecosystem [30]

Demand for comfort features to drive the interior applications segment in the automotive plastics market for passenger cars. By application, the automotive interior segment accounted for the largest share of the automotive plastics market for passenger cars in 2020. Interior application leads the market as plastics are being increasingly used in these applications to provide impact resistance and dimensional stability. Use of plastics in interior applications provides high durability, colour, and aesthetic appeal to automobiles.

3.3. Automotive Interior Market

The automotive interior market is estimated to be worth USD 153.5 billion in 2022 and is projected to reach USD 201.2 billion by 2027, at a CAGR of 5.6%. 2027. The market is driven increasing customer preference for convenience, premium features, and advanced safety, use of variety of lightweight and advanced materials and innovative finish, integration of smartphone connectivity, enhanced functionalities in lighting.

The interior segment includes components such as the interior lighting, interior door panels, inner door handles, window motor, door control module, door locks, interior trims, seats, seat belts, car upholstery, dashboard, infotainment systems, instrument cluster, steering wheel assembly and component, airbag, floor components and parts (carpet and other floor material), hood and trunk carpets, seals, frame, breaks and gears, cables and connector and socket.

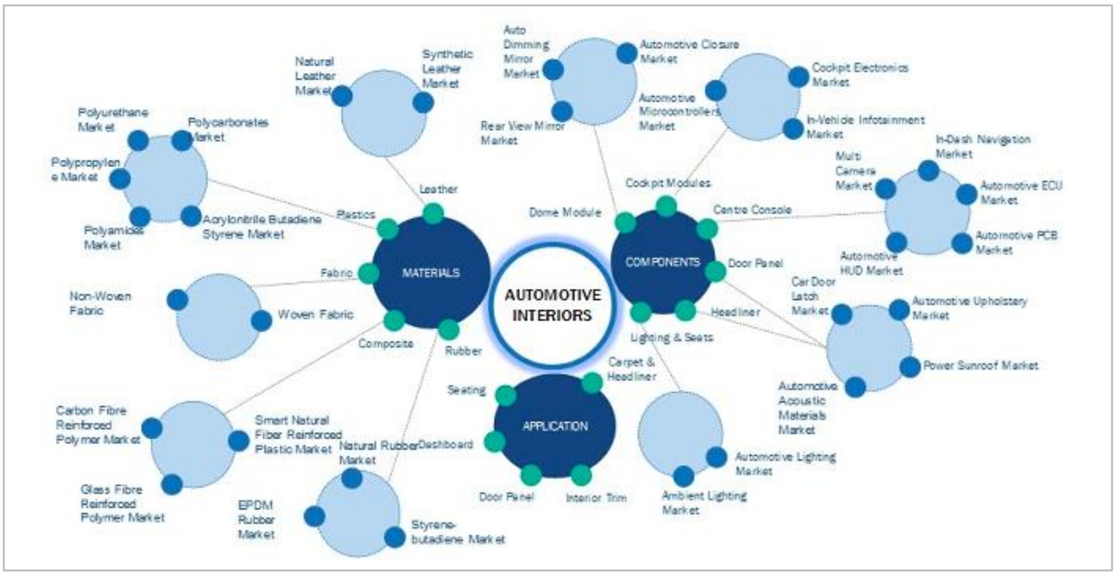

Fig. 3. Automotive Interiors [31]

The introduction of new materials and advanced technologies has enabled manufacturers to reduce vehicle weight and design interiors with greater comfort. In automotive interior components, weight reduction is mostly achieved in the seating system. Lightweight materials are quite beneficial in making vehicles more efficient. According to industry experts, around 5 – 7 % of fuel can be saved on a weight reduction around 10%.

As one of the major segments of automotive interiors; automotive upholstery market was valued at USD 6,302.50 million in 2022. The size of this market is expected to increase to USD 10,054.42 million by the year 2029, while growing at a Compounded Annual Growth Rate (CAGR) of 6.9%. The market for automotive upholstery is primarily driven by the growing vehicle production, consumer demand for in-vehicle comfort and customized automotive interiors. Leading players of this segment are; Adient PLC, Continential (Germany), Grupo Antolin (Spain), Visteon (US), Marelli (Japan), Toyota Boshoku Corporation, Faurecia SE, CMI Enterprises (JKSP Solutions), IMS Nonwoven, Katzkin Leather Inc. (Stahl Holdings BV), Lear Corporation, Seiren Co. Ltd, The Woodbridge Group.

3.3.1. Automotive Seat Segment

Automotive seat market is estimated to grow from USD 53.7 billion in 2023 to USD 58 billion in 2030 at CAGR of 1,2. The increasing stringency in safety regulations and industry standards, demand for quality, advanced features and cost effectiveness, innovation and customisation options in the seating segment, and increasing focus on electric vehicles are driving the automotive seats market. Asia Pacific and America will remain the top regional market for this product. The major OEMs of the automotive seats market have the latest technologies, diversified portfolios, and strong distribution networks globally. The major players in the automotive seat market are Adient (US), Faurecia (France), Lear Corporation (US), Toyoya Boshoki Corporation (Japan), and Magna International (Canada).

3.3.2. Aircraft Seat and Seat Upholstery Market

According to Markets and Markets research data; aircraft seat upholstery market is estimated to be 2.3 billion USD by 2027 and will be growing at a CAGR of 3.6 %. Growing demand for first and business class seats are the rising number of premium economy classes in commercial aircraft are some of the key factors driving market growth. According to same resource, aircraft seating market will be 8.7 billion USD by 2027 and will be growing at a CAGR of 6.8 % each year.

3.4. Automotive Exterior Materials Market

The market value for Automotive Exterior Materials Market was USD 14.84 billion in 2022 and is expected to reach USD 25.07 billion in 2032, growing at a CAGR of 6% during the forecast period.

Increasing demand for lightweight and durable materials, expanding production of electric and Hybrid Vehicles, and stringent fuel efficiency and emissions regulations drives the market expansion.

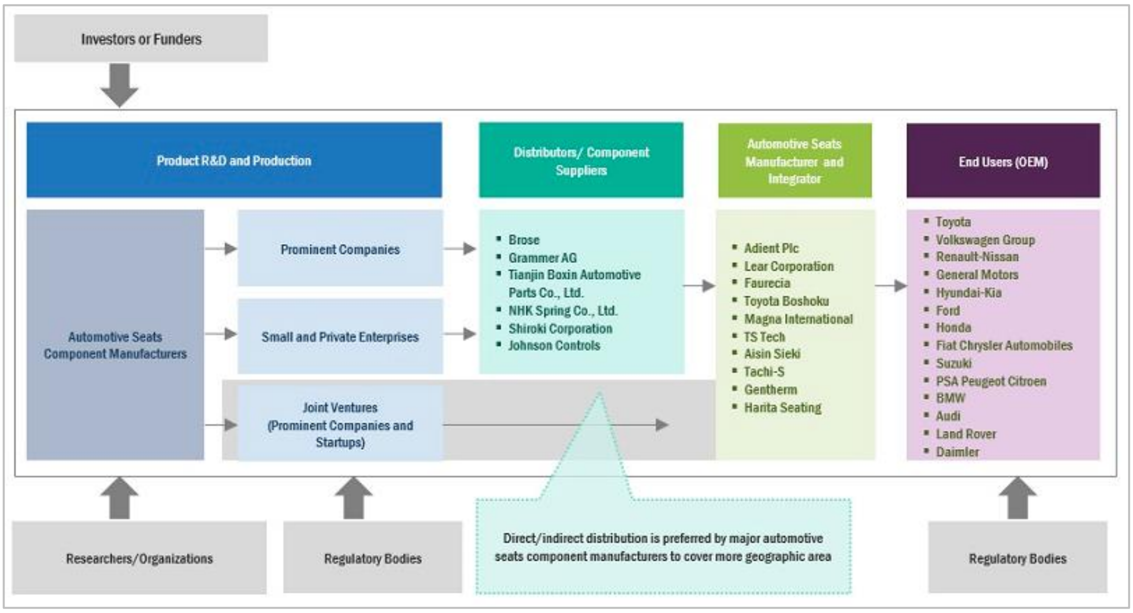

Fig. 4. Value Chain of Automotive Seats Market [32]

The automotive industry is pursuing lightweight materials to boost fuel efficiency and reduce carbon emissions. Using lightweight materials on the outside, which enhances fuel efficiency, can reduce a vehicle's overall weight. Aluminium, carbon fiber composites, and magnesium are lightweight materials extensively employed in the automotive sector. The usage of these materials not only decreases the vehicle's weight but also improves its performance and handling. Steel, aluminium, composites, plastics, glass, and other materials are the categories used to categorize the worldwide exterior vehicle materials market. Steel has been the most popular material for the fabrication of exterior automotive components. Steel is a common material for carmakers due to its strength, resilience, and affordability. Aluminium and composites are, however, gaining ground in the industry due to the trend toward lightweight vehicles and the requirement for increased fuel efficiency.

Composites – formed of a combination of two or more materials – are also anticipated to increase substantially. Composites have a high strength-to-weight ratio, better fuel efficiency, and design flexibility, among other benefits. They are increasingly employed in fabricating body panels, hoods, and fenders. Additionally, the development of sophisticated composites, such as carbon fiber composites, is further projected to fuel the growth of the composite segment in the automotive exterior materials market.

Polymers are also gaining favour in the automotive industry thanks to their lightweight and design flexibility features. They are utilized to fabricate bumpers, grilles, and other exterior components. Polymers offer various advantages, such as decreased production costs, increased fuel efficiency, and enhanced design possibilities. With the increased focus on sustainability and eco-friendliness, using recycled and bio-based plastics will likely gain traction in the automobile exterior materials market.

3.5. Automotive Material Testing

The automotive industry involves complex products that must be carefully engineered to ensure safety and performance across a variety of crucial subsystems. This imperative for meticulous engineering is only amplified by the high level of competition in the industry, which pushes automotive manufacturers to innovate constantly in pursuit of continuous product improvement. In this context, material testing takes on added importance. Materials need to be specified as precisely as possible to ensure optimal cost, weight, and performance. And testing results need to be of the utmost quality to avoid errors that could drive costly recalls (or worse, safety issues).

Along with other automotive materials testing, interior and safety testings are the most related areas with Bursa technical Textile and Composite Materials Cluster. From seat belts, to headrests, to brake pedals, every part of a vehicle interior needs to be designed for optimal usability, comfort, and safety. Automakers must navigate testing for a vast array of components including:

- **Seat and Interior Components:** Crucial seating components need to perform under extensive long-term use in operating environments that can range from sub-zero arctic temperatures to scorching desert sun. Testing processes need to cover attributes including fatigue strength for seat materials, foam hardness tests for headrests and other cushioned surfaces, and stiffness for headrests.
- **Safety Components:** Safety systems including seatbelts (with tests strictly regulated by UN/ECE-R16), air bag fabrics and connectors, and anti-pinch sealing systems for doors/windows all require an extensive array of testing capabilities to ensure reliable operation even after years of use.
- **Operational Controls:** Pedals (clutch/brake/gas), emergency break levers, and control switches all need to be precision engineered to ensure ease-of-use with optimal haptic, optical, and acoustic feedback for associated user actions. Doing so successfully requires specialized testing capabilities like curved-force actuators for pedals and specialized servo actuator grips for emergency brake lever testing.

3.6. Sustainable Materials in Automotive

One trend that becomes clear from these efforts is that car manufacturers are taking action by using resources more responsibly – be it energy, materials, or cutting down on water usage during production as Audi plans to do. While carmakers have made varying degrees of progress towards climate targets, these companies appear to recognise the need to reduce the mark they leave on the planet.

Carmakers are also raising the amount of recycled materials in their vehicles. This does not only apply to reusing key manufacturing materials such as steel and aluminium, but also recycled PET bottles, nylon yarn, and fishing nets. Mercedes-Benz wants to increase its share of secondary raw materials in its car fleet by an average of 40% by 2030, with others, including Stellantis, aiming for a minimum target of 35%.

Meanwhile, VW is no longer using chrome for trim on doors, instrument panels and steering wheel clips in the ID.Buzz, as part of plans to increase its sustainability ratio. The company is introducing more recycled materials across its electric ID family, including recycled marine debris. Sustainable materials such as bamboo fibres are also of growing interest to carmakers, while many are also exploring animal-free leather alternatives based on cactus and mushroom mycelia as well as plastic alternatives. This is significant, as experts estimate that by 2040 around 60% of automotive-industry emissions will come from materials used in production. Notably, bio-based materials can help minimise weight and increase both energy and emissions savings.

3.7. Curtains and Window Blinds

The global curtains and window blinds market is estimated to reach a revenue of USD 35 billion by the end of 2025 growing at a CGAR of 4%. Further the market generated revenue of USD 21 billion in the year 2022. The growth of the market can be attributed to growing urbanisation which is further boosting the construction activities.

The curtains and window blinds market is highly competitive, and the key players involved in the industry are Hunter Douglas Inc., Hillarys, Budget Blinds, LLC, Advanced Window Blinds, Aspect Blinds, Stevens (Scotland) Ltd., Aluvert Blinds, Decora Blind Systems Ltd, Draper, Inc., Louvolite, Segablinds, Serge Ferrari, Schenker Storen AG, Resstende S.r.l., Bandalux and Franc Gardiner.

3.8. Protective Fabric Market

Protective fabric is a textile related product that prevents the person and/or product from coming in contact with the adverse elements of the environment. Protective Fabrics Market size was expected to grow from USD 3.30 billion in 2021 to USD 4.54 Billion by 2028 at a CAGR of 4.58%.

The global protective fabrics market is expected to grow in the near future, attributed to increase in demand from end use industries such as building and construction and healthcare industry. Rising concern for industrial workers safety also drives the market for protective fabric. By raw materials protective fabrics can be made of aramid, polyamide, PBI, Polyester, polyolefin, cotton fiber etc. By type protective fabrics can be classified as heat and fire resistant, cold resistant, chemical resistant, UV resistant, ballistic and mechanical resistant, chemical resistant. 3M, DuPont, Lakeland, Glen Raven, Milliken & Company, Klopman International, Concordia Textiles, TenCate Protective Fabrics, Teijin Limited are among the key industry players.

Key players operating in the global composites market include DuPont de Nemours Inc, Gurit Holding AG, Hexion Inc, Mitsubishi Chemical Holdings Corp, Nippon Electric Glass Co Ltd, Owens Corning, SGL Carbon SE, Teijin Ltd, Solvay SA, and Toray Industries Inc. Players operating in the global composites market focus on providing high-quality products to fulfil customer demand.

3.9. Highlights from Project Studies

The 3D weaving manufacturing technology led the market for technical textiles and accounted for more than 23.7% share of the global revenue in 2021. The demand for 3D weaving technology-based products in construction, ballistic, automotive, marine, and other application industries is driving segment growth and is expected to dominate the market. 3D knitting manufacturing technology is estimated to account for a volume share equivalent to 8,917.4 kilotons in 2021 as it finds application in 3D shaped dimensionality which is found in knit structures and weft knitting. Moreover, the increasing application of 3D knitting in the construction and civil engineering segment is expected to propel market growth. 3D Weaving dominated the technical textiles market with a share of 23.7% in 2021, owing to its wide on automotive, aerospace, military, medical & healthcare application industries.

Thermoforming manufacturing technology was estimated to account for USD 22.8 billion in 2021. This is attributed to the increasing application of the same in automotive, aerospace & aviation, business machines & equipment, and others. In addition, it is highly used in the medical and healthcare sector for packaging blisters and other medical equipment. Several other technologies such as nanotechnology, finishing treatments, and heat-set synthesis, among others, are used in the market to improve the overall appearance, size, and strength of the product. Moreover, increasing the use of nanotechnology in product manufacturing further improves the property of the product such as texture, durability, and colour. The future of the technical textiles sector in Bursa and Türkiye is influenced by global developments. Two of the most influential are “Sustainability” and “Industry 4.0”.

3.10. Sustainability

In the 2030 Agenda for Sustainable Development, the 17 Sustainable Development Goals were established by the United Nations in 2015 and describe necessary worldwide developments to achieve a better and more sustainable future for all. The most relevant ones for the technical textiles industry are goals 9 (Industry, Innovation and Infrastructure), 11 (Sustainable Cities and Communities) and 12 (Responsible Consumption and Production).

For the technical textile industry, sustainability sets new requirements on the choice of raw materials, production processes and design of existing and new products. Raw materials used for technical textiles need to be sustainable and can no longer be based on non-sustainable fossil sources such as crude oil. Instead, the most abundant source of sustainable raw materials, agriculture, needs to be used. There will be a trend towards using more naturally occurring fibres such as cotton, jute, flax, etc., as well as semi-synthetic cellulose-based polymers such as viscose for technical textiles. Synthetic fibres used for technical textiles will need to be made from monomers sourced from sustainable sources such as agriculture. Some commonly used polymers such as PET and PE can be made from bio-based monomers, but new polymers such as polylactides (PLA), poly(hydroxy alkanoates) (PHAs) and poly(ethylene 2,5-furandicarboxylate) (PEF) will also be introduced. These new polymers have new properties, and the technical textile industry will have to adapt to them. The share of raw materials obtained from recycling of previously used products that have reached the end of their life will increase; these raw materials may not have the same quality as newly sourced raw materials, which will affect their properties.

In addition, the production process also needs to be sustainable, which means that sustainable resources such as renewable energy and bio-based auxiliary materials such as treatment agents, dyes, etc. will have to be used, and their use minimised. The production process also needs to minimise waste generation by optimising the process and introducing additive manufacturing where possible.

Finally, the final product needs to be designed with recycling in mind, so that after the end of its useful life, it can be reused for other purposes or converted back into raw materials for the same or other products ("cradle to cradle"). The product needs to be designed such that it can be separated into different parts that can be easily reused or recycled, with a minimum number of different parts that need to be reused or recycled separately and no parts that cannot be recycled because they contain components that cannot be separated.

We expect that the customers of the new centre will need services to help them with:

- The introduction of new bio-based raw materials for their products
- The introduction of new bio-based auxiliary agents in their production process
- Optimization of the production process, minimizing raw material and energy use and waste production
- New product design according to "cradle to cradle" principles
- Life Cycle Assessment services, also because the technical textile producers will be required to provide these assessments to their customers.
- Market research services for their new sustainable products.

3.11. Digitalization and Industry 4.0

The third industrial revolution, that of digitalization, is taking a new turn with the fourth revolution, that of interconnectivity, data power and artificial intelligence (Industry 4.0). The technical textile industry and Composites sector need to adapt to these revolutions and needs to take advantage of their opportunities to stay competitive by adapting them into the production process and into the products they make. Production will need to be further automated by introducing connected devices that use AI to optimise production (both quantitative and qualitative). Production also needs to be able to adapt to the individual needs of each customer. It may be attractive to introduce Industry 4.0 functionalities such as Internet-of-Things into new products as well as automation of material preparation and production and finishing of final goods. The business models used may also be innovated from other similar CISOP projects either that are completed or being carried out in other cities of Istanbul and Denizli in technical textiles and composites industries relevant subjects.

The introduction of new digitised production processes, optionally using interconnected production devices and AI. These services may be offered in cooperation with Bursa Model Factory which is also working in the fields of digitalization of production methods and application of lean management styles in manufacturing in various industrial sectors of Bursa.

3.12. Highlights from "Use of Composites and Technical Textile Materials in Construction for Earthquake Resistance Structures" Workshop and Action Plan

The Action Plan Workshop has been held on 8 and 9 June 2023. Main issues have been discussed among participants of the workshop. The following statement has been accepted as the General Purpose statement to form the basis of the studies and Action Plan "Sustainably increasing the use of composite materials and technical textiles in the construction of new earthquake-resistant buildings and strengthening of existing buildings in Türkiye, especially in earthquake zones".

4. Conclusions

Discussions and recommendations were moderated in three main headings:

- Techniques, Standards and Legislation,
- Collaboration, Education and Awareness Raising,
- Production and Supply Chain.

Following SWOT Analysis work undertaken in each topic, recommendations were collected. Below are the recommendation sections from the workshop report.

Techniques, Standards and Legislation: The most prominent issues in the legislation are the preparation and certification of product standards. In field for implementation tensile and adhesion testing has to be mandatory. Testing of materials arriving at the construction site, housing stock, making arrangements to reduce risk, and assigning competent and experienced engineers in building inspection were other issues emphasized.

Regarding policy, the recommendations include the adoption of earthquakes, disasters and especially risk reduction as the top priority issue of our country by politicians and the public, and the establishment of the Ministry of Disasters in this context. Under the heading of projects, the development of alternative strengthening approaches by determining the type of buildings to be retrofitted in the pilot provinces with the working groups to be formed has emerged as an important issue. On the other hand, other issues emphasized were the establishment of a scientific board to increase cooperation and coordination and the provision of extensive training to practitioners in the field.

Collaboration, Education and Awareness Raising: It is recommended to develop the relevant legislation under the guidance of public institutions in building reinforcement, to develop standards for the products used, project design and application, to increase inspections and introduce deterrent penalties to prevent bad practices. Undergraduate and graduate programs and curricula should be created in cooperation with the composite and technical textile industry and universities. The development of research projects should be supported. Intermediate levels of vocational and technical education need to be shaped by defining qualification criteria, including post-graduation. Vocational training and application training should be organized in cooperation with the chamber of civil engineers and the sector. Sectors should cooperate more comprehensively to ensure the right application with the right materials in the right projects. Experienced and more knowledgeable experts in the field of reinforcement should be appointed in relevant public institutions. Cooperation mechanisms that bring all stakeholders together should be established. Adequate financial support should be provided to R&D projects and strengthening efforts and joint studies should be supported. Cooperation should be developed with countries that have managed to strengthen their power. It is also recommended to establish a Ministry of Disasters for the coordination of all activities regarding earthquakes.

Production and Supply Chain: It has been stated that public supports should be increased in order to increase the production capacity, which will be insufficient in the face of the increasing demand for reinforcement, and the public should assume a serious role in this regard. It has been stated that government support is needed not only for technical textile and composite materials, but also for increasing the production capacity and quality of carbon fiber, which is an important raw material. In the incentive package regarding reinforcement, it would be beneficial to include support not only in the construction field, but also in technical textiles and especially in the field of reinforcement, for companies producing in the field of reinforcement. It has been suggested that in addition to increasing investment incentives in the field of R&D and production, measures should be taken to protect domestic production against imports. It was emphasized that the public should increase R&D and innovation supports for new product development.

In response to the increasing demand in the field of reinforcement, it has been stated that the curriculum should be developed and new departments should be opened in vocational high schools and engineering education in order to eliminate the inadequacy in the quality and quantity of personnel who will apply in this field. Similarly, it has been suggested to improve education on technical textile and composite material production. On the other hand, it is envisaged that it would be appropriate for manufacturers to provide material training to practitioners. It has been stated that these trainings should be at international standards. It has been stated that quality control and tests should be disseminated both during the production process and during reinforcement applications and standards should be determined in this field. It has been proposed to establish a ministry (Ministry of Earthquake and Disaster) that will play a leading role in determining training contents, coordinating and directing applications, and conducting quality control tests and inspections. In addition, one of the prominent issues was the creation of multi-disciplinary NGOs to strengthen coordination and cooperation and the establishment of working groups that will bring together the public and private sectors. Additionally, it has been suggested to establish a "thermoset recycling facility" for environmental protection.

In the action plan section of the document there are responsibilities attributed to BTSO, BUTEKOM and BUTEXCOMP:

- BTSO: Preparation and implementation of a project to determine typical buildings in selected pilot provinces and to develop solution examples and alternative approaches for reinforcement, especially composite materials and technical textiles, by establishing a scientific committee and working groups,
- BTSO: Increasing public awareness about the importance, effectiveness and efficiency of building strengthening in reducing loss of life and property in earthquakes,
- BTSO: Creation of reinforcement cluster with fibrous polymers,
- BUTEKOM: Preparation and publication of publications showing correct and incorrect practices regarding composite materials or technical textiles,
- BUTEKOM: Establishing R&D collaborations on composite materials and technical textiles in buildings in cooperation with industry, civil society and universities,
- BUTEXCOMP: Organizing training courses (application-oriented) in certified international standards by BUTEXCOMP in the existing center,
- BUTEXCOMP: Quality Control Testing of materials to be used in building reinforcement at international standards,
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