

Clusters analysis in technical textiles and composite materials sector: a regional case study

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ABSTRACT – REZUMAT

Clusters analysis in technical textiles and composite materials sector: a regional case study

This study was carried out as a cluster analysis for the Technical Textile and Composite Materials Cluster in the Bursa region of Türkiye. The study seeks to establish a solid foundation for the initial phase of cluster development in Bursa and for future stages, particularly the formulation of the cluster strategy and execution plan. The study's industrial scope encompasses technological textiles and composite materials due to Bursa's advanced enterprises and robust infrastructure, which enable it to specialise in several areas and emerge as a global industry hub. Cluster analysis examines the components of the Diamond Model to establish a foundation for a strategic outlook on the future. The SWOT part provides a concise overview of the main concerns, followed by the concluding sections introducing the initial vision statement and important strategic areas for future actions.

Keywords: composite materials, technical textiles, clusters analysis, Bursa

Analiza clusterelor în sectorul textilelor tehnice și materialelor compozite: un studiu de caz regional

Acest studiu a fost realizat ca o analiză a Clusterului Textilelor Tehnice și al Materialelor Compozite din regiunea Bursa din Turcia. Studiul urmărește să stabilească o bază solidă pentru faza inițială de dezvoltare a clusterului în Bursa și pentru etapele viitoare, în special formularea strategiei clusterului și a planului de execuție. Scopul industrial al studiului include textilele tehnologice și materialele compozite, datorită întreprinderilor avansate și infrastructurii robuste din Bursa, care îi permit să se specializeze în mai multe domenii și să devină un hub industrial global. Analiza clusterelor examinează componentele "modelului diamant", pentru a stabili o bază pentru o perspectivă strategică asupra viitorului. Analiza SWOT oferă o imagine de ansamblu concisă a principalelor preocupări, urmată de secțiunile finale care introduc declarația de viziune inițială și domenii strategice importante pentru acțiunile viitoare.

Cuvinte-cheie: materiale compozite, textile tehnice, analiza clusterelor, Bursa

INTRODUCTION

Cluster thinking has significantly improved the economic policy agenda, academic circles, and the corporate world over the past thirty years [1]. Clusters refer to agglomerations of enterprises and organizations operating in the same industry, located in close proximity to one another, and linked by shared characteristics and distinctions [2]. These clusters have the potential to collaborate and generate synergistic effects [3]. A search conducted on Google in February 2015 for 'Cluster Competitiveness' yielded 14900 results. The resulting pages are primarily from renowned institutions such as the World Bank, as well as institutions that promote clustering, such as the US Cluster Mapping Project and the European Foundation of Cluster Excellence. Michael Porter is widely credited for the tremendous popularity of clusters and their correlation with competitiveness. Porter emphasized that the fundamental source of competitive advantage is located inside clusters [4]. The World Economic Forum (WEF), an organization that regularly assesses the economic environment of prominent countries globally, regards the role of clus-

ters as a significant factor in national competitiveness. According to the annual Global Competitiveness Report (GCR) by WEF, the level of cluster development in a country is considered as a factor within the pillar of "business sophistication". The business sophistication and innovation pillars are the most critical components of the WEF's Global Competitiveness Index. The intensity of interest in clusters can also be measured by the connections the notion has with a diverse range of current happenings. Cluster development is seen as a solution to the common issue of the "missing middle" problem that small and medium firms (SMEs) face in developing countries [5]. Clusters have been identified as catalysts for promoting regional innovations and globalization in certain instances. The concept is captivating, garnering the interest of governments as a policy tool and corporations as a strategic choice. The concept of promotion is being widely adopted by governments in the majority of countries. The literature extensively covers studies on cluster development from both advanced and emerging economies. Zeng attributes the remarkable rise of China over the

past four decades to industry clusters, providing an illustrative illustration of their influence [6]. China's ranking as the second country in cluster development, following Italy, which was the first to deploy clusters (formerly known as industrial districts), among 144 nations in the World Economic Forum's Global Competitiveness Report (2014–2015), serves as evidence of this fact. The development path of a rising country such as China exemplifies the brilliance of Michael Porter's concept of clusters as the driving force behind the competitiveness of states, regions, and industries. There is only a limited amount of analysis on the competitiveness of clusters [7]. The majority of studies conducted on clusters are predominantly unidirectional [8].

As to the WEF, a nation's competitiveness refers to the collection of institutions, regulations, and factors that affect the country's degree of production. Porter conceptualized clusters as the fundamental basis for increased productivity [9]. Clusters can be defined as a subset that is part of the nation. Clusters can be seen as a condensed representation of a country to assess competitiveness. This is because they effectively incorporate local institutions, policies, and influences, which can subsequently be expanded to the national level. Therefore, it is crucial to quantify the competitiveness of clusters to understand the overall competitiveness of a nation [10].

We conducted regional and global market research and added value analysis on technical textiles [11] and composite materials [12] in our past studies. Our study indicates a rising demand in global marketplaces for high-value-added items like technology textiles. In the past ten years, numerous countries have revamped their production systems to prioritize the manufacturing of these items to enhance their economic competitiveness internationally. Global exports of technical textiles totalled over 118 billion dollars, reflecting a 3.38 percent growth from the previous year. Türkiye's exports in 2021 totalled \$2.413 billion, marking a 12.91% reduction from the previous year. The Grubel-Lloyd Index calculation for technical textile product groups in Türkiye indicates bilateral intra-industry trade, with few exceptions. The mean index value for all technical textile items was computed as 0.7968. By 2028, Mobiltech, Indutech, and Packtech subcategories of technical textiles are projected to be the leading sectors in the commercial market.

The need for high-value composite products, such as technological textiles, is rising in today's global markets. In the past ten years, numerous countries have changed their manufacturing processes to focus on these items to enhance their competitiveness in the global economy. Türkiye's composite material exports grew by 19.48% in 2021 compared to the previous year, totalling 2.7 billion lire. 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 [13]. The technical textiles and composite industry have been shown to have a substantial impact on the global economy due to aspects like as production prices, technology, product quality, innovation, and sustainability, as indicated by this study. The technical textiles and composite industries' growth and success rely on their capacity to convert competitive attributes into value-added goods. Value-added goods are differentiated from commodity goods by providing unique features, functionalities, and benefits. This enables enterprises to increase prices and generate greater profits.

In addition, in the first part of this study, the main participants, skills and areas that need to be developed within the Bursa Technical Textile and Composite Materials Cluster ecosystem were determined. It laid the foundation for the next stages of cluster development in Bursa, especially in terms of formulating the cluster strategy and implementation roadmap.

Within the scope of this study, it was prepared as a cluster analysis for the Technical Textile and Composite Materials Cluster in the Bursa Region of Türkiye. The study provides a concrete basis for further steps in the first stage of cluster development in Bursa, especially for the development of the cluster strategy and implementation roadmap. Information is provided on regional factors that have an impact on cluster development.

METHODOLOGY

Cluster analysis is crucial for assessing and positioning the competencies of a cluster about future trends and directions, to provide a competitive framework for both the cluster and its enterprises. Technical textiles and composite materials industries are highly fragmented and have complicated value chains. A thorough grasp of the industry structure, an integrated strategy, and an analysis of industry trends are essential. Before utilizing established tools like value chain analysis and M. Porter's Diamond framework, it is essential to comprehend the primary factors influencing the sector. This document has utilized a customized and well-organized analysis framework to examine the cluster environment and industry based on process, material, application, and technology (figure 1).

The study utilizes three primary analysis tools: i) desk review, ii) value chain analysis, and iii) cluster analysis (figure 2). The results of these analyses have

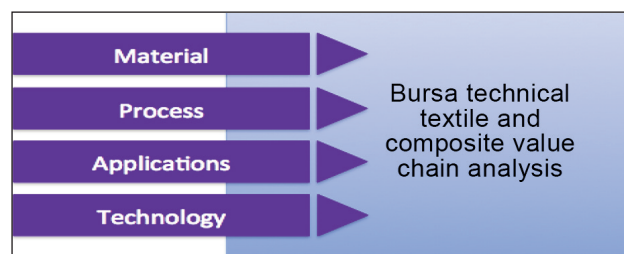


Fig. 1. Value chain analysis context

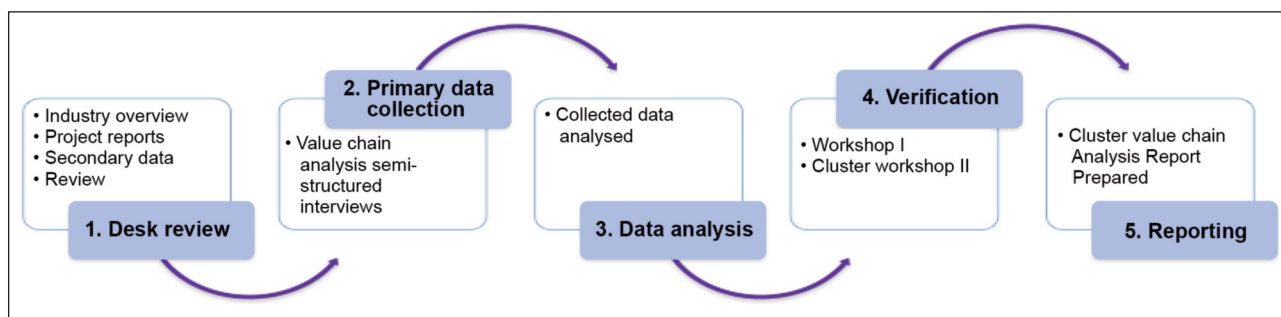


Fig. 2. Workflow

been examined and structured in the procedure given below.

Desk review

This study aims to analyse the industry structure and gain a comprehensive understanding of the industry through defining market categories, market size, and growth. The project evaluated and merged previous analyses and reports into pertinent portions of the study to provide an industry overview and assess the present situation of the sector in Bursa. Desk review, as a form of secondary data gathering, offered valuable insights for designing and developing tools to achieve the study's objectives before moving forward with subsequent steps.

Primary data collection

The main method used for obtaining primary data in this study was Value Chain Analysis. A customized project has been created to align with the industry framework. Primary data was gathered by creating a survey sheet and conducting semi-structured interviews with companies and stakeholders. During the study, 57 companies and significant stakeholders were interviewed.

Data analysis

It involved the examination and manipulation of primary and secondary data using various sector and cluster methods. Value Chain Analysis, Porter's Diamond, and SWOT analysis were employed to analyse the gathered data. A value chain map draft was created.

Data verification

It involved presenting the analysis results and draft value chain, which were then discussed in two workshops. Key competencies and opportunities for development were identified through a value chain map, and the results of the analysis were confirmed.

Reporting

The finalized value chain map was based on collected data, analysis, and input from stakeholders and cluster enterprises, and reporting work was carried out.

Bursa Chamber of Commerce and Industry (BTSO): BTSO aims to meet the common needs of its members, facilitate their professional activities, ensure the

development of the sector, ensure the superiority of honesty and trust in the interaction of members with each other and with the public, and maintain professional discipline and harmony (Türkiye).

Bursa Technology Coordination and R&D Centre (BUTEKOM): To lead the work in national and international organizations (fairs, seminars, R&D project markets, etc.) and to convey the information in the organizations to corporate and expert members (Türkiye).

Bursa Technical Textile and Composite Materials Cluster (BUTEXCOMP): Bursa Technical Textile and Composite Materials Cluster is an innovation cluster that brings together companies producing textiles, technical textiles and composite materials, sub-industry companies, academic and research institutions and public institutions, reflecting the entire sectoral value chain (Türkiye).

CLUSTER ANALYSIS

Cluster concept and terminology

Clusters can be characterised as geographically limited critical mass of strongly interdependent firms (i.e. sufficient to attract specialized services, resources and suppliers), knowledge-producing agents (universities, research institutions), and bridging institutions and customers, have relationships and are linked to each other in a value adding production chain [14]. Porter also describes a cluster as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities". According to Porter, it is clear that clusters are dependent on informal contacts, which are based on trust and reciprocity. Equally, the transfer of ideas and a common labour pool enhances competition and reinforces the competitive advantage of the cluster as a whole.

Another definition has been published by the European Cluster Collaboration Platform, which emphasises cluster scale and specialised expertise of industrial clusters. According to this definition; "Industrial clusters are groups of firms, related economic actors, and institutions that are located near each other and have reached a sufficient scale to develop specialised expertise, services, resources, suppliers, and skills".

There is an important issue that shall be highlighted before moving on to the details of this report. First of

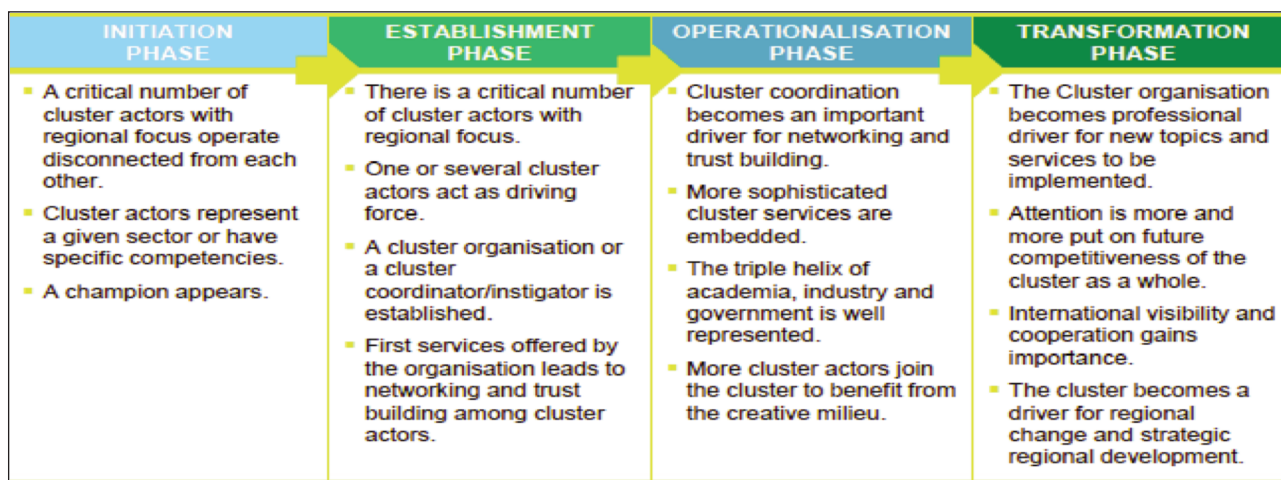


Fig. 3. Four stages of cluster development [15]

all, a “cluster” is quite different from a complete sector in two ways: (a) it includes support agencies and key supply-chain companies and organisations; and (b) it usually splits up a sector to focus on specific distinctive sub-sectors, especially product or market-based. These differences between a “cluster” and a “sector” have implications for cluster development. The challenge is to develop effective strategies – ones that reflect an understanding of the complexities of cluster dynamics in a changing world.

The cluster analysis study was mainly based on Michael Porter’s Diamond of Competitiveness. Critical to Porter’s analysis of clusters are the dynamic effects created by the interaction of industry and place. Porter attributes the success of local cluster development in the global economy to the following set of factors:

- **Factor conditions:** include access to a pool of skilled workers, availability of physical infrastructure, basic research, and applied technology, sources of capital that are tailored to the needs of particular industries. Factor conditions support the development of the cluster.
- **Context for firm strategy, structure and rivalry inside the cluster:** The benefit of domestic rivalry is the pressure it creates for constant upgrading of the sources of competitive advantage.
- **Demand conditions:** level of sophistication and demand of consumers. Clusters may develop where the presence of the home market stimulates the development of and fosters competitive advantage among suppliers. According to the cluster theory, three broad attributes of home demand have an impact on the competitiveness of clusters: (1) Composition of home demand, (2) The size and pattern of growth of home demand, and (3) The mechanisms by which a nation’s domestic preferences are transmitted to foreign markets.
- **Related and supporting industries:** internationally competitive home-based suppliers create advantages in downstream industries in several ways. First, they deliver the most cost-effective inputs in

an efficient, early, rapid, and sometimes preferential way.

- **Government:** government at all levels has an influence on the business environment and the innovative potential of clusters: i) improves the quality of basic inputs that firms draw upon, such as human resources, physical and technological infrastructure and capital; ii) creates rules, regulations and incentives that encourage innovation and upgrading; iii) build upon and reinforce the formation of local clusters.
- **Institutions for collaboration:** institutions for collaboration are formal and informal organisations and networks that: i) facilitate the exchange of information and technology, ii) foster various kinds of collaboration and cooperation that can improve the business environment in a cluster [4].

It is also highly important to bear in mind that clusters are evolving systems. Starting from the analysis stage, the establishment of the cluster, and developing and implementing the cluster road map have to be reality-based and should consider the maturity level of the cluster surrounded with its regional context. Figure 3 shows the main four stages of cluster development and the key indicators of each stage.

Cluster profile

Bursa Technical Textile and Composite Materials Cluster is an innovation cluster located in Bursa. Development of the technical textile and composite cluster is based on the strong presence of the textile, automotive and furniture industries. Textile, technical textile and composite materials manufacturing industries constitute the sectoral scope of the cluster.

Composition of the cluster

As of May 2023, number of companies participated in the cluster and value chain analysis was 57. Distribution of companies by scale is as follows 68% SMEs, 27% Large-scale companies and 5% start-ups (figure 4, a). Distribution of companies by sub-sectors is; 66.7% technical textiles, 12.26% textiles, 12.26% composite materials and 8.80% another sector (figure 4, b). Other sectors are the companies

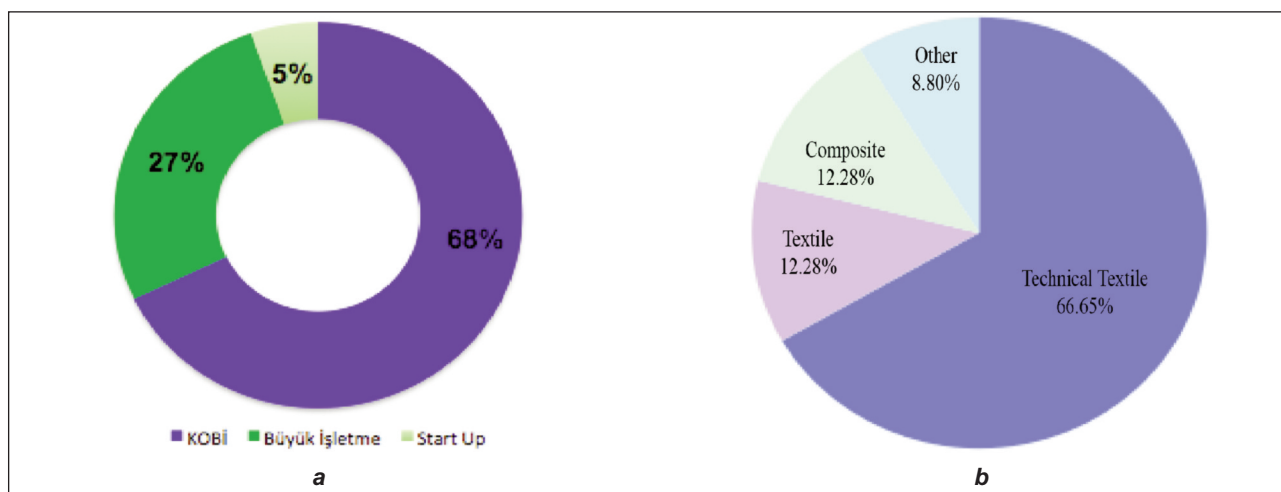


Fig. 4. Graphs of: a – Distribution of cluster companies by scale; b – Field of operation

in supporting industries, the main field of operations are chemical manufacturers and suppliers, metal and plastic manufacturers etc. As the initial stage of the cluster development below profile can be considered as the company composition of the cluster.

Along with companies, the Technical Textile and Composite Materials Cluster is well represented and supported by other actors of the triple helix. Research institutions, business support organisations, universities, development agencies and other key stakeholders are natural members of the cluster with their active involvement in the activities started by the cluster analysis and other related activities of the project. The cluster has at least 15 natural members from key stakeholders.

Cluster products and specialisation

Bursa is a province highly specialised in manufacturing textiles and apparel, especially in home textiles products; curtains and upholstery and baby and kids wear. Secondly, Bursa is one of the leading provinces for automotive manufacturing. Additionally, the manufacture of furniture products constitutes another sectoral concentration and export. Development of technical textile and composite materials is in parallel with developed industries and specialised product groups can be listed as follows:

- Vehicle seat group, trim and chassis systems,
- Functional (home, hotel, hospital) textile products including curtains made of functional textiles; i.e. acoustic and blackout curtains,
- Apparel, active wear technical textiles,
- Carbon fibre weaved textures, materials comprising reinforcement materials such as carbon fibres, glass fibres,
- Interior and exterior moulded parts for the automotive industry,
- Interior automotive textiles,
- Synthetic yarns.

Diamond analysis

Factor conditions

The strength of factors conditions in a cluster ecosystem has strong implications for cluster competitiveness.

Identification of weaknesses in factor condition parameters can constitute a basis for cluster development strategies in which different actors of the cluster can take roles. Factor conditions including the presence of a skilled workforce, innovation and research infrastructure are among the key parameters for improving competitiveness of companies and the cluster.

Bursa Technical Textile and Composite Materials Cluster have a variety of competitive advantages in terms of factors and conditions. Below are the key findings from the Cluster Analysis Field Study about factor conditions of the cluster;

- Bursa is an industrial province with a highly developed industrial infrastructure and strengthened with a skilled workforce. There are 26 OIZs Bursa home to key manufacturing industries of Bursa. (+)
- Bursa's geographical location constitutes a strong advantage for the development of technical textile and composite materials. With the strong transportation infrastructure proximity of Bursa to leading other industrial centres such as İstanbul, Kocaeli and Eskisehir, especially for automotive and aviation industries is one of the most important competitive advantages. Proximity to European markets is also another important competitive advantage. (+)
- Due to the sectoral scope of the cluster including textile, technical textile and composite materials it is not possible to identify an exact number of employments of the entire cluster ecosystem. However, the number of employees in the current composition of the cluster is more than 6360 employees (+)
- Knowledge accumulated in textile manufacturing and automotive is very high, however, findings of the analysis reveal that there is a need for improving skills, knowledge and capacity of the workforce and talents in Bursa in line with the needs of technical textile and composite materials. It is not wrong to conclude that the level of skills and knowledge of the workforce for technical textile and composite manufacturing is low. Need for improving skills of

technicians, engineers and other related staff taking role in design, manufacture and marketing of technical textiles and composite materials. (–)

- Apart from textile engineering, and chemistry faculties, the presence of polymer engineering and materials science are highly crucial for innovation and research studies to be undertaken for developing new products for technical textiles and composite materials. In this sense presence of Bursa Technical University and Uludağ University with the aforementioned faculties is highly important. However, there is a need for improving collaboration between universities and cluster companies. (+, –)
- The Bursa Technical Textile and Composite Materials Cluster ecosystem is highly competitive in terms of the presence of research institutions including BUTECOM, BUTAL and TSE. However, there is a significant need for test, analysis and certification services for companies, to leverage dependency on foreign providers. There is a need for centres to promote themselves better and introduce their services to the industry (+, –)
- The number of research studies on technical textile and composite materials in collaboration with regions' research institutions has to be increased. Several research projects such as Horizon Europe have to be increased. (–)
- The strong infrastructure of BUTECOM constitutes an important competitive advantage for running collaborative research studies; there is a need for an increasing number of studies and development of collaborative work within the cluster to activate the potential of the Centre for the transformation of the textile industry to technical textiles and composite materials. (–)
- Bursa is one of the provinces in Türkiye with an improved cluster development culture. Both institutions and companies are highly familiar with the need for clusters to increase competitiveness. (+)
- A high level of entrepreneurial culture, presence and support of Techno Parks in Bursa is one of the key competitive factors in Bursa.

Taking this factor as an advantage need to promote start-ups to be established in the technical textiles and composite materials industry. (+)

- There is a need for a qualified workforce at different levels and operations for manufacturing technical textile and composite products. (–)

For the transformation of the Bursa textile and manufacturing industry to technical textile and composite materials, the status of factor conditions constitutes a competitive environment for the development of the cluster. However, there are still essential steps to be taken, especially improving specialization in the industry. There is a need to improve knowledge of technical textile

and composite materials among companies and the workforce. There is a need for improving and upskilling both the current workforce and students in line with the increasing needs of companies for entering and manufacturing technical textile and composite materials.

In terms of developing research and innovation aspect factor condition analysis reveals that there is a need for improving collaboration projects between universities and cluster companies. Especially when it is the case for improving collaborative and joint projects in basic and applied research presence and applications for Horizon Projects gain utmost importance. To increase both the number of projects and improve specific research capacity for technical textile and composite material areas there is a need for taking steps to develop Horizon Europe Projects.

Firm strategy, structure and rivalry

As M. Porter stated in *Competitive Advantage of Nations*, “The role of domestic rivalry illustrates how the diamond operates as a self-reinforcing system. Vigorous domestic rivalry stimulates the development of unique pools of specialized factors, particularly if the rivals are all located in one city or region... Another benefit of domestic rivalry is the pressure it creates for constant upgrading of the sources of competitive advantage. The presence of domestic competitors automatically cancels the types of advantage that come from simply being in a particular nation – factor costs, access to or preference in the home market, or costs to foreign competitors who import into the market. Companies are forced to move beyond them, and as a result, gain more sustainable advantages. Moreover, competing domestic rivals will keep each other honest in obtaining government support”.

Well-understood parameters of the diamond and how these parameters work in a given cluster provide a unique opportunity to set well-established bases for developing cluster strategies (figure 5). It is therefore highly important to review the findings of the cluster analysis for the Bursa Technical Textile and

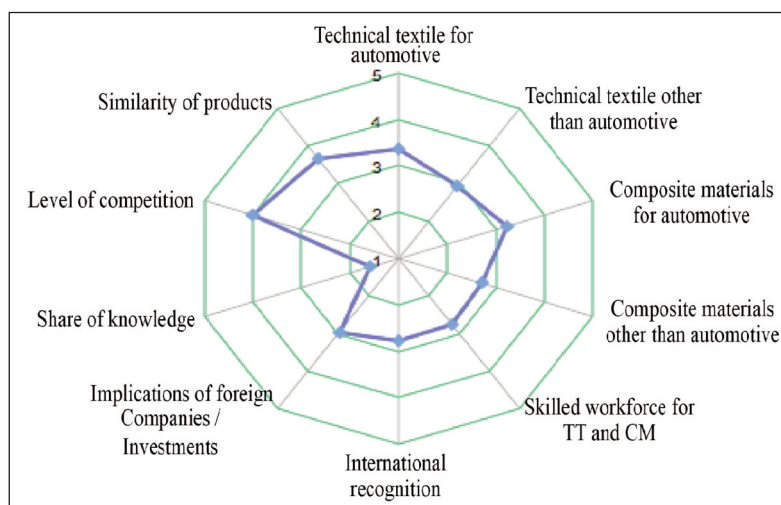


Fig. 5. Selected parameters in technical textile and composite materials competitiveness

Composite Materials Cluster. Within the scope of the cluster value chain analysis set of questions was raised to evaluate selected parameters providing insights into firm rivalry.

Companies were asked to evaluate given parameters from 1 to 5 according to the presence of each factor in Bursa. The level of similarity in cluster companies has been evaluated as 3.65, which puts relatively limited pressure on competition, by product type. The level of competition between companies was evaluated as 4.00, which can push companies to change to more innovative solutions, especially in the manufacturing of technical textiles and composite materials. Regarding the current level of technical textile and composite materials for automotive and areas other than automotive, it is seen that the current status has been evaluated under 4 points. It would not be wrong to comment that at the current stage of manufacturing technical textiles and composite materials level of competitiveness of Bursa has to be improved. Production of technical textiles and composite materials has to be increased for different application areas including automotive. Other parameters worth underlining are: i) low level of international recognition of Bursa in technical textile and composite materials production, elaborated as 2.77; ii) low level of skilled workforce, elaborated as 2.76; iii) low level of share of knowledge by 1.58. Taking into consideration the above chart, there is a need for improving the skills of the workforce, need for improving international recognition and increasing the level of knowledge exchange in the cluster ecosystem. Below are the key findings about the nature of competition in the cluster ecosystem.

- Collaboration among cluster companies towards developing new projects or a product in a new innovative area is low, however, it is seen that willingness for collaboration is high, especially for developing innovation capacity in new areas of technical textile and composite materials as well as developing new export markets. (–, +)
- Presence of network relations along with the industry value chain has been identified. Companies are working together as Tier 1 and Tier 2 suppliers of automotive OEMs. The presence of such networks among cluster ecosystems is considered one of the key drivers for competition and innovation in close collaboration with the end market side. (+)
- In line with the current maturity level, products in technical textile and composite materials are in the transition and development stage. Companies manufacturing technical textile products and/or composite materials are – mainly – also manufacturers of textile products, plastic and metal products. When it comes to competition among companies for sales of similar products, the level of competition based on product differentiation and innovation is medium. (–)
- Level of awareness and readiness among companies towards innovation for transformation to technical textile and composite materials is high. (+)

- To facilitate innovation-driven competition and collaboration among companies there is a need for increasing “critical mass” specific to technical textile and especially composite material manufacturing companies. (–)
- The level of specific and value-added technology and manufacturing infrastructure for producing specialised technical textile products and composite materials needs to be increased. (–)
- Low level of profitability in the current business model especially shaped by the global supply chain of the textile industry. Need for entering new market segments and willingness to adapt to innovation-based new business models. (–)
- Capabilities of companies have to be improved in manufacturing competence from weaving to technical textile manufacturing such as warp knitting, and improved processes such as laminating and coating (–)
- When it comes to competing internationally, one of the most important aims is as a province/cluster to be known with a specialised area at regional, national and global levels. Analysis reveals that Bursa is not known with competencies for manufacturing technical textile and composite materials globally yet. There is a need for increasing parallel manufacturing competencies and visibility of the cluster through different channels including globally known cluster and sectoral initiatives and platforms. (–)
- Need for development and investment in sample manufacturing lines, and operations within companies as well as in common-use facilities. (–)
- Findings of analysis and workshop reveal that companies need to increase their competencies in materials, need for technical training on materials and possible production areas for companies in consideration with current and new materials companies can use for productions. (–)
- There are seven companies in Bursa, a member of the Composite Industrialists Association. (+)

Key findings of the “firm rivalry” parameter, which are considered to be the basis for cluster strategy can be concluded as “need for technology adaptation and development”, “need for innovation-based business models”, “need for increasing innovation-based completion among companies” and “need for increasing critical mass of companies specialised in technical textile and composite materials”.

Demand conditions

Demand conditions have been analysed both at industry-level implications and home demand level. Presence of level of sophistication and demand of consumers is highly determinant in the development of new and innovative products in the technical textile and composite material industry. Products in most cases can carry interdisciplinary functions, which may be used in different end markets but with similar purposes. Key findings about demand conditions from desk review and cluster analysis are presented as follows:

- There are manufacturing plants of automotive OEMs such as Tofaş, and Oyak Renault. Their work with regional companies as Tier 1, Tier 2. (+)
- The number of companies as suppliers and manufacturers to automotive OEMs and the level of joint research studies has to be increased. The need for more collaborative work and development especially SMEs to integrate in the supply chain has to be increased. (–)
- Both technical textile and composite materials buyers/OEMs have to be members of the cluster and take a role in cluster development. (–)
- Bursa is one of the exporting provinces of Türkiye. Likewise, companies in the cluster are exporting their products to a wide range of countries. Experience in export is a competitive advantage for the cluster for entering markets in technical textile and composite materials-related segments. Cluster analysis also revealed that Germany is the leading export market for companies. Germany is also among the primary target export markets for technical textile and composite material products. (+)
- Bursa is home to end markets and other related clusters constituting home demand for cluster companies. These end markets are the furniture industry and the need for upholstery textiles, automotive and the need for various functional interior and exterior textile and composite materials, apparel industry and the need for functional textiles.

One of the biggest competencies of the Bursa Technical Textile and Composite Materials Cluster is the presence of home demand in the region. OEMs such as Tofaş, and Oyak Renault work with companies as regional suppliers of Tier 1, Tier 2. Their demand for sophisticated and innovative products and collaborative work with regional companies leads to faster development of specialization.

The presence of supporting industries

Related and supporting industries under this parameter have been reviewed along with the value chain of the cluster and the industry. Supporting industries in the analysis have been identified as the actors providing input materials and services mainly for core companies manufacturing yarns, textiles and composite materials. In this sense main actors identified, as supplying industries are; chemical and other finishing substances providers, resin and other service providers etc.

- Input materials manufacture of high tenacity/high-performance technical textile and composite materials play key importance in many ways, including cost, quality and diversity of the product. As stated, in initial analysis studies of the project; “Cluster companies producing technical textiles get raw materials from European countries such as Spain, Italy, and France, particularly Germany. 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”. There is a need for studies to eliminate

the risks of dependency on supplying certain raw materials from abroad. (–)

- Reinforcement materials such as acrylic, carbon fibre and glass fibres are among the key materials providing added value to products. Fibres reinforced with aforementioned reinforcement materials purchased from out of Bursa, either from İstanbul or imported. The purchase of acrylic fibres to manufacture high-tenacity yarns can be limited due to the monopoly structure of the main suppliers. For glass fibres, companies can purchase from Şişecam or one of the supplier companies in Bursa. Composite fibres can be also purchased from different suppliers in Türkiye. Supplying industry in technical textile and composite materials may be challenging from time to time both at the availability of the input material at the required volume and adequate price. Suppliers of reinforcement materials have the bargaining power over manufacturing companies. (–)
- Another group of supplying and related industry actors is chemicals and auxiliary chemical providers. The cluster has actors in Bursa providing high-quality chemical substances and finishing materials. (+)
- Resin is one of the key input materials for composite manufacturing. There is a need for increasing resin manufacturing capacity in Bursa. (–)
- Plastic and metal processing and moulding technologies, and moulding suppliers are important providers for manufacturing companies. There is a need for supporting key technologies for a better competence level. (+, –)
- Companies providing finishing services such as dyeing, and lamination have to be improved with the information, skills and manufacturing capabilities. (–)
- Support needed for access to textile machinery for technical textiles, and composite materials. This support can be in the form of financial support and advisory services for adaption and maintenance of current technology and processes (–)

Government and business support environment

Under this parameter of the Diamond, apart from the expected role of government, the presence and implications of the business support environment have been reviewed. Below are the key findings about government parameters based on cluster analysis and findings from Cluster workshops undertaken.

- Cluster development is a well-accepted approach in Bursa and BTO is a leading business support organisation for the establishment of clusters and implementation of cluster development supports such as UR-GE Projects. (+)
- Public Institutions are supporting the development of clusters in Bursa. (+)
- Presence of Smart Specialisation Strategy prepared by BEBKA. (+)
- Strong OIZ infrastructure is one of the key assets for the competitiveness of clusters in Bursa. (+)
- Strong presence and support of UIB for export development of companies. (+)

- There are incentives such as TUBITAK, KOSGEB, and Ministry of Trade that companies can benefit from, however, there is a need to apply for incentives and funds specifically designed to support the transformation of companies from textile to technical textiles. (+, –)
- Test, analyse and consultancy services provided by stakeholders including Bursa Technical University, however cluster and value chain analysis reveal that there is a need for increasing test services for meeting the needs of companies manufacturing technical textiles and composite materials. (+, –)
- Export promotion and export development supports needed for improving export capacity in technical textile and composite materials products, primary markets have been indicated as EU markets. (–)
- Need for supporting companies in sample production, prototypes and testing for preparing companies for international markets. (–)
- Exchange of know-how has to be promoted and enriched within the cluster with the help of business support organisations and especially by the cluster management body.
- In test, analysis and certification, the cluster environment has to be improved, need for tests, analysis and internationally accepted certifications in Bursa. (–)
- Need for promotion and branding of the cluster and cluster companies. (–)

SWOT

Strengths

- Cluster is based on a critical mass of textile manufacturers and historical background in manufacturing textiles and automotive in Bursa
- Presence of know-how and critical mass of automotive industry and supporting industries and close linkages with technical textile and composite materials
- Presence of competence and knowhow on functional fabrics
- High company awareness in clustering in Bursa, willingness of companies to participate in cluster studies
- High level of complementarity and presence of actors along with technical textile and composite materials value chain in Bursa
- Support of BTSO and presence of BUTECOM
- Strong support and ownership of stakeholders, public institutions and universities
- Developed industrial infrastructure and presence of well-developed OIZs
- Proximity to other industrial regions and key markets
- Presence of skilled workforce due to industrial concentration in Bursa
- Presence of leadership of BTSO and BUTECOM
- Presence of advanced supporting industries
- Strong entrepreneurship environment

Weaknesses

- Manufacture of technical/high-tenacity yarns has to be increased, and capacity and competencies have to be increased
- Need for increasing capacity of manufacturing composite materials, supporting companies in their product and product manufacturing processes, increasing the number of companies manufacturing composite materials
- Lack of technical knowledge on materials, processes for manufacturing technical textile products and composite materials in line with trends and needs of end markets
- Low level of collaboration and projects between OEMs and SMEs in Bursa, need for increasing number of joint projects and involvement OEMs and large companies in cluster activities
- Companies in cluster and value chain ecosystems do not know each other's capabilities, products and where they can collaborate, there is a need for cluster internal networking activities
- Lack of knowledge and awareness in traditional companies about their possibilities for manufacturing technical textile products,
- Need for improving specialisation in lamination applications and improving lamination infrastructure of companies
- Need for improving factor conditions, especially upskilling the current workforce and improving the employment environment in line with industry needs,
- There is a need to improve resin manufacturing
- Relatively low number of companies manufacturing composite materials, products and carbon weaving companies in Bursa

Opportunities

- Continuous growth of industry and increasing demand for technical textile and composite materials
- Presence of BUTECOM and services for companies to manufacture more innovative products, and infrastructure for prototyping, sample manufacturing
- Willingness of companies for cluster development
- Strong supporting industries, and complementarity of the industry value chain
- Presence of OEMs, Tier 1 and Tier 2 companies in Bursa for manufacturing products for the Mobiltech industry
- Supporting and promoting the transformation of traditional textile manufacturers to technical textiles,
- Variety of opportunities in different application areas such as Mobiltech, Protech, Builtech

Threats

- High demand for reinforcement materials such as carbon and glass fibres, acrylic fibres; on the contrary increasing prices, limited access to acrylic fibres and in some cases carbon and glass fibres

- Possibility of late uptake of green and digital transition, sustainability is one of the key determinants of the industry
- Lack of knowledge and awareness in traditional companies about their possibilities for manufacturing technical textile products,
- Need for an increasing number of companies operating in the composite materials segment
- Possibility of low interest of large-scale companies and OEMs to collaborate with cluster companies
- Presence of innovative competitors in the EU and the globe, ongoing investments in new products and projects of competitors
- A relatively long period is required for a product idea to become commercialised, which needs time and investment.

ADDITIONAL FINDINGS AND DISCUSSION

Bursa Technical Textile and Composite Materials Cluster Strategic Approach

“Strengthening open innovation for new product development and product diversification towards high-performance and sustainable products”.

With the comprehensive analyses carried out within the scope of clustering studies, the basic issues for the success of the cluster in the medium and long term have been identified. The focus of the cluster is innovation. Bursa Technical Textile and Composite Materials Cluster is an innovation cluster.

Although the products within the cluster have a wide range, it is beneficial to optimize the cluster resources by clarifying the main areas of expertise. The sectoral transformation vision put forward by the BUTEXCOMP Project and BUTECOM should continue in the future with the cluster development and implementation stages. Sectoral transformation of the cluster based on the principles of “innovation” “productivity” and “growth through internationalization” are among the main strategic priorities.

In the technical textiles and composite materials sector, especially in the field of high-performance automotive materials and textiles, Bursa should be positioned as one of the first production and solution centres that come to mind in Türkiye and the world. With its production infrastructure and capabilities, Bursa will be among the centres that have a say in areas such as home and office technical textiles and, the strengthening of buildings with innovative materials and protective textiles.

It is aimed for the Bursa Technical Textiles and Composite Materials Cluster to strengthen its position in the world market as the address of high-performance and sustainable materials in the technical textile and Composite materials sector. From this perspective, the cluster vision proposal in the cluster strategy document is as follows: “BUTEXCOMP Cluster aims to be one of the best-known clusters in the EU with its technical textile and composite products and solutions for transportation, home and clothing areas, and other areas where sustainable and high-performance materials are used” stated.

It is possible to achieve the proposed vision only with a strong strategy and road map. As briefly mentioned above, the main strategies are the development of open innovation in the cluster ecosystem, increasing specialization and efficiency to accelerate the sectoral transformation and internationalization of the cluster for technology and market development. These main strategies are supported by strategies of strengthening the skill and knowledge infrastructure, strengthening the network and cooperation structure, and strengthening the national and international recognition of the cluster. Another fundamental basis of the cluster strategy is sustainability and digitalization; These will be included in all strategic pillars and actions of the cluster.

The cluster governance structure has a critical role in achieving cluster goals and success. In this regard, it is important that the cluster management and coordination team, which will continue its operations within the cluster governance structure, begins its activities within the scope of the Cluster Strategy and Road Map.

Cluster foundation and supporting strategies

Strategic priority areas

Both in the first months of the project and during the cluster analysis studies, sectoral data were scanned, interviews were held with companies operating in the cluster ecosystem, and sectoral trends were examined during the cluster development roadmap process. Through analysis studies, priorities – improvement areas – that form the basis of the basic and supporting activities in the cluster road map have been determined. These areas are the following:

- Developing open innovation, applied research and innovation-oriented collaborations in the cluster ecosystem, especially new products and product diversification in technical textiles and composite materials.
- Continuing the sectoral transformation approach by strengthening the production technologies, capacities and processes of cluster companies and supporting industries.
- Strengthening the cluster’s testing, analysis and certification competencies and infrastructure, taking into account sectoral needs, in the light of the sustainable and digital transformation approach,
- Getting a higher share of the export market, and for this purpose, internationalization through technology and commercial collaborations in the global environment.
- Increasing network development and strengthening ties between cluster companies to act together in line with the cluster vision and common opportunities.
- The need to increase Bursa’s national and international recognition as a cluster in technical textile and composite material products and solutions.
- Developing knowledge, training and skills in the cluster ecosystem to meet the needs of the industry, the use and application of technical textiles and composite materials, especially in automotive, transportation, home and clothing technical textiles, construction and other fields.

- The need to operationalize and institutionally develop the cluster coordination unit to ensure the smooth implementation of the cluster action plan towards the achievement and realization of the cluster vision.

Cluster master strategies

Innovation strategy

Cluster innovation strategy, the development of an open innovation culture in the cluster ecosystem (The term open innovation refers to the development of an organization's innovation (products, services, business models, processes, etc.) but also multiple external sources (customer feedback, published patents, competitors) to stimulate innovation, external institutions, public, etc.). Although the companies in the cluster have R&D and innovation studies and collaborations with universities, it has been determined that innovation-oriented studies are relatively within the company and have a closed structure. The cluster aims to support collaborative innovation among cluster actors in light of the needs and trends of the priority target sectors in the field of technical textiles and composite materials. The cluster with its innovation strategy aims to carry out studies throughout the technology readiness levels and to support collaborations starting from the product idea to the commercialization stage. The cluster innovation strategy is aimed to strengthen the structure of the cluster that produces intellectual property, patents and licenses.

Innovation in the Bursa Technical Textile and Composite Materials cluster can be interpreted as a "paradigm shift from closed innovation to open innovation" that can be achieved through collaboration. In other words, the cluster's strategy can be summarized as "maximizing research and innovation efficiency for new ideas and products through collaboration".

The cluster innovation strategy priority areas are:

- Strengthening the research and innovation environment in the cluster ecosystem;
- Supporting the innovation capabilities and work of cluster companies;
- To support entrepreneurship and the opening of new businesses in the cluster ecosystem.

R&D and Innovation areas that come to the fore within the scope of clustering studies:

- To develop knowledge on thermoplastic composites, especially in the automotive industry, and to carry out product development, new product and R&D studies;
- Conducting R&D and innovation studies in the fields of advanced materials, semiconductors, biomaterials, smart materials, and nano-engineering materials;
- Carrying out studies in the fields of carbon and glass-reinforced plastic composites and technical textile materials;
- Bio-based composites with fireproof properties;
- Natural fibre-reinforced technical fabrics, carbon and aramid fabrics;
- Conductive threads, mixtures and coatings, especially those made of metal, copper, etc.;

- Recycling waste materials and using them in the production of composite materials and technical textiles;
- Developing lightweight products (i.e. seating systems) with lightweight materials; thermoplastics;
- Carrying out studies in the field of recycling of composite materials among the forward-looking areas;
- Prepreg, perform 3D, 2D, autoclave, tape fabric, thermosets, epoxy, engineering plastics composite materials;
- Fabrics that provide high strength and heat balance;
- Electromagnetic, encapsulation, lamination, plasma, metal plating, etc. fields;
- Research studies on materials, products and application methods for strengthening buildings and the use of technical textiles and composite materials in building technology.

Transformation strategy in production

"Continuous industrial transformation through the adaptation, development and adoption of sustainable production solutions"

The second pillar of the key strategies of the cluster strategy is productivity. The strategic goal is to ensure the continuation of the sectoral transformation approach initiated with the BUTEXCOMP Project. The basic idea behind this strategic area is to increase the production capabilities and productivity of companies producing technical textiles and composite materials to meet the growing demand in the market in terms of technology and quality. Productivity strategy consists of 3 subcomponents. These sub-components;

- Adaptation of new production processes and technologies;
- Resource efficiency, digitalization and sustainability;
- Development of cluster capacity in industrial testing, analysis and certification areas.

Internationalization strategy

"Maximizing the effectiveness of commercialization"

The internationalization strategy of the cluster aims to ensure that cluster companies produce value in line with the internationalization objectives of the cluster and to internationalize the cluster as a whole. The internationalization strategy aims to increase the export market and technology partnerships of clusters and cluster companies, thus supporting the integration of global value chains and information and technology exchange.

The internationalization strategy aims to enter new export markets and/or integrate into global supply chains and establish connections with actors in target countries. Within the scope of the internationalization strategy; Business relations will be established with other clusters, actions will be taken to create job opportunities for cluster members, and cluster members will be supported in their international goals, including export development and technology collaborations, information about market opportunities and cooperation opportunities will be collected and shared with cluster companies, and collaborations will be developed between clusters and companies in

the global environment. . There are two sub-areas of internationalization strategy.

- Improving the export capability of the cluster and increasing its export market share,
- Developing technology-focused global collaborations between clusters, research centres and companies.

Cluster support strategies

Knowledge and skills development strategy

Developing skills and knowledge in line with the cluster's research, innovation, specialization, technology, production and market needs are among the supporting strategies of the cluster. The strategy is directly related to the parameters of factor conditions and aims to contribute to the improvement of the level of cluster competition in the form of collaborative actions with universities, vocational schools and cluster companies. This strategy also aims to increase the level of industrial knowledge, facilitate the transfer of technical knowledge and contribute to the formation of relevant regional policies. As a two-way strategic area: i) increasing the level of knowledge in a cluster environment; ii) contributing to the development of skills related to studies on the production of future products of technical textiles and composite materials with a focus on primary target markets. In this context:

- Supporting cluster actors with collaborative projects, contributing to increasing the knowledge of universities and academicians in the cluster ecosystem, and enabling the number of articles and publications to be increased.
- Facilitating national and international partnerships and collaborations between research institutions and universities for sectoral transformation.
- Developing the necessary skills for design, development, production and marketing for industry, especially at the level of technicians and engineers.
- Develop and provide information about the industry, trends, markets, technology and processes to cluster members.

Network development strategy

Network development is the second supporting strategy of the cluster, which aims to increase relationships between cluster firms and establish connections with relevant actors in the internal and external environment of the cluster to achieve the cluster's goals and vision. Network development provides cluster actors, especially cluster companies, the opportunity to collaborate and work with companies or the cluster to develop competencies, technologies and competitive collaborations aimed at a common market. The network development strategy is linked to the core strategies of the cluster; it includes establishing connections at regional, national and international levels:

- Intra-Cluster Network Development: it is aimed to strengthen ties between cluster members, facilitate the exchange of experience and technical knowledge transfer, and increase the number of specialized companies within the cluster. The strategy

aims to strengthen the cluster profile by bringing new members to the cluster in line with the strategic objectives of the cluster especially in the areas of innovation, production and internationalization.

- Cluster network development activities at the regional and national level will include establishing relationships with relevant clusters at the regional and national level. First of all, relationships will be established by initiating informational meetings through visits to clusters and relevant business support organizations. The network development strategy also aims to establish connections between cluster companies and OEMs located in Bursa and other regions of Türkiye.
- Cluster network development activities at the international level will be linked to the internationalization strategy of the cluster, including the development of relationships with clusters, companies possible actors and platforms relevant supply chains, research institutions and international organizations.

Cluster promotion and branding

Cluster promotion and branding is one of the most important support strategies of the cluster that can help both the cluster and its members to be recognized at national and international levels and to position themselves as a technical textile and composite material centre in the EU and in the world for the determined priorities. Cluster promotion and branding strategy aims to contribute to the strategic positioning of the cluster through branding of the cluster in line with a cluster communication strategy.

CONCLUSIONS

Analysis shows that the technical textile and composite materials business in Bursa is transitioning to a more specialized level by providing value-added products and solutions through a cluster development method. Technical textiles are distinguished by the solutions and services they provide, while composite materials are characterized by their strength and performance, typically achieved via the use of reinforced materials and specialized methods. It is possible and highly beneficial to create an early vision and mission statement for Bursa technical textile and composite materials based on their competitive advantages, key competencies, and analysis-based knowledge of areas to be developed. This statement can be further verified with cluster members. Clusters offer a variety of products and services within the technical textiles and composite materials sectors. It is advisable to concentrate on certain segments and enhance specialization. Bursa can enhance its manufacturing capacity, innovation, talent development, and know-how in the Mobiletech and home tech areas. By enhancing its competitive value chain, supporting industries can offer customized services to companies, aiding small and medium-sized enterprises in joining global value and supply chains.

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REFERENCES

- [1] Babkin, A.V., Kudryavtseva, T.J., Utkina, S.A., *Identification and Analysis of Industrial Cluster Structure*, In: World Appl. Sci. J., 2013, 28, 1408–1413, <https://doi.org/10.5829/idosi.wasj.2013.28.10.13923>
- [2] Porter, M.E., *Clusters and the New Economics of Competition*, In: Harv. Bus. Rev., 1998, 76, 77–90
- [3] Rosenfeld, S.A., *Bringing Business Clusters into the Mainstream of Economic Development*, In: Eur. Plan. Stud., 1997, 5, 3–23, <https://doi.org/10.1080/09654319708720381>
- [4] Porter, M.E., *The Competitive Advantage of Nations*, Free Press, 1990, 1, 1–929
- [5] Herliana, S., *Regional Innovation Cluster for Small and Medium Enterprises (SME): A Triple Helix Concept*, In: Procedia – Soc. Behav. Sci., 2015, 169, 151–160, <https://doi.org/10.1016/J.SBSPRO.2015.01.297>
- [6] Zeng, D.Z., *How Do Special Economic Zones and Industrial Clusters Drive China’s Rapid Development?*, 2011, <https://doi.org/10.1596/1813-9450-5583>
- [7] Farinha, L.M.D.C., Ferreira, J.J.D.M., Gouveia, J.J.B., *Innovation and Competitiveness: A High-Tech Cluster Approach*, In: Rom. Rev. Precis. Mech. Opt. Mechatronics, 2014, 41–48
- [8] Chattopadhyay, U., *Evaluation of Cluster Competitiveness: Review, Framework and the Methodology*, Executive Summary CF 2015, 13
- [9] Porter, M.E., *Location, Competition, and Economic Development: Local Clusters in a Global Economy*, In: Econ. Dev. Q., 2000, 14, 15–34, <https://doi.org/10.1177/089124240001400105>
- [10] Bhawsar, P., Chattopadhyay, U., *Evaluation of Industry Cluster Competitiveness: A Quantitative Approach*, In: Benchmarking An Int. J., 2018, 25, 2318–2343, <https://doi.org/10.1108/BIJ-02-2017-0022>
- [11] Karahan, M., Ahrari, M., Karahan, N., *Technical Textiles Market Research and Added Value Analysis: A Regio-Global Case Study*, In: Recent – Rezult. Cercet. Noastre Teh., 2023, 24, 162–180, <https://doi.org/10.31926/recent.2023.71.162>
- [12] Karahan, M., Ahrari, M., Karahan, N., *Composite Materials Market Research and Export Potential Analysis: A Regio-Global Case Study*, In: Recent – Rezult. Cercet. Noastre Teh., 2023, 24, 113–121, <https://doi.org/10.31926/recent.2023.70.113>
- [13] Ahrari, M., Karahan, M., Karahan, N., *Competitiveness Factors in Textiles and Composites Industry and Transformation into Value-Added Products*, In: Recent – Rezult. Cercet. Noastre Teh., 2023, 24, 132–141, <https://doi.org/10.31926/recent.2023.70.132>
- [14] Toussaint-Comeau, M., Newberger, R., Augustine, D., *Inclusive Cluster-Based Development Strategies for Inner Cities: A Conference Summary*, In: Econ. Dev. Q., 2016, 30, 171–184, <https://doi.org/10.1177/0891242416642104>
- [15] Sedlmayr, B., Köcker, G.M., Schneider, K., *Cluster Development Guide*, 2020

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