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Competency Mapping of Textile and Composite Industries: A Regional-Global Case Study

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Abstract
There has been a recent uptick in the demand for technical textiles and other high-value products on international marketplaces. Many nations have shifted their manufacturing focus to these items in the recent decade in an effort to boost their economic standing and compete on a global scale. Using Bursa as an example, this research intends to shed light on the present state of the textile sector in Türkiye and its shift towards technological textiles with higher value additions. This article examines Türkiye's role in the current global trade quantities of products, as well as import-export data. Also covered are the latest developments in the industry as well as the state of the market for technical textiles. Worldwide sales of technical textiles reached around $118 billion, up 3.38 percent from the previous year. With a decline of -12.91 percent from the previous year, Türkiye's exports in 2021 were 2.413 billion dollars. With the exception of a small number of product categories, the Grubel-Lloyd Index analysis of Türkiye's technical textile industry showed that trade within the industry is bidirectional. All technical textile products had an average index value of 0.7968. Based on their intended use, technical textiles are grouped into twelve distinct types. Subcategories of technical textiles such as Mobiltech, Indutech, and Packtech are expected to have the most significant trade products by 2028.

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

1. Introduction

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

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

We have conducted regional and global market research on technical textiles [25] and composite [26] materials, including an analysis of added value. Our study indicates that there is a growing demand in global marketplaces for high-value-added items like technology textiles. Many countries have reorganized their production systems in the past decade to prioritize the manufacturing of these items in order to enhance their economic competitiveness internationally. Global exports of technical textiles amounted to over 118 billion dollars, showing 3.38 percent growth from the previous year. Turkey's exports in 2021 totaled $2.413 billion, marking a 12.91% reduction from the previous year. With only a few exceptions, the Grubel-Lloyd Index calculation for technical textile product groups in Turkey shows bilateral intra-industry trade, with only a few exceptions. The mean index value for all technical textile items was determined to be 0.7968. By 2028, Mobiltech, Indutech, and Packtech subcategories of technical textiles are expected to be the leading sectors in the commercial market [27].

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

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

This research intends to provide a strategic plan for technical textiles makers to identify new markets and pinpoint prospective market opportunities. The discussion focuses on the technical textiles groups

in which Türkiye has more export potential and the countries to which exports may be increased in these sectors. This study also highlights Türkiye's capacity in technological textiles. The goal is to identify new product categories by analysing technology and market developments within these groupings.

2. Methodology

The diagnostic investigation pertaining to the requirements of dynamic enterprises operating within the textiles and composites industry encompassed two distinct phases. Initially, a total of 140 companies were visited to complete a questionnaire. Subsequently, in the second phase, 50 companies were chosen from the initial pool of 140 using two objective scoring systems. These selected companies were then visited for in-depth diagnostic interviews conducted by experts in the field of Technical Textiles and Composites. A preliminary questionnaire was initially prepared. The experiment was conducted during a pilot phase including prominent companies in the textile and composite industries. The questionnaire was subsequently refined to enhance the efficiency of data collecting. The extensive survey utilized during the screening step has nine distinct modules, including a cumulative sum of 91 inquiries.

The screening questionnaire for the diagnostic study consisted of nine modules, each addressing specific aspects of companies' operations within the textiles and composites industry. These modules included:

Activity/Production, comprising 8 questions, aimed at understanding the company's production processes and activity levels.

Supply/Sales, with 17 questions, focused on assessing the company's supply chain management and sales strategies.

Human resources, encompassing 10 questions, delved into the company's workforce management practices and personnel-related policies.

Research and Development (R&D), featuring 24 questions, aimed to gauge the company's investment and focus on research, development, and innovation initiatives.

Quality, consisting of 5 questions, aimed to evaluate the company's approach to maintaining and improving product quality standards.

Sustainability, with 2 questions, assessed the company's commitment to environmental sustainability and responsible business practices.

Value chain, comprising 8 questions, explored the company's integration within the broader value chain and its relationships with suppliers and customers.

Transformation, featuring 7 questions, focused on understanding the company's adaptability and readiness for industry changes and technological advancements.

Clustering, consisting of 10 questions, aimed to identify potential synergies and collaborative opportunities among companies within the industry.

These modules collectively provided a comprehensive framework for analyzing the needs and capabilities of active companies in the textiles and composites sector.

Due to time limitations, a shortened version was adapted from the long version with 73 questions. The companies to be visited for the first phase study were selected using rational sampling strategies from a database of 2734 companies from the company register provided by Bursa Chamber of Commerce and Industry (BTSO). The companies were established in Bursa, with at least one staff on the payroll. The database was constructed from companies' activities using their NACE codes. A pilot sample of 20 companies were selected in order to try out the questionnaire. This selection was skewed towards larger companies, as those are more likely to engage in technical textile and composite production. A first sample of 175 companies was then randomly selected using a stratified method. However, when it was found that the non-response rate was much higher than expected, a second (144 companies) and third (80 companies) sample were taken to which a turnover threshold was applied. The high nonresponse rate of the first sample was attributed to the busy schedules of company owners or related high-level managers and the larger number of companies of smaller sizes included in the first sample that had already ceased their activities or showed no interest in transformation and participation in the project activities. In the second and third samples, smaller companies with a low turnover were not

included. The semi-structured questionnaire for the second phase is made up of questions to diagnose companies' limitations and challenges regarding prototyping and new product development. It focuses on companies' needs and plans for prototyping and new product development considering their technology levels, decision-making process for new product development, obstacles for developing new ideas and challenges in R&D processes, new product development projects, project teams' needs, their skill and knowledge gaps and needs, marketing strategies, transforming to technical textile and composites, clustering perceptions etc. The questionnaire is a tool to explore the companies' needs.

3. Competency maps

During this study, competency mapping was used to identify strengths and weaknesses of a sub-sector by means of indicators (Figure 1). The aim was to better understand their needs in order to increase competitiveness and facilitate transformation or new investments to technical textile or composite materials manufacturing effectively. Amongst 30 indicators available from the questionnaire answers, twelve indicators were selected on which BUTEXCOM services were believed to have an influence. These 12 indicators were used to analyse the sub-sectors of conventional textile, technical textile and composites. These were scored from 1 to 10 perceptionally by companies as a self-done exercise within the diagnostic study questionnaire. Amongst these 12 indicators, six were taken as determinants of competency and 28 competency maps have been constructed for the sub-sectors.

Fig. 1. Determinants of competency

Maps give an impression of the grouping of sub-sectors or the relationship between factors represented by the XY axis. Logistic regression models for the prediction of different dependent variables which were defined by sector experts have been constructed in order to determine the significant independent factors affecting a dependent factor. Data were transformed to binary outcomes, which allow straightforward decisions between two alternatives. For these models, the degree of competency was divided into less competent (between 1 to 5) and more competent (6 to 10). Due to insufficient observations by sectors and sub-sectors, the logistic regression analysis was applied to whole variables without disaggregation by sectors and sub-sectors. Then the results were applied to sectors and sub-sectors. For competency maps, only significant factors were interpreted below.

3.1. Quality Technical Competence

Quality-technical competence describes an area of knowledge or skill that is useful in a particular industry's production responsibilities. Quality is the ability to achieve the optimum product life cycle with minimum failure and to meet expectations of the user. Technical competence is however the ability

to apply a technology (mostly hi-tech) self-confidently and continuously with minimum failure. Therefore, they are shown in a combination in our analysis because they complement each other. Different industries require diverse requirements depending on the products or services they offer. Mastery of functional and technical skills is essential for a company to become a competent manufacturer in various fields.

Table 1 shows factors with P values. If the P value is below 0.05, the factor has a significant relationship with quality technical competence. It can be interpreted that as the standards and certification and R&D opportunities are increased by "1" unit, then quality and technical competence increases by 25 ad 26 per cent, respectively. It should be noted that these odds may change for different sectors and sub-sectors. So only the "standards and certification" and "R&D opportunities" maps are interpreted below for conventional textile sub-sectors and technical textile sub-sectors together with composite manufacturers. Considering the logistic regression analysis mentioned above, only two maps were analysed here.

As seen in Figure 2, the most important indicator for quality and technical competence was noticed as R&D opportunities. It can specifically be said that supporting "garment", "workwear fabric and apparel", and "curtain fabric manufacturing" sub-sectors' R&D capabilities may increase their quality and technical competence.

Table 1. Logistic regression model for quality technical competence

Independent Variables	Estimate	Odds Ratio	Pr(>|z|)
(Intercept)	-3.79	0.02 ✓	0.00
Qualified workforce	0.07	1.07 ✗	0.50
Access to Coaching / Consulting / Training services	0.11	1.12 ✗	0.30
Standards and certification	0.22	1.25 ✓	0.03
R&D opportunities	0.23	1.26 ✓	0.03
Innovation competence of the company	0.09	1.10 ✗	0.33
Access to technical information	-0.09	0.91 ✗	0.37

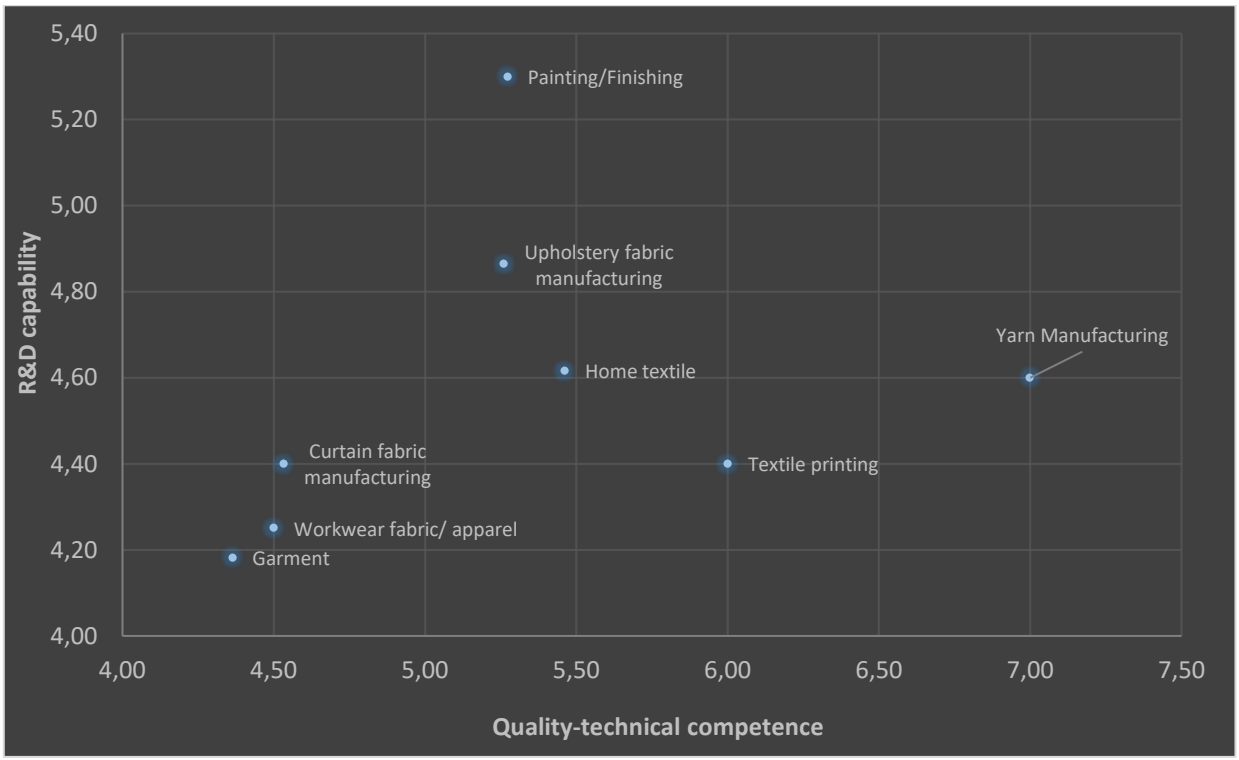

Fig. 2. Competency map for R&D capability on quality-technical competence for conventional textile sub-sectors

The "standards and certification" factor was found as the second most important factor affecting the quality and technical competence (Figure 3). A positive linear relationship between the two indicators can be seen from the competency map below. The most competent sub-sector is the "yarn manufacturing" sector. However, the standards and certification factor does not create difference for "textile printing" and "fabric covering" sub-sectors in terms of quality and technical competence. Companies feel themselves equally competent for quality, although "textile printing" sub-sector reports weakness regarding the standards and certification factor.

Figure 4 shows the positioning of technical textile subsectors on the map regarding R&D opportunities and quality and technical competence. For example, companies in Protech and Medtech sectors reported that they have got R&D opportunities and it causes a significant competence for quality. For technical textile sub-sectors and composite manufacturers, an increase in R&D opportunities for composites and Clothtech may cause an increase in their quality and technical competence.

For technical textile sub-sectors and composite manufacturers, an increase in R&D opportunities for composite and Clothtech may cause an increase in their quality and technical competence (Figure 5). The map indicates that the support for Clothtech, Hometech and Medtech may cause an increase in quality and technical competence.

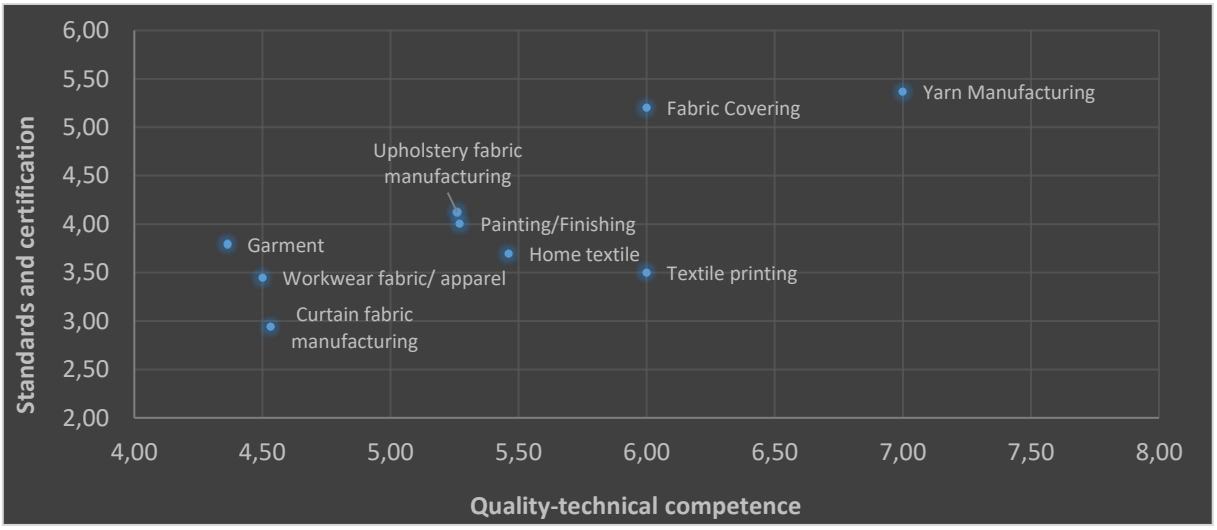

Fig. 3. Competency map for standards and certification on quality-technical competence for conventional textile sub-sectors

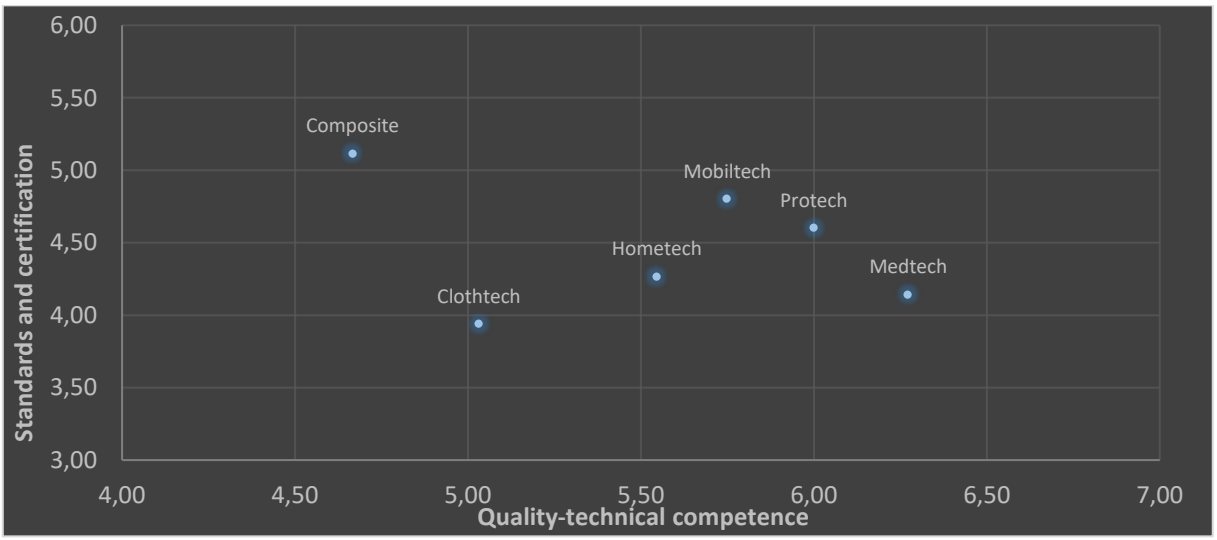

Fig. 4. Competency map for the standards and certification on quality-technical competence for technical textile sub-sectors and composite manufacturers

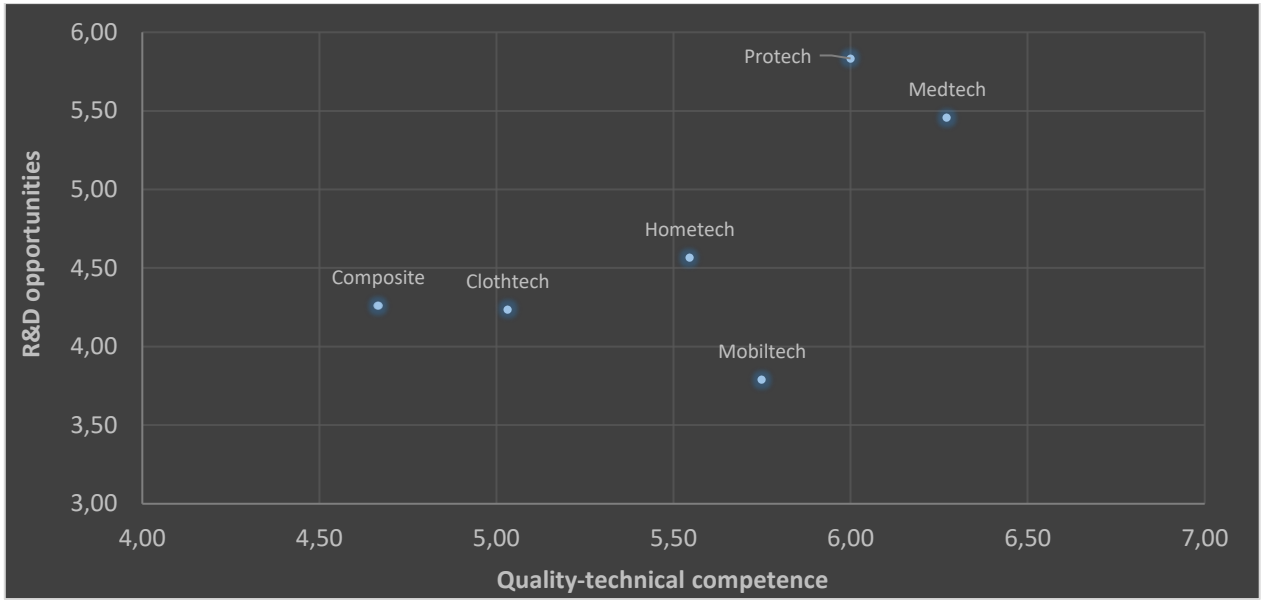

Fig. 5. Competency map for R&D capability on quality-technical competence for technical textile sub-sectors and composite manufacturers

3.2. Competency on new market entrance

The competency on new market entrance deals with determining target markets properly and effectively.

Table 2 shows factors with P values and their odds. The factors with P values below 0.05 have a significant relationship with market entry. Network structure has an important relationship with market entry. As the network structure increases by 1 unit, the competency of the market entry increases with 12 per cent.

Table 2. Logistic regression model for market entry

Independent Variables	Estimate	Odds Ratio	Pr(>|z|)
(Intercept)	-2.49	0.12	0.01
Qualified workforce	0.01	0.99	0.88
Proper clustering / Network structure	0.32	1.12	0.01
Access to Coaching / Consulting / Training services	-0.26	0.87	0.05
Innovation competence of the company	0.13	1.13	0.14
Standards and certification	0.18	1.25	0.08

The proper clustering is a significant independent factor on the market entry (Figure 6). However, manufacturers of home textile sub-group reported that they have proper clustering but do not have sufficient competency on the market entry. It is proposed that supporting the clustering of garment and upholstery fabric manufacturing sub-sectors may give more chance for them to be in the market.

Figure 7 shows a relationship between proper clustering and entrance to market. Support for proper clustering and network structure for all sub-sectors of technical textiles and composites may increase their competences for market entry.

3.3. R&D Competency

A company's R&D competency depends on many factors. Amongst five pre-selected independent factors, two of them were evaluated as significant for improving the R&D competences (Table 3). The logistic regression analysis shows that an increase in workforce quality and access to technical information impact the increase in R&D competence of companies.

Fig. 6. Competency map for the proper clustering and network structure on market entry competence for conventional textile sub-sectors

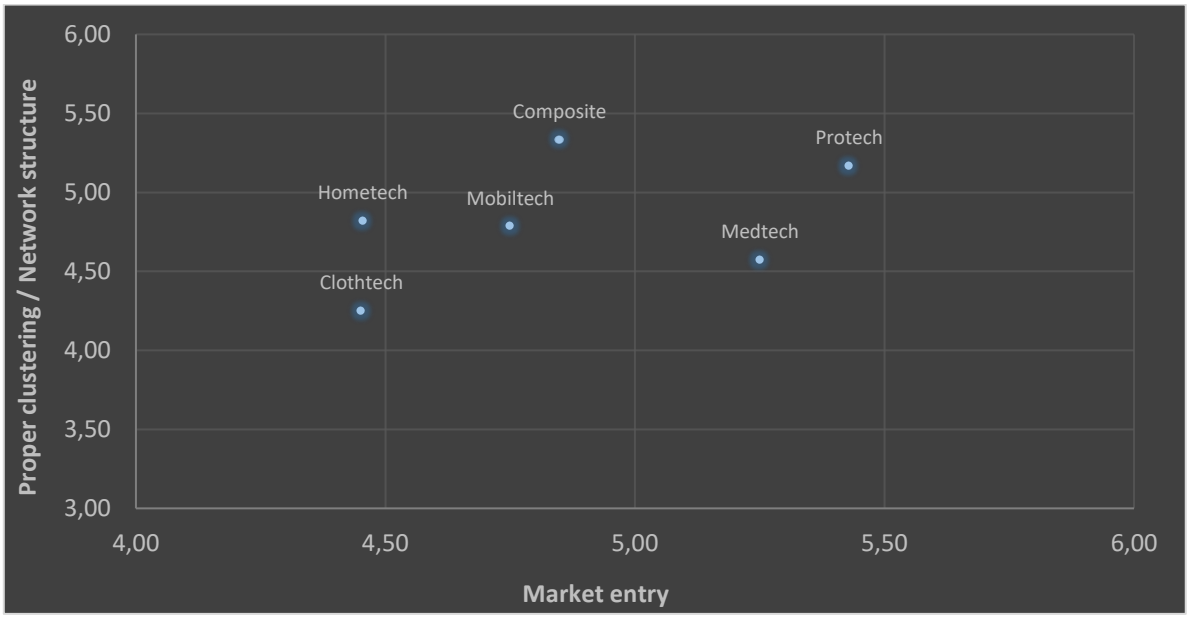

Fig. 7. Competency map for the proper clustering and network structure on market entry competence for technical textile sub-sectors and composite manufacturers

Table 3. Logistic regression model for R&D competence

Independent Variables	Estimate	Odds Ratio	Pr(>|z|)
(Intercept)	-3.17	0.10 ✓	0.00
Qualified workforce	0.23	1.18 ✓	0.01
Access to technical information	0.21	1.14 ✓	0.03
Standards and certification	0.10	1.07 ✗	0.34
Access to Coaching / Consulting / Training services	-0.16	0.91 ✗	0.11
Innovation competence of the company	0.09	1.06 ✗	0.32

As seen in Figure 8, there is a positive correlation between the qualified workforce and R&D competence. As the workforce quality increases, R&D competence increases. It is proposed that "fabric coating" can be supported for strengthening the quality of its workforce, then its R&D capability may increase. It can also be said for all sectors as their R&D capabilities are reported to be low.

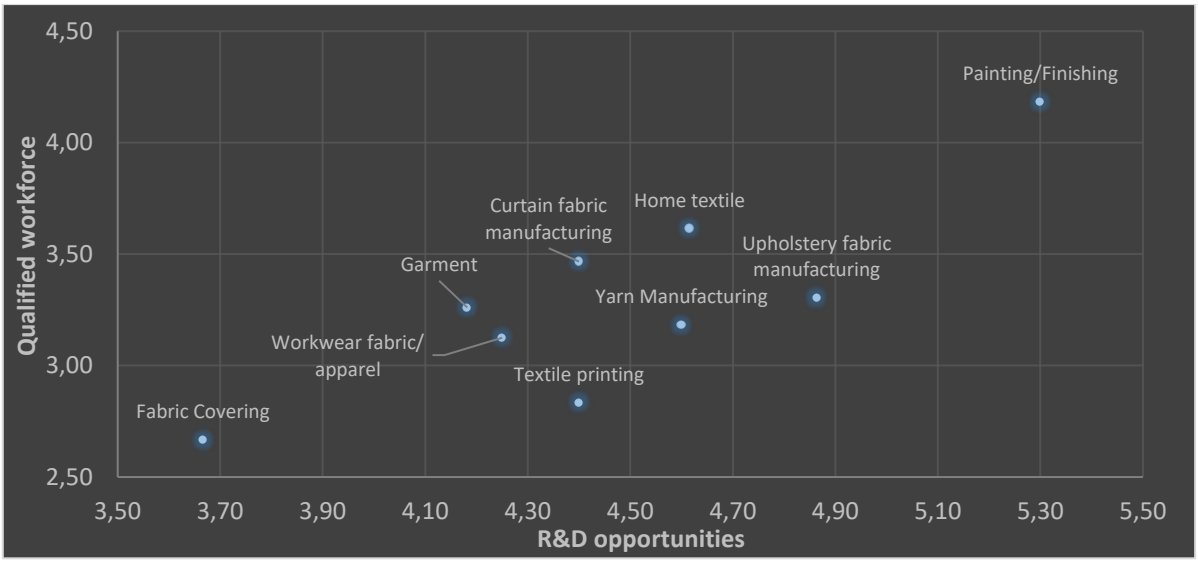

Fig. 8. Competency map for the qualified workforce on R&D competence for conventional textile sub-sectors

The relationship is also valid for technical textile sub-sectors and composite manufacturers (Figure 9). As the Mobiltech, Clothtech and Hometech sub-sectors and composite manufacturers are supported, their R&D competency may increase.

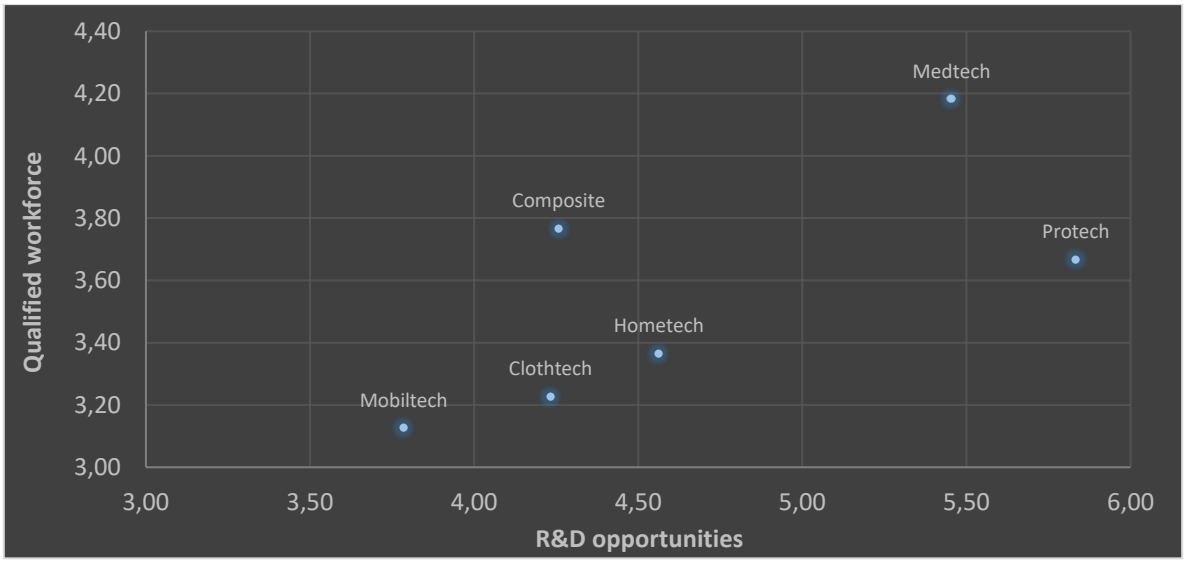

Fig. 9. Competency map for the qualified workforce on R&D competence for technical textile sub-sectors and composite manufacturers

Access to technical information also has got an impact on R&D competence. As seen in Figure 10, "fabric coating covering" sub-sector manufacturers reported that they could not access technical information, so their R&D competence is low. The situation is almost the same for most of the sub-sectors of conventional textile as they reported low access to technical information, so these companies have low R&D competence as well.

3.4. Foreign trade and marketing competency

Foreign trade and marketing competency is one of the most important competencies in all sectors and their sub-sectors. Table 4 informs that especially proper clustering and network structure, access to coaching, consulting, and training services and access to government incentives are factors with an effect on foreign trade and marketing competence. More access to technical information and coaching, consultancy and training services may strengthen foreign trade and marketing competence.

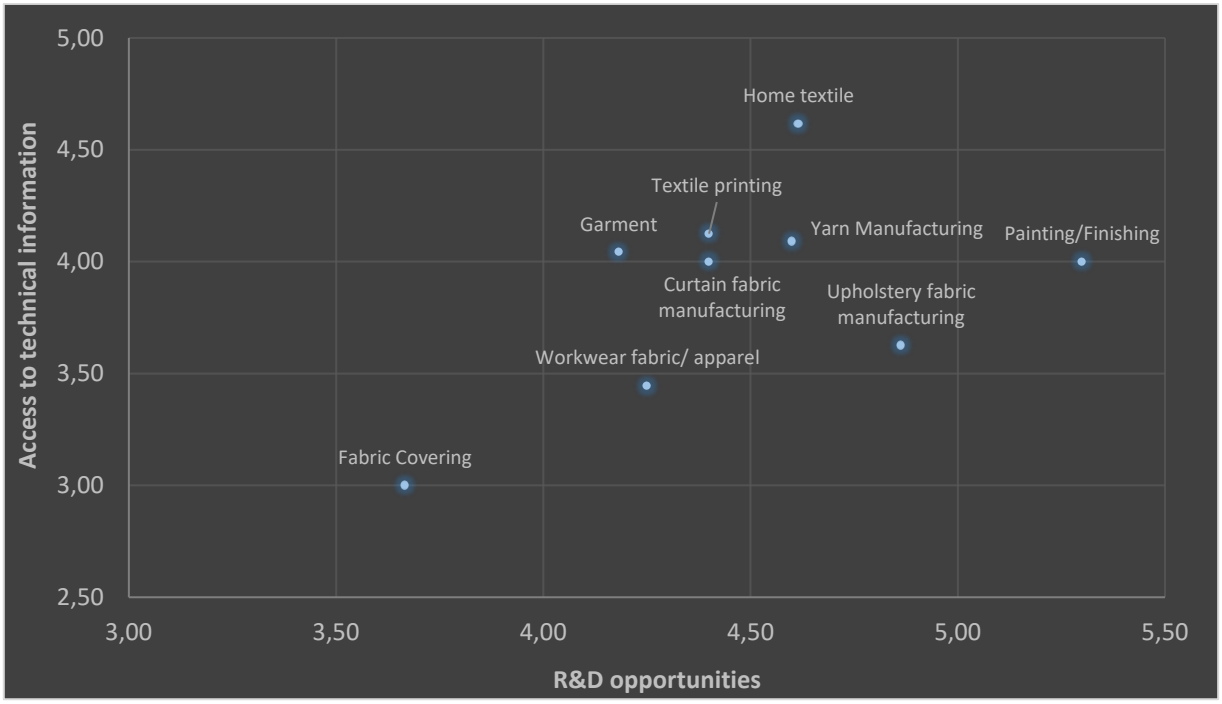

Fig. 10. Competency map for the access to technical information on R&D competence for conventional textile sub-sectors

Table. 4. Logistic regression model for foreign trade and marketing competence

Independent factors	Estimate	Odds Ratio	Pr(>|z|)
(Intercept)	-2.39	0.03	0.02
Qualified workforce	0.17	1.16	0.06
Proper clustering / Network structure	0.25	1.24	0.02
Standards and certification	0.09	1.29	0.36
Access to Coaching / Consulting / Training services	0.31	1.28	0.01
Innovation competence of the company	0.03	1.11	0.72
Access to government incentives	0.18	1.23	0.03

Figure 11 screens the relationship between proper clustering and network structure and foreign trade and marketing by conventional textile sub-sectors. Although overall analysis shows that the proper clustering has an impact on foreign trade and marketing, it is however not valid for conventional textile sub-sectors.

The impact of proper clustering and network structure on foreign trade and marketing seems significant for technical textile sub-sectors and composite manufacturers (Figure 12). Proper clustering may increase foreign trade and marketing competence for the sub-sectors. It is noted that proper clustering is important for technical textile sub-sectors and composite manufacturers.

Access to coaching, consultancy and training services is also significant for technical textile sub-sectors and composite manufacturers (Figure 13). Access to these services may strengthen foreign trade and marketing competence of technical textile and composite sectors.

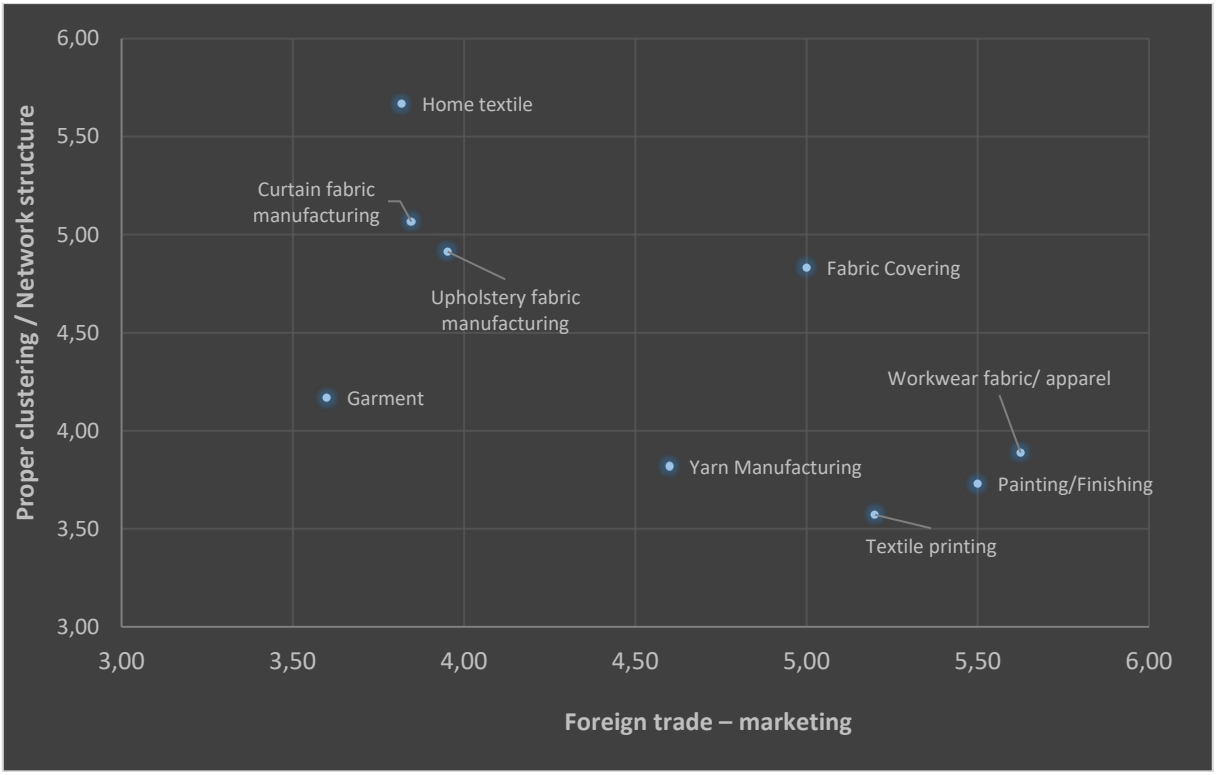

Fig. 11. Competency map for the proper clustering and network structure on foreign trade and marketing competence for conventional textile sub-sectors

Fig. 12. Competency map for the proper clustering and network structure on foreign trade and marketing competence for technical textile sub-sectors and composite manufacturers

The last significant factor on foreign trade and marketing is the access to government incentives especially for conventional textile sub-sectors (Figure 14). There is a positive relationship between independent and dependent factors. As the access to government incentives increases, foreign trade and marketing competence increases.

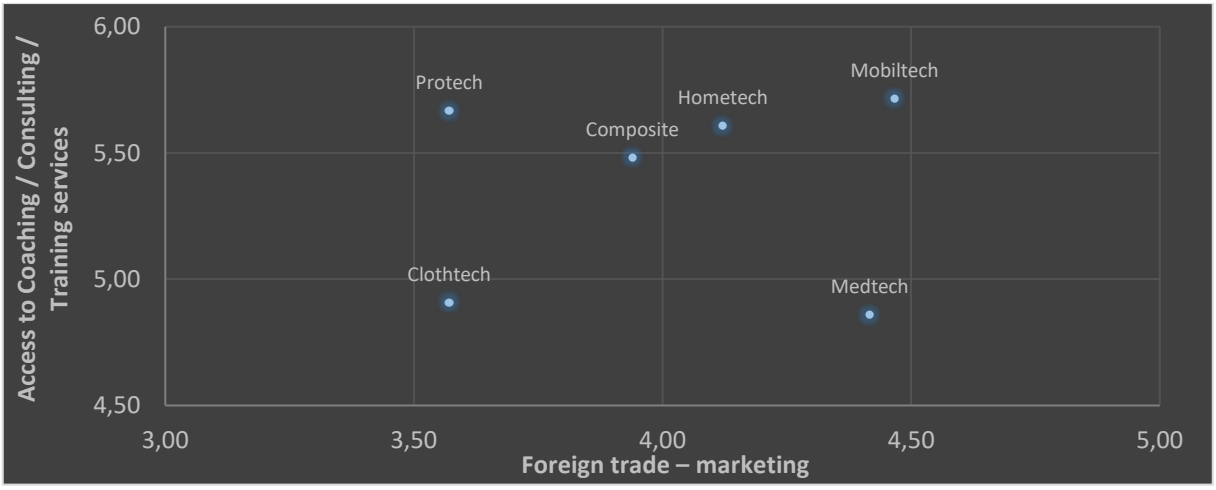

Fig. 13. Competency map for the access to coaching, consultancy and training services on foreign trade and marketing competence for technical textile sub-sectors and composite manufacturers

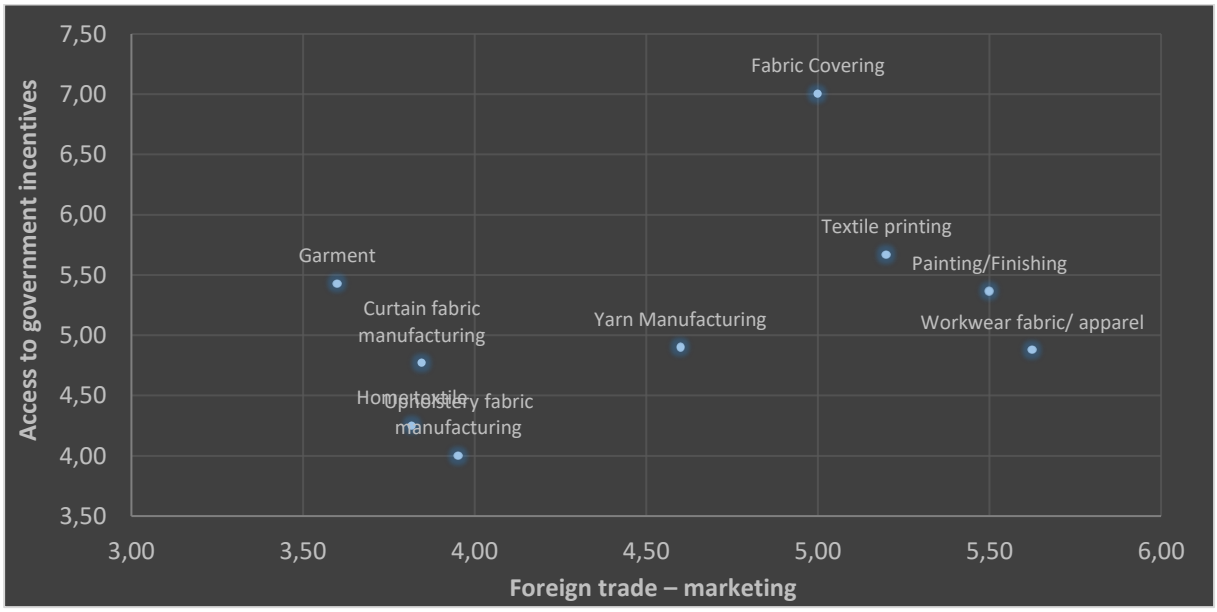

Fig. 14. Competency map for the access to government incentives on foreign trade and marketing competence for conventional textile sub-sectors

3.5. Online survey on training and consulting needs

A different data collection tool was used to gather information on the companies' needs for training and consulting. 23 companies who produce technical textiles and composite materials, or intend to invest in these areas were contacted through the online survey. Almost four-fifths (78 percent) of the companies that responded to the online questionnaire claimed that they produced in the specific areas, while the remainder (22 percent) stated that they either partially produce in the specific areas or do not produce in these areas but are planning to do so. Except for one company, all others claimed to be considering a change in the area of technical textiles and composite materials. Ten of the 22 businesses that intend to transform said that they produce textiles or technical textiles, and 12 said they produce plastics or composite materials.

As seen in Figure 15, companies who identify as textile manufacturers have indicated that they are also interested in the subject of composite materials. Automotive and transportation textiles, agricultural textiles, sports textiles, and health textiles are reportedly the most popular sub-sectors in technical textiles. Interest in composites has been focused on applications in the infrastructure, automotive and transportation, aerospace, marine, and defence sectors.

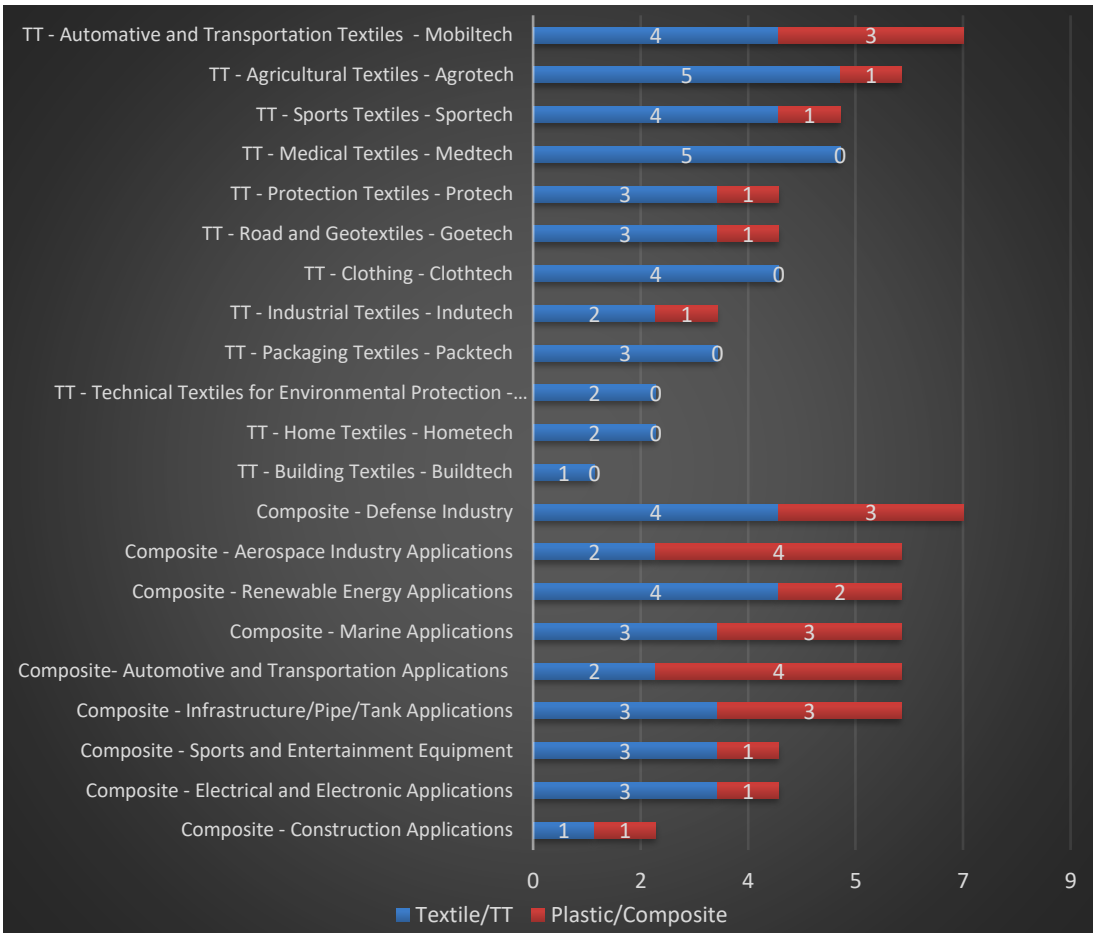

Fig. 15. Interest in technical textile and composite material sectors (%)

The conversion request to the relevant sectors is depicted in Figure 16. Companies stated that transformations are planned into home tech and Oekotech for environmental protection in technical textiles areas. The plans of composite companies are transformation into automotive and transportation applications, sports and entertainment equipment as well as infrastructure applications in the composite material sub-fields.

The sectors in which the companies that responded to the survey intend to make additional investments are depicted in Figure 17. Automotive and transportation textiles, sports textiles, and agricultural textiles are the top sectors in technical textiles, with a greater desire to invest in composite materials coming next. The companies in the Composite sector intend to invest in the sub-areas of the defence industry, automotive and transportation applications, maritime applications, and infrastructure applications as listed by the companies. Higher transformation and investment interest has been noted in composite sub-areas than in technical textile sub-areas.

Companies have outlined the most crucial concerns for their development in the fields of technical textiles and composites in Figure 18. The companies regard the R&D cooperation and access to skilled people resources as being the two most important concerns affecting their product development. Companies producing textiles and technical textiles, however, stressed that, in addition to having access to trained human resources, product development support are more crucial than R&D collaborations. Companies that manufacture composites have stated that support for testing and analysis is one of their top priorities. Consulting and mentoring services were ranked higher than training seminar activities as a need by all organisations that responded to the survey. While the demand for company-based consulting and mentoring services rises, the demand for training and seminars declines due to the generalisation of these activities. The businesses who disclosed that they produce textiles and technical textiles also acknowledged the significance of access to the final market for their growth.

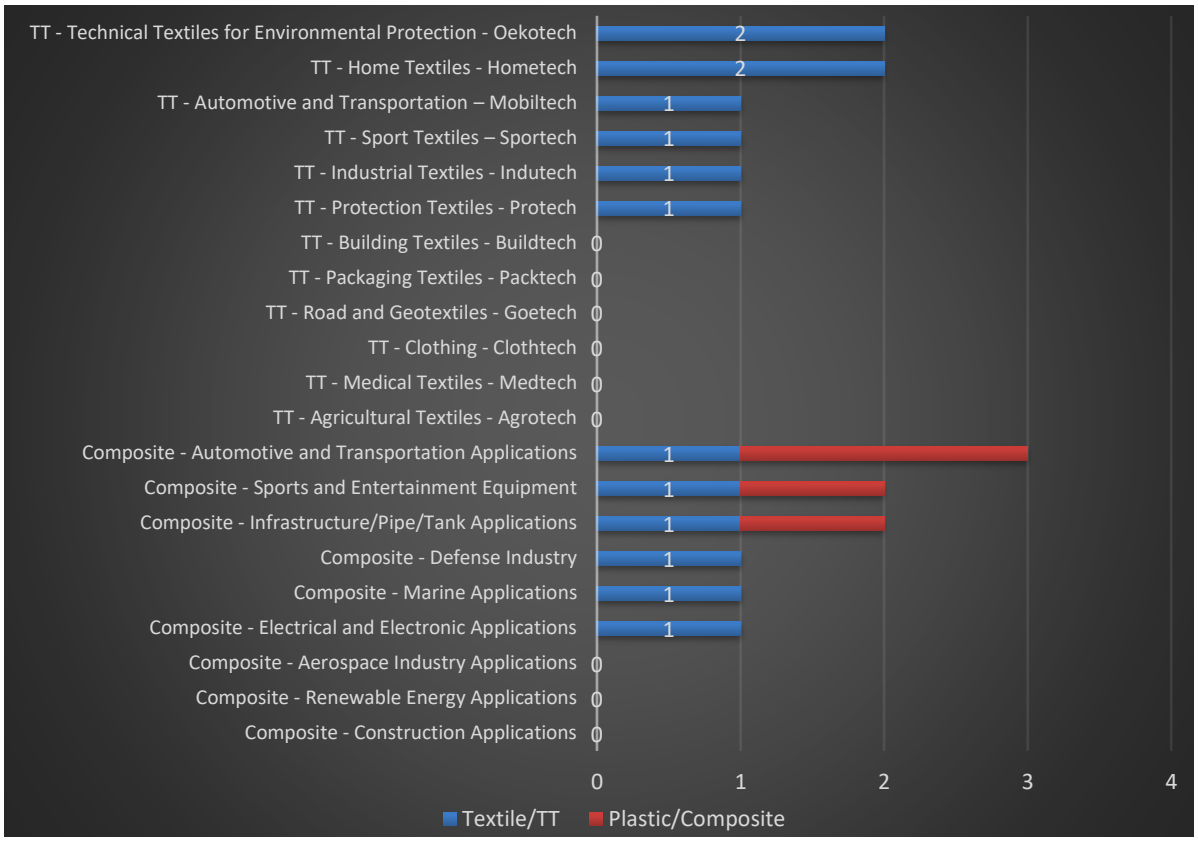

Fig. 16. Transformation into technical textile and composite material sectors (%)

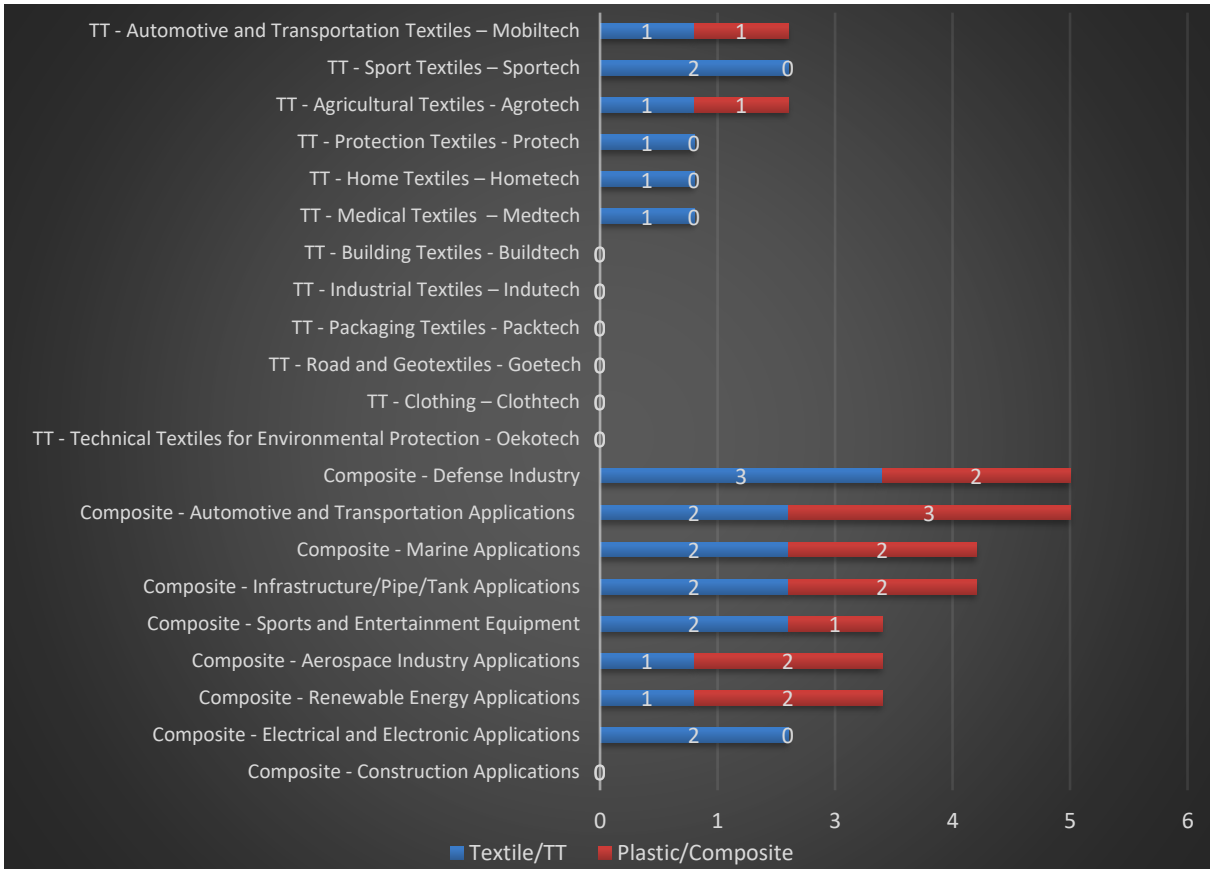

Fig. 17. Willingness to invest in technical textiles and composite materials (%)

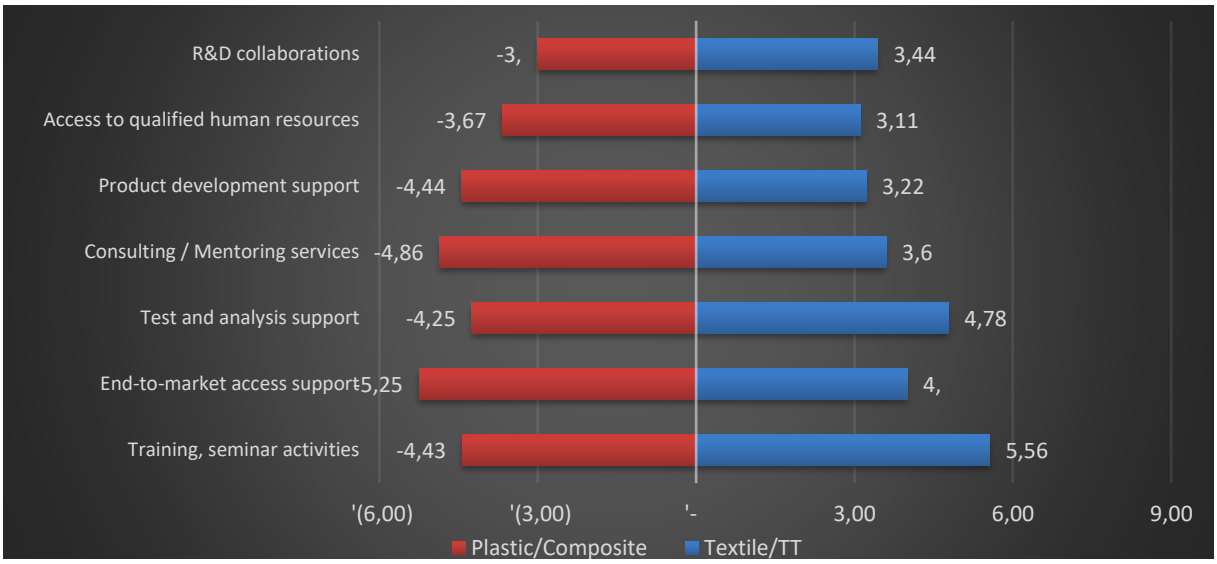

Fig. 18. Topics in order of importance in terms of development

All the companies that responded to the survey mentioned that they would like to make use of the services that will be given as part of the Butexcomp project.

In giving seminars as part of the services of the project, the most popular session will be on fast manufacturing technologies, as can be seen in Figure 19. Following that unique coating and laminating processes, as well as advanced preform technologies are demanded by the companies. In textile and technical textile businesses, training on smart textiles and wearable technology is also in high demand.

Training is in high demand in organisations that manufacture composite materials. Rapid production technologies once again take centre stage when we consider the requested training courses. Training request for Technologies related to advanced composite materials however come second in the assessment of requirements as shown in Figure 20. The request of training in the subjects of comfort fibres and comfort textiles is also prominent for businesses in the textile and technical textile industries.

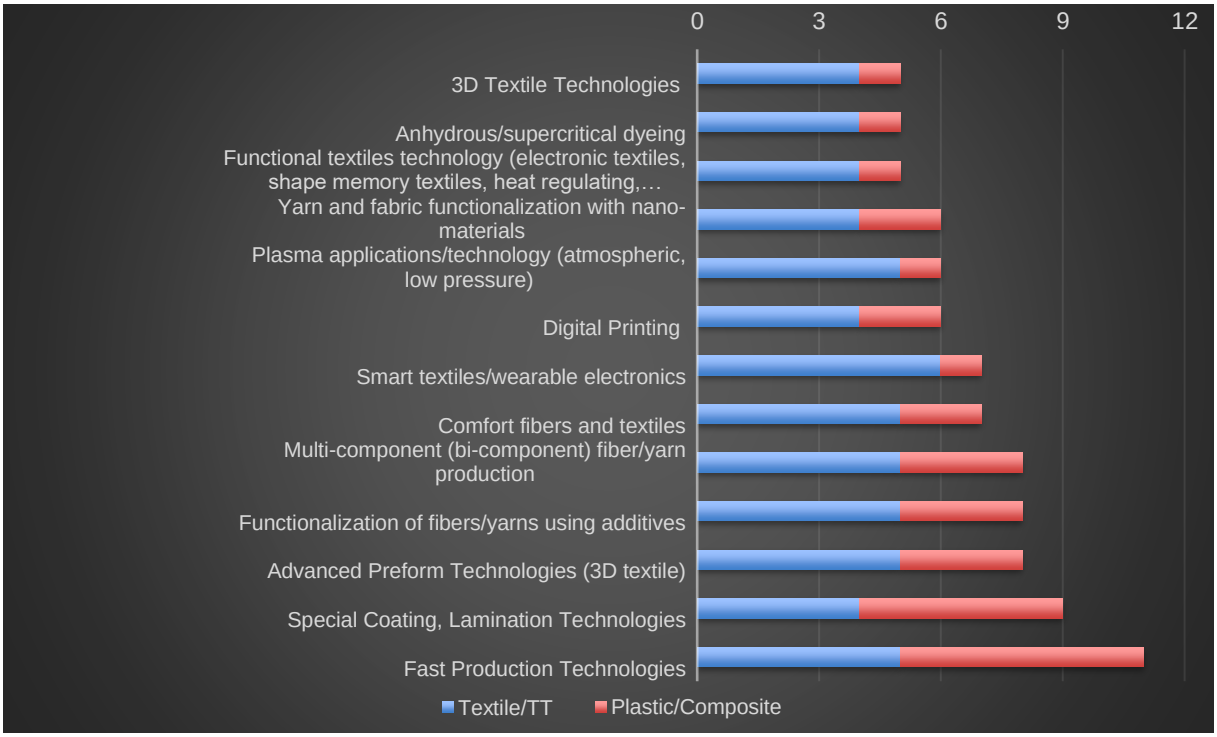

Fig. 19. Most requested seminar subjects

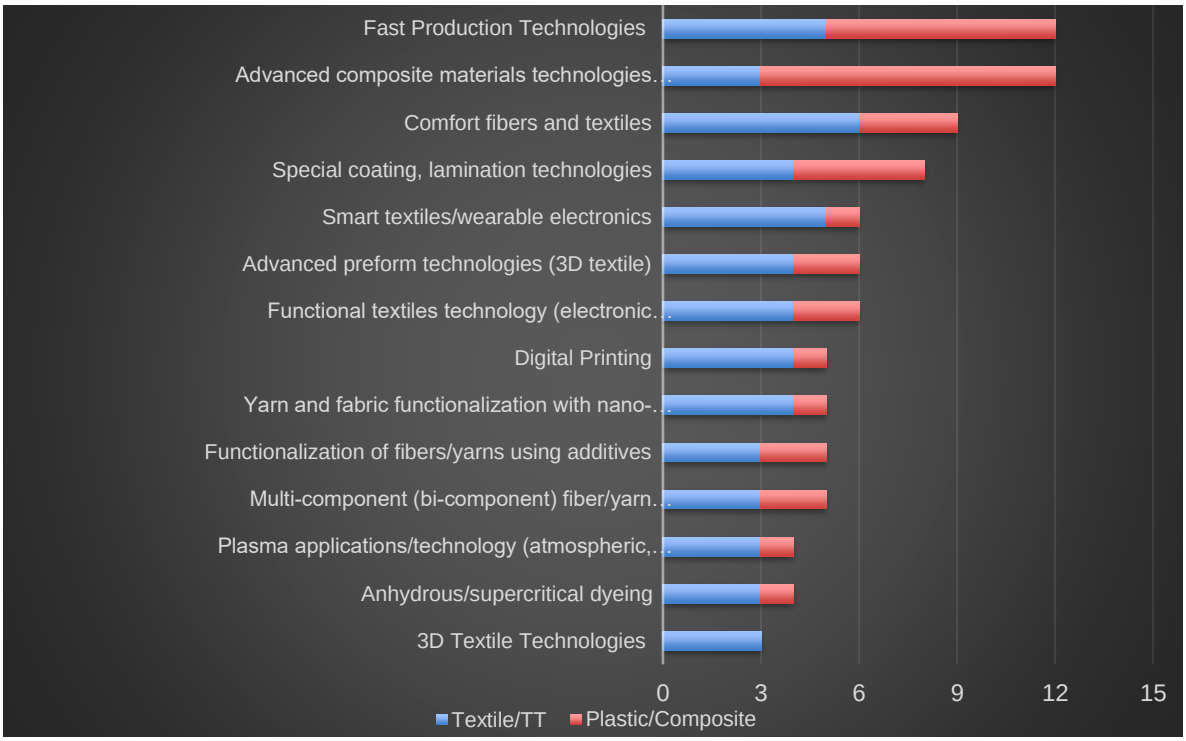

Fig. 20. Most requested training subjects

The consultancy or mentorships request on Advanced composite materials technologies came out on top in the assessment. Request of consultancy on Special coating and lamination technologies come next in requirements. On the basis of consulting, it is understood that the topic of rapid production technologies is also at the forefront. The list of further requested topics is provided in Figure 21.

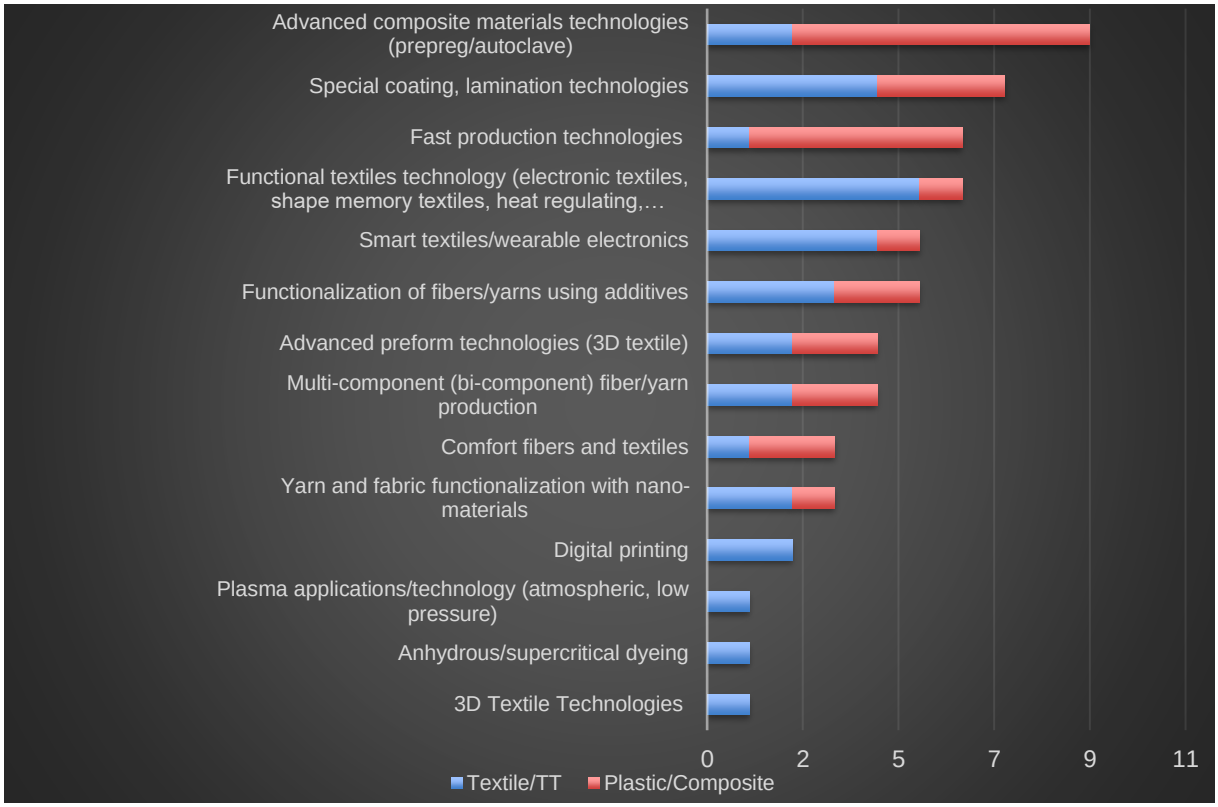

Fig. 21. Most requested consultancy and mentoring subjects

Companies also require technical training in areas such as the use and operation of BUTEKOM laboratory equipment, the operation of materials used in composite materials and technical textile structures, the improvement of design development and numerical analysis skills, management of R&D projects and innovation, and TRIZ education.

Figure 22 shows the demands of the companies responding to the survey for general training. Business plans, R&D support programmes, technical and financial feasibility, and engineering approach structuring are given priority by the companies. These are followed by requests for training in control, testing, nonconformity and warranty, serial production, creative solutions and proposals for production processes and products, and quality documents and certificates. In accordance with the future of the sector and their market shares, the companies said that it would be beneficial to provide creative solutions in production processes and products, as well as the best TT and composite application areas, through seminars. Control, testing, non-compliance, assurance, and clustering recommendations come after these seminar topics.

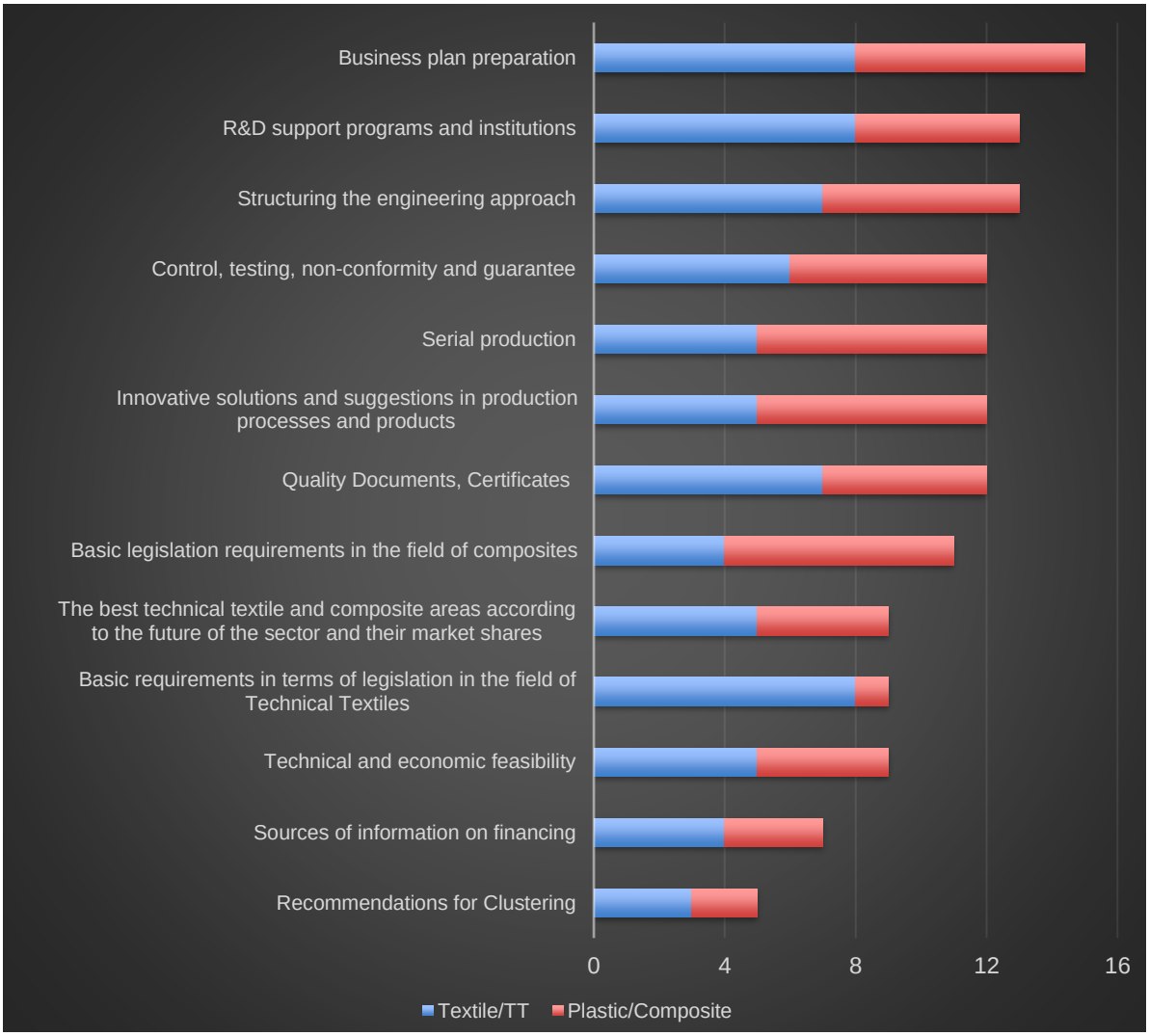

Fig. 22. Most requested general education subjects

The demand for general consulting and mentorship among the companies that responded to the survey is depicted in Figure 23. With regard to R&D assistance programmes, about 60 percent of companies give priority to technical and economic feasibility considerations. Following these consultations, there is a need for consultation regarding the structuring of the engineering approach as well as the need to know the legislation for basic requirements in the field of composites.

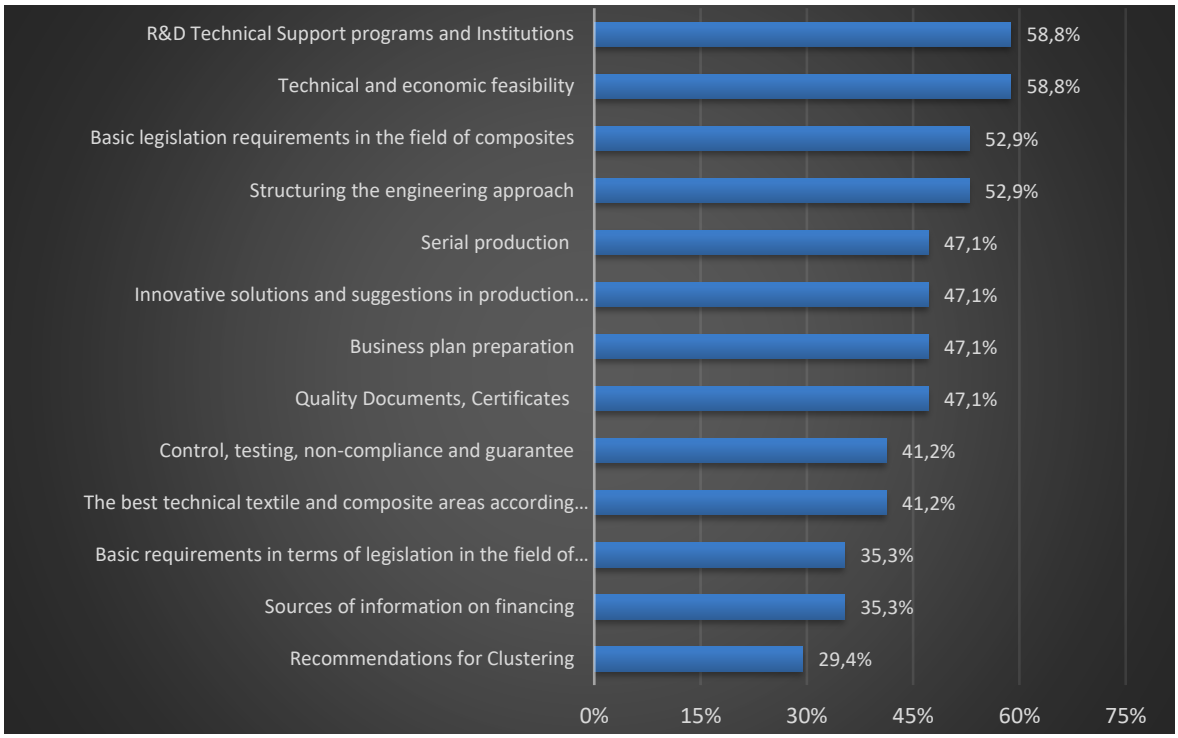

Figure 23. Most requested consultancy and mentoring subjects

4. Conclusions

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

It was noted that research and development opportunities were the most important indication for technical competence and quality. One may argue that the quality and technical competence of the "garment," "workwear fabric and apparel," and "curtain fabric manufacturing" sub-sectors could be enhanced with the help of their research and development capabilities. The issue of "standards and certification" was identified as the second most significant factor influencing quality and technical proficiency. Companies in the Protech and Medtech industries have reported acquiring R&D possibilities, leading to a substantial enhancement in their qualitative competency. An increase in research and development prospects for composites and Clothtech may lead to improved quality and technical expertise for technical textile sub-sectors and composite businesses. Additionally, Clothtech, Hometech, and Medtech support can enhance quality and technical expertise.

Effective clustering is a key independent factor in market entry. Manufacturers in the home textile sub-group stated they had adequate clustering but lack the necessary competencies for market penetration. It is suggested that promoting the clustering of garment and upholstery fabric production sub-sectors could increase their market opportunities. Enhancing clustering and network structure in all sub-sectors of technical textiles and composites could improve their capabilities for entering the market.

A positive association exists between the skilled workforce and research and development expertise. Higher workforce quality leads to an increase in R&D competency. This relationship is applicable to technical textile sub-sectors and composite makers. Supporting the Mobiltech, Clothtech, and Hometech sub-sectors and composite manufacturers can enhance their research and development capabilities. Access to technical information also influences R&D competence. The Medtech and Protech sub-sectors expressed difficulty in accessing technical information while having a relatively high R&D capability compared to other sub-sectors and composite manufacturers.

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