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MODERN APPROACHES TO INCREASING ADDED VALUE IN PRODUCTS BASED ON SYNTHETIC FIBERS

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Annotatsiya: This article comprehensively examines modern approaches to increasing added value in products based on synthetic fibers within the framework of textile industry theory. Porter's competitive advantage concept and the resource-based view were applied as the methodological foundation. Four core directions — functional finishing, nanotechnology application, smart textile systems, and production based on recycled synthetic fibers — were individually studied to determine their role in added value creation and to demonstrate harmonization opportunities with strategic branding. Based on a comparative analysis of the European Union sustainable textile strategy and international scientific literature, the prospective directions of these approaches were identified, and practical recommendations for textile enterprises were developed.

Kalit so'zlar: synthetic fibers; added value; functional textiles; smart textiles; nanotechnologies; recycled pet; branding strategy; sustainable manufacturing.

INTRODUCTION

Structural changes observed in the global textile and apparel industry are shaping a fundamentally new system of value creation within production chains. Synthetic fibers — polyethylene terephthalate (PET), nylon, acrylic, polypropylene, and others — currently occupy a dominant position in global fiber production. According to Textile Exchange, in 2022 their share accounted for 68 percent of total global fiber output [2]. However, the technological evolution of the industry indicates that the value derived directly from these fibers still does not fully reflect their existing potential.

Under modern economic conditions, competitiveness is determined not only by the low cost of agricultural or petrochemical raw materials, but also by the technological and intellectual value added to products created on the basis of these materials. From the perspective of the competitive advantage model proposed by Michael Porter [6], enterprises can maintain long-term stability in a competitive environment only through differentiation and reliance on unique resource capabilities. Applied to the textile industry, this logic suggests that increasing added value in products based on synthetic fibers is becoming not only a strategic priority, but also an economic necessity for textile enterprises.

From a practical standpoint, the 2022 sustainable textiles strategy of the European Union [3] emphasizes that in the coming decade, long service life, reparability, and recyclability of fiber products are expected to become important market efficiency standards. According to a report by the Ellen MacArthur Foundation [1], less than 1 percent of textile materials are currently reused in the production of new textile goods. This situation clearly demonstrates substantial reserve opportunities for creating additional value through more efficient resource utilization.

Academic literature has extensively examined separate technological directions for creating added value in products based on synthetic fibers, including functional finishing [14], nanotechnology applications [12], smart textile systems [9; 17], and the sustainable circular economy paradigm [1-13]. However, there is still a limited number of comprehensive academic studies integrating these directions with strategic management theory and systematically comparing them with one another. This gap constitutes the main scientific problem addressed by the present research.

The purpose of this article is to theoretically systematize modern approaches to increasing added value in products based on synthetic fibers and to identify the factors influencing their market success. To achieve this objective, the following tasks were set: (1) to analyze existing theoretical and methodological foundations; (2) to identify the main technological and market-oriented directions of value creation; (3) to assess the strategic opportunities and limitations of each approach; and (4) to develop practical recommendations for textile enterprises.

The article is structured as follows: literature review, methodology, analysis and results, conclusion, and recommendations. Based on the selected sources, the research was conducted using open-access materials in the fields of management theory, textile engineering, and sustainability studies.

LITERATURE REVIEW

In economic theory, the concept of added value is expressed as the sum of all additional economic characteristics acquired by a product during the production process. The value chain concept proposed by Michael Porter [6] in 1985 made it possible to analyze this process by dividing it into a set of primary and support activities. Primary activities include material supply, production operations, marketing, and service, while support activities include technological development, human resources, and infrastructure. This model has also been widely applied to the textile industry and serves as an effective instrument for identifying opportunities to create added value at each stage.

The Resource-Based View (RBV) theory, developed by Birger Wernerfelt [7], emphasizes that competitive advantage can be generated not from the external environment, but from the enterprise's internal intangible resources — knowledge, technology, networks of relationships, and brand capital. Jay Barney [8] further demonstrated that these resources provide sustainable competitive advantage only when they possess VRIN characteristics (valuable, rare, inimitable, and non-substitutable). In the context of synthetic fibers, functional finishing technologies, patented nano-formulations, and investments in brand image can all be regarded as resources that may be analyzed according to VRIN criteria.

Philip Kotler and Kevin Lane Keller [18] argued that a substantial share of a product's added value stems not from its technological features, but from the value perceived by consumers. This perspective makes the role of branding and communication strategy in the value chain even more significant for products based on synthetic fibers.

Modern textile science has extensively explored the possibilities of increasing the consumer value of products by incorporating functional characteristics into fibers or by applying finishing treatments to fabrics. In a broad literature review on antimicrobial textile methods published in MDPI Materials, Morais et al. [14] demonstrated the possibilities of imparting medical and hygienic properties to synthetic fiber products through the use of silver nanoparticles, copper-based compounds, and organic antimicrobial agents. Such products are able to occupy a significantly higher price position in the market compared to conventional textile goods.

In the field of nanotechnology, the fundamental work by Yetisen et al. [12], published in ACS Nano, is of particular importance for the textile sector. This study discusses in detail numerous applications, including the creation of nano-coatings through electrostatic assembly, the development of hydrophobic and oleophobic properties on fiber surfaces, protection against UV radiation, and the enhancement of electrical conductivity. In particular, it is emphasized that the added value generated through nanotechnology derives not only from the properties of the fabric itself, but also from the stability and precision of those properties.

In the field of smart textiles, the fundamental review article published in 2014 in MDPI Sensors by Stoppa and Chiolerio [9] provides an in-depth analysis of the technological convergence between wearable electronics and textile materials. It demonstrates that through the integration of sensors, energy-harvesting elements, and conductive yarns into fabric, products can evolve beyond conventional clothing into bio-medical devices capable of monitoring human жизнедеятельность. Cherenack and van Pieterse [17], in their studies published in the Journal of Applied Physics, also identified the key technological challenges in this area — flexibility, washability, and energy supply systems.

Over the past decade, sustainable production requirements have also become an important source of added value in the global textile industry. In its landmark report *A New Textiles Economy*, the Ellen MacArthur Foundation [1] outlined numerous mechanisms through which the textile industry's transition from a linear model to a circular model can generate both economic and environmental benefits. Recycled PET fibers (rPET) and bio-based synthetic fibers are increasingly viewed as new pathways for creating added value within this circular model.

The sustainable textiles strategy of the European Union [3] envisages the mandatory implementation of the Extended Producer Responsibility principle for manufacturers by 2030. This makes the use of recyclable materials beneficial not only environmentally, but also economically. According to analyses by the European Environment Agency [13], textile products represent the fourth largest category of primary raw material consumption in Europe, and this indicator has considerable potential to be reduced through circular approaches.

The analytical report *The State of Green Fibers* published by Fashion for Good [21] also provides an in-depth assessment of the economic and environmental synergetic effects of recycled synthetic fiber technologies. Likewise, the textile market analysis conducted by WRAP [25] shows that brands using recycled materials have significantly increased consumer trust.

In conclusion, the literature review indicates that four main directions of added value creation in synthetic fiber products — functional finishing, nanotechnologies, smart textiles, and recycled raw materials — have been studied to a considerable extent. However, the competitive potential among these directions and their integration with strategic branding still require further research. This study seeks specifically to address that gap.

RESEARCH METHODOLOGY

The study is primarily theoretical and analytical in nature and combines three main methodological approaches.

The first approach is a systematic literature review. Under this method, search results from the Scopus, Web of Science, and Google Scholar databases covering the period from 2012 to 2024 were analyzed using the keywords “synthetic fibers value added,” “functional textiles,” “smart textiles,” “nanofinishing,” and “recycled PET textiles.” The selection criteria included open-access publication status, indexing in Scopus or Web of Science, and direct relevance of the article’s topic to the creation of added value. A final list of 25 sources was compiled.

The second approach is comparative analysis. Four identified technological directions — functional finishing, nanotechnologies, smart textiles, and recycled raw materials — were comparatively assessed through a matrix based on five parameters: technological complexity, capital requirements, value-added potential, implementation period, and target market segment. These parameters were developed on the basis of strategic management tools frequently used in the literature, particularly Porter’s value chain model and the Resource-Based View (RBV) theory.

The third approach is document analysis. Based on the methodology systematized by Bowen [20], official reports of international organizations (Ellen MacArthur Foundation [1], Textile Exchange [2], European Commission [3], ILO [11], UNIDO [10], EEA [13]) as well as publicly available industry analytical reports (Grand View Research [5], McKinsey [4], WRAP [25]) were examined. These sources were used to assess the current state of the industry, its trends, and the regulatory and policy environment.

The scope of the research covers global trends in the textile and apparel industry. The main focus is placed on products based on synthetic fibers, while natural and semi-synthetic fibers remain outside the boundaries of the study. As a methodological limitation, it should be noted that reliance on quantitative empirical data is limited: the research is mainly theoretical and qualitative in nature, and separate empirical studies are recommended in the future for quantitative observation.

The main output of the research is a conceptual model (Figure 1) systematizing the mechanisms of added value creation in synthetic fiber products, as well as a comparative evaluation table of the four directions (Table 1). These instruments are intended to support strategic decision-making by managers of textile enterprises.

ANALYSIS AND RESULTS

The conceptual model developed to illustrate the process of creating added value based on synthetic fibers is presented as a five-stage value chain. This model is based on integrating the theoretical constructs of Michael Porter [6] and Birger Wernerfelt [7] with the technological realities of the textile industry (Figure 1).

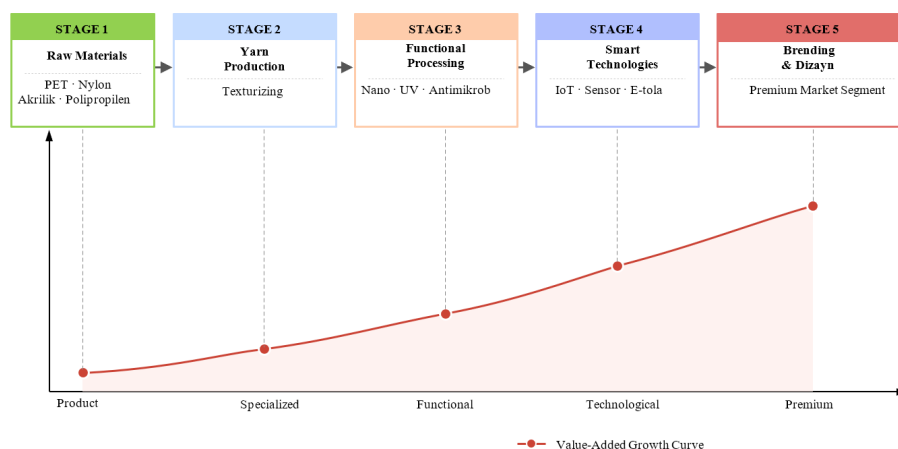


Figure 1. Model of Added Value Creation in Synthetic Fiber Products¹

¹ author’s development

As illustrated in the model, the first stage — raw materials (PET, nylon, acrylic, polypropylene) — consists of products with compressed margins intended for direct commodity trade. The second stage — yarn production and texturizing — provides the product with its first differentiation features; however, the added value at this stage remains relatively low. The third stage — functional finishing — elevates the product from a commodity category to a specialized product category and ensures a sharp increase in the value curve. The fourth stage — integration of smart technologies — moves the product beyond the boundaries of the traditional textile sector and connects it with the field of technological devices. The fifth stage — strategic branding and design — retains the greatest potential for value creation and serves as a tool for transforming consumer perceived value into real economic value.

Creating functional properties in textile products is one of the most widespread modern ways of generating added value. The category of functional finishing includes the following directions: antimicrobial and hygienic protection, UV-radiation protection, moisture management, flame retardancy, elimination of static electricity, and odor control.

As noted by Morais et al. [14], the market for antimicrobial textile technologies continues to demonstrate steady growth in medical, sportswear, and military apparel segments. Active substances such as silver nanoparticles, copper-based compounds, and ammonium derivatives may be introduced into synthetic fiber fabrics through three methods — exhaustion, padding, and microencapsulation. Each method has its own technological capabilities and economic cost structure.

Textile products with UV-protection properties have generated particularly strong consumer demand in sportswear, healthcare, and outdoor apparel sectors. Fibers based on polyethylene terephthalate and nylon naturally possess the ability to partially block UV radiation due to their chemical structure, and through the introduction of special additives, this property can be enhanced to standardized protection levels [12].

Moisture management technologies provide clear advantages to synthetic fibers, particularly in the sportswear industry. The possibility of creating thermoregulating fabrics through a system of capillary channels on the surface of microfiber polyester represents a commercially significant direction of functional finishing. According to a McKinsey & Company report [4], the specialized sportswear and activewear segment remains one of the fastest-growing segments of the global apparel market.

The application of nanotechnologies in the textile sector represents a qualitatively new level of added value creation. In the fundamental study published in ACS Nano, Yetisen et al. [12] described in detail a system of methods used for nanoscale treatment of textile materials, including surface treatment of fibers using particles smaller than 100 nanometers, electrospinning, plasma technologies, and chemical vapor deposition.

Nanotechnologies perform three main functions in textiles. The first function is the creation of protective coatings: hydrophobic and oleophobic (super water- and oil-repellent) surfaces. Materials treated in this way are positioned in the apparel sector as “self-cleaning” products and are sold at significantly higher prices compared to conventional materials [12]. The second function is conductivity: providing electrical conductivity to fabrics through the use of carbon nanotubes and metallic nanowires, which is a key element for smart textiles. The third function is antimicrobial protection: silver nanoparticles are widely used in medical textiles due to their exceptionally high nanoscale efficiency in creating antimicrobial coatings.

The main barriers to the application of nanotechnologies include technological complexity, capital intensity, and wash durability issues. The loss of nano-coatings after several washing cycles shortens the functional lifespan of the product, and this issue has not yet been fully resolved at the industrial scale. This aspect continues to receive focused scientific attention [12].

For Uzbekistan, the implementation of nanotechnologies in the textile industry may be advanced through technology transfer and joint investment projects involving international organizations such as United Nations Industrial Development Organization (UNIDO) [10]. Within such a cooperation model, raw materials may be sourced locally, while technological know-how is introduced by international partners, and the final product is exported at premium prices. This creates an effective mechanism for retaining added value within the domestic economy.

The concept of smart textiles refers to fabrics created through the integration of electronic components and textile materials that perform certain sensor or actuator functions. According to the academic classification proposed by Stoppa and Chiolerio [9], smart textiles are divided into passive types (which only sense environmental indicators) and active types (which respond to the information detected).

The main application areas of smart textile technologies include healthcare (monitoring vital indicators, ECG garments), sports (movement analysis, thermoregulation), defense and safety (thermal and chemical protection), as well as industrial protective clothing. In these segments, product prices are not directly

comparable with conventional apparel, because the product is no longer simply clothing, but a technological device built on a textile platform [17].

Cherenack and van Pieteron [17] identified three key technological challenges for this field. The first is flexibility, meaning that the electronic components must withstand washing and drying processes. The second is the power source, since battery weight and size reduce wearing comfort. The third is the lack of production standardization, reflecting the standards gap between the textile and electronics industries. Research aimed at resolving these issues is currently among the most rapidly developing areas.

From an economic perspective, smart textile products possess the highest added value potential. Foundational sources such as Hearle [20] and Rana & Fanguero [19] have described in detail the value creation mechanisms of advanced technological materials in this direction. However, the principal barrier remains the exceptionally high investment cost and the long time required for market entry. For small and medium-sized textile enterprises, this direction is often implemented not independently, but through consortium arrangements with major technology companies.

Among synthetic fibers, recycled polyester (rPET) — mainly produced from beverage containers (PET bottles) or textile waste — currently represents one of the fastest-growing segments in the sustainability field. According to annual reports by Textile Exchange [2], the use of rPET in the global textile industry continues to increase year by year, and many leading sportswear brands have adopted voluntary commitments regarding the use of rPET.

As noted by the Ellen MacArthur Foundation [1], technologies for producing fiber from textile waste and used plastics not only reduce environmental costs, but also increase independence from fluctuations in raw material prices. This creates an additional stability factor in the cost structure of enterprises producing on the basis of rPET. Furthermore, in the European market, demand for rPET products creates direct pricing advantages by improving a brand's "green" rating.

Within the framework of the European Union strategy [3], it is expected that from 2030 onward all textile products sold in the European market will be required to contain at least a certain share of recycled materials. The European Environment Agency [13] has supported this policy direction with scientific evidence. These regulatory requirements further strengthen the competitive advantages of enterprises that have mastered recycled fiber production technologies. Similar conclusions were also presented in the analysis of the Extended Producer Responsibility (EPR) mechanism published by OECD [16].

The value creation mechanism of recycled synthetic fibers consists of two channels. The first is the cost channel: rPET may be priced lower than or equal to virgin polyester, thereby creating opportunities to increase profit margins. The second is the brand capital channel: products labeled with eco-certifications strengthen consumer confidence in quality and enhance brand loyalty. This correlation was empirically confirmed in the analysis conducted by WRAP [25].

In products based on synthetic fibers, technological features do not automatically become added value — they must be accepted by consumers and considered worth paying for. At this point, branding strategy plays a decisive role. From the perspective of the "total product" model described by Philip Kotler and Kevin Lane Keller [18], when consumers purchase technologically advanced textiles, they are buying not only the physical characteristics of the fabric, but also the brand promise, design aesthetics, and consumer identity associated with it.

Large fashion conglomerates such as Kering Group [24] demonstrate the environmental and social value of their products quantitatively through the use of Environmental P&L methodology. This approach positions the brand not only as a clothing producer, but also as a carrier of cultural and environmental values, thereby increasing consumers' willingness to pay. As noted by Fashion for Good [21], for many synthetic fiber products sold at premium prices, brand communication rather than technological difference serves as the primary value argument.

In international branding practice, two distinct pathways are clearly visible. The first is the technological brand: brands such as Nike Dri-FIT, Polartec, and Gore-Tex possess proprietary technologies that become central to brand identity and justify price differentiation. The second is the value-based brand: brands such as Patagonia and Stella McCartney use sustainability philosophy as their core communication axis, positioning products based on rPET or organic materials within premium market segments. Both pathways represent different, yet equally successful, mechanisms for creating added value in products based on synthetic fibers.

The four technological directions discussed above, together with branding strategies, are systematized in a comparative table based on five parameters. The table is intended to serve as an initial prioritization tool for managers of textile enterprises in the strategic decision-making process (Table 1).

Table 1. Comparative Evaluation of Approaches to Creating Added Value in Synthetic Fiber Products²

Approach	Technological Complexity	Capital Requirement	Value Growth Potential	Implementation Period	Market Segment
Functional finishing (antimicrobial, UV)	Medium	Medium	High	6–18 months	Sports, medical
Nanotechnology-based treatment	High	High	Very high	18–36 months	Military, medical, sports
Smart textiles and IoT integration	Very high	Very high	Very high	24–48 months	Healthcare, technological
Recycled fiber (rPET-based)	Medium	Low–Medium	Medium–High	12–24 months	Eco-retail, sports
Branding and design strategy	Low	Medium	High	6–12 months	Premium, fashion

As can be seen from table 1, functional finishing represents an optimizing approach that requires relatively low capital investment and a short implementation period, while being capable of serving broad market segments. Nanotechnologies and smart textiles possess very high added value potential; however, their technological complexity and capital requirements are correspondingly high, making such investments more suitable for large enterprises or consortium-based ventures. Recycled fiber represents a balanced medium-term strategy that directly responds to growing market demand for sustainability. Branding strategy, in turn, serves as a cross-cutting element that complements all other approaches and ensures their effective market positioning.

This analysis demonstrates that the optimal pathway for leading textile enterprises is not the selection of a single approach, but rather the sequential or parallel combination of several approaches in accordance with their technological and financial capabilities. According to forecasts by grand view research [5], the premium functional textile products sector is expected to continue its growth in the coming years, indicating that favorable market conditions for such investments are likely to remain strong.

CONCLUSION AND RECOMMENDATIONS

This study analyzed modern approaches to increasing added value in products based on synthetic fibers within a conceptual framework that combines porter's competitive advantage concept [6], the resource-based view theory [7; 8], and industry-based empirical evidence. The scientific conclusions of the research are summarized in the following four key positions.

- First conclusion: added value creation is a staged process, and moving from the trade of raw materials to the level of branded technological products requires consistent investment, knowledge, and organizational capacity from textile enterprises. The developed five-stage conceptual model (figure 1) can serve as an instrument for systematizing this process.

- Second conclusion: functional finishing, nanotechnologies, smart textiles, and recycled raw materials are directions with distinct technological and market characteristics, and their effectiveness varies depending on the enterprise's specific resource base, target market segment, and investment opportunities. The comparative evaluation table (table 1) presents these differences in a systematic manner.

- Third conclusion: branding strategy and design are not only an independent pathway for creating added value, but also perform a cross-cutting support function for the other four technological directions. If technological differentiation is not transformed into conscious consumer perception through branding communication, its market effect remains limited.

- Fourth conclusion: the sustainable textiles strategy of the european union [3] and international regulatory documents are creating a favorable regulatory environment for the use of recycled materials and the circular production paradigm in products based on synthetic fibers. This trend is making rpet-based production and sustainability communication an important component of future competitive advantage.

From the perspective of practical implications, the following recommendations were developed:

1. Medium-capacity textile enterprises are advised to choose functional finishing at the initial stage, since this approach allows them to achieve high market differentiation with relatively low capital requirements.
2. Large-scale manufacturers should consider cooperation in the fields of nanotechnologies and smart textiles through international technology partnership programs (unido, horizon europe) in order to share investment costs and technological risks.

² author's development

3. Export-oriented textile enterprises are recommended to develop a phased investment plan for product lines based on rpet and other recycled materials in order to ensure compliance with the sustainability standards of the European market.

4. Any technological investment should be developed in parallel with a branding strategy. If technological differentiation is not communicated to consumers, it will not generate effective market value.

The following limitations of the study should be noted. First, the research is theoretical and qualitative in nature, while the study of a quantitative empirical database remains a separate topic for future research. Second, the specific features of the textile industry of Uzbekistan were not examined in detail, which remains an open direction for future studies. For future research, the most relevant direction is considered to be an empirical assessment of the practical effectiveness of these approaches based on the example of textile

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