



Tunisia national report on textile sector

WP1-D1.2: Tunisia National report

Authors

Lassaad GHALI (ISET KH)
Helmi KHLIF (ISET KH)
Nesrine BOUSSAADA (ISETKH)
Imed BENMARZOUG (ISET KH)
Mouna GAZZEH (ISET KH)

Contributors

Amine HAJ TAIEB (ISAMS-USF)
Bassem KORDOGHLI (ATCTex)
Yosra BRAHEM (Mfcpole)
Fadhel JAAFAR (ISMM-UM)
Faouzi KHEDHER (ISMM-UM)
Lobna ABID (ISMM-UM)
Ferial BOUATAY (ISMM-UM)

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Abbreviations and Acronyms

Abbreviation	Full name
ALECA	Full and Comprehensive Free Trade Agreement
ANGed	the National Agency for Waste Management
ANPR	National Agency for the Promotion of Research
APII	Industry and Innovation Promotion Agency
ATCTex	Tunisian Association of Textile researchers
ATE	Other than totally exporting
BIO	Business and industrial organization
BTS	Tunisan solidarity bank
CETTEX	Textile Technical Center
CIRAT	International Congress of Applied Research in Textiles
CITET	the Tunis International Center for Environmental Technologies
CITT	International Textile Competition
CNEAR	National Committee for the Evaluation of Research Activities
DGET	General direction of technological studies
DGRS	General direction of scientific research
DGVR	Directorate General for Research Development
ENIM	National Engineering School of Monastir
EU	European Union
FCPR	venture capital mutual funds
FDI	Foreign Direct Investment
FODEC	Competitiveness Development Fund
FOPRODI	the funds for industrial promotion and decentralization
FOPROMAT	Fund for the promotion and mastery of technology
FSM	Science Faculty of Monastir
FTTH	Tunisian textile and clothing Federation
GDP	Gross domestic product
GEMTEX	Textile Materials Engineering Research Laboratory, ENSAIT, Roubaix
GII	Global innovation index
HEI	High educational institute
ICT	Information and communication technology
IFM	Frensh Fashion Institute
INNORPI	National Institute for Standardization and Industrial Property
INS	National Institute of statistics

IN'TECH	The risky mutual fund
IS2M	High institute of fashion of Monastir
ISAMS	higher institute of arts and professions of sfax
ISET	High institute of technological studies of ksar Hellal
ITCEQ	Tunisian Institute for Competitiveness and Quantitative Studies
ITP	Priority Technology Investment
LESTE	laboratory for the study of thermal and energy systems
LGM	Mechanical engeneering laboratory
LGTex	Textile engeneering laboratory
LIMA	Laboratory for interface and advanced material
MEI	Mechanical and electrical industry
MHERS	Ministry of higher education and scientific research
MOBIDOC	programs for the mobility of researchers
MPTex	Textile material and process research unit
OECD	Organisation of Cooperation and economic development
PAEI	Entrepreneurship and Innovation Support Program
PAQ	Quality Support Programme
PASRI	Research and Innovation System Support Program
PCAM	Program for business competitiveness and the facilitation of market access
PEJC	projects to encourage young researchers
PEJEC	projects to encourage young teacher-researchers
PIRD	the Research and Development Investment Premium
PMI	Industrial Modernization Program
PMN	Upgrading Program
PNRI	National research and innovation program
PRF	federated research projects
RCA	revealed comparative advantage
RIICTIC	the incentive scheme for creativity and innovation in the field of ICT
SME	Smal and medium entreprise
SNI	National Innovation System
SNRI	National Research and innovation system
STI	Science and technology
TCI	Textile and clothing industries
TCL	textile and clothing and leather
TE	totally export oriented
TTO	Technology Transfer Offices

UNIDO	United Nations Industrial Development Organization
URCAE	Environnement and applied chemistry research unit
VRR	Research Valorization Fund
WP1	Working package 1
WTO	World Trade Organisation

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INTRODUCTION - FOREWORD

The present report, named Tunisia National Report, constitutes the second deliverable of the Wintex project. This project will be accomplished by the joint work of 13 Tunisian and European partners with the aim of helping to connect Tunisian higher education institutions with the textile industry through two main pillars: the innovation textiles' centers and the Academia Textile Industry Council. The expertise acquired from European partners is crucial for setting up these centers, training their staff and ensuring their efficiency and their role as engines of innovation and technology transfer in the Tunisian textile sector. This project is financed by the European Union with a Grant Agreement which amounts to EUR 999,998.

The Tunisia National Report is part of the first phase of the project, which is the preparation phase constituting Work Package 1 (WP1) and aims to present a study on the Tunisian textile sector.

In this Research report related to textile sectors, we intend to cover sector main needs, main strategies and how re-inventing the textile sector in Tunisia for more innovation, creativity, added value, design textile clothing strategies for more sustainability. Specially, the research fields reported in this document cover:

- Macroeconomic data of the Tunisian textile sector
- Mains needs of the sector
- Strategies having been applied for the development of innovation
- How reinventing textile sector.

Elsewhere, the Tunisian national report on the textile sector is the synthesis of documentary research work and field research work through questionnaires and through discussion groups. As lead organization for WP1, ISET piloted the writing of report with the collaboration of the following partners:

- USF: Organization and reporting of two rounds of focus groups concerning results of questionnaires. The focus groups outputs are used as inputs of the national report.
- ATCTex: responsible for carrying out rounds of questionnaires with researchers and analyzing the results.
- MFCpole: responsible for carrying out rounds of questionnaires with industrialists and analyzing the results. The analysis reports of the questionnaires for the researchers and industrialists are used to feed the national report.

Finally, this report has been structured around six main parts. The first one recalls the general context of the project as well as the methodology approach of the study.

The second part reported the macroeconomic data of the Tunisian textile sector according to desk research results, confirmed by the results of the questionnaires.

The third part was dedicated to identify the Main needs of the textile sector in terms of innovation. We are reporting in this part the strategic visions of industrialists and visions of researchers about innovation in textile sector. Industrial needs for innovation and diagnosis of innovation environment by industrialists as well as researchers needs, and diagnosis of innovation environment are also presented.

The presentation and evaluation of strategies implemented for the development of innovation is the subject of the fourth part. The discussion about the news innovation strategies is presented in the fifth part.

We present also in the sixth part a synergy with similar national and international projects. The last part of the report is dedicated to the presentation of the study synthesis and the conclusions drawn.

1. REMINDER OF THE STUDY OBJECTIVES

1.1 General framework and objectives of the study

Textiles and Clothing is one of the main export sectors of Tunisia and the second largest manufacturing sector but faces losses of jobs and companies since decades because of fierce international competition. It needs to improve its competitiveness and compensate with innovation and better valorised know-how its higher costs than other countries and its deficiencies on raw materials and textile upstream in general to organize a migration from subcontracting business models to co-contracting and brand named and innovative finished products with higher added value, often involving the mastery of sophisticated and modern production techniques. For this, producers must take steps to strengthen competitiveness, more rationality and social responsibility on the part of the consumer must be provoked, and a stable and investment-friendly ecosystem on the part of the state must be promoted.

Textile products based on better safety, sustainability and wellbeing are a potential market for companies in the Tunisian sector. They have a higher value-added and the market is expanding with rapid growth following global demand. This activity can provoke spill over effects on other sectors of the manufacturing industry (automobiles, aeronautics ...), which can go as far as the formation of clusters. However, this rise of the sector requires the development and strengthening of the value chain of the textile and clothing industries sector through access to the production of raw materials and high-tech products.

In this context, WINTEX project aims to facilitate the provision of Tunisian students, researchers and industrials in textile field with competencies and skills needed by these markets. Several higher education and training institutions specializing in the field of textiles and clothing should allow this competitive advantage, but still need support to do so.

The support of Erasmus + program received by WINTEX is expected to help 3 Tunisian Universities to get, with the help of EU Partners, expertise, exchange ideas and experience, financial support, capacity building and to brainstorm ideas to help textile clothing sector in order to better shape training courses and specialized education in textile field and encourage close interactions of authorities with the concerned companies, with two objectives:

The short-term objective is to define roadmaps to guide future innovations of textile and fashion businesses, and to allow ideas to better fit industrial constraints and address current market needs. The long-term objective is to offer mentoring services to all partners and to give help to companies interested in developing new sustainable technologies and textile products, aligning social modernization and culture preservation.

Thanks to WINTEX it is expected to develop a more professional and complete approach that will federate experts of several disciplines to support the best projects and allow their transfer within a

textile company partner of the project. The new training model will be disseminated and promoted through this project network and during related competitions after the end of the project.

Practically the project aims the fostering of enterprise-university collaboration in Tunisia by the establishment of three innovation textiles' centers at each participating HEIs, which will boost the collaboration among textile SMEs and participating HEIs and will become focal points for industry encounters providing support and guidance to HEIs' students for embracing innovation and entrepreneurship in the textile sector. They will provide services for innovation development, matching industry needs with research results, promoting cooperation between researchers and industry, developing and promoting of new products and opening of new markets, providing support to researchers and to business owners to commercialize their innovative ideas. They will integrate green technologies and Key Enabling Technologies in the textile sector with particular emphasis at each of the institutions in each to not overlap services and provide better and more comprehensive support to local SME needs.

The establishment of an Academia Textile Industry Council will also play a crucial role in establishing long-term cooperation between HEIs and industry of the textile and clothing sectors in Tunisia that will become the grounds for the implementation of the innovation triangle in Tunisia for the textile and clothing sectors.

So, the present national rapport aims to:

- Assess the importance of the innovation in the textile sector for the economies of Tunisia and the collaboration between universities and companies in the textile sector.
- Assess training needs for experts in innovation textiles' centers in Tunisia.
- Assess the most favorite pedagogical approach for experts in the innovation textiles' centers.

1.2 Study Methodology

1.2.1 Methodology Approach description

The methodology approach is based on two complementary components: Desk research and Field research revolving around the essential points:

- The macroeconomic perimeter of the textile-clothing sector,
- Development and innovation and their relationship with knowledge: relationship between business and university,
- Synergy with ongoing and similar projects

The desk research regroups studies concerning Tunisian sector's macroeconomic scope and its national and international positioning. It also presents the sector innovation sphere. Finally, it presents the strategies implemented by different textile innovation stakeholders. The desk and field

research have been started at the same time. Desk research has provided information to adjust field research. The strategy is based on the collection of data from the two resources, and then a work of framing and refinement has been carried out. In a second period, field research has been restarted and readjusted.

The methodology approach aims to provide information about the main needs of textile sector, main strategies and how to re-invent the textile sector in Tunisia for more innovation, creativity, added value and design textile clothing strategies for more sustainability. Especially this includes information about:

- How moving towards a more circular textile clothing sector,
- How moving from only sub-contracted textile clothing industry to more co-contracting and why not to the finished product,
- How to move from mass production to mass customization production,
- How to integrate the design process in the industrial process?
- How to use the new technologies to innovate in new textile products and applications for more functional textile, functional garments, functional underwear,

The Desk research objective is to collect data on the sector by analyzing relevant reports and strategic documents in order to diagnose the textile sector in Tunisia. This documentary research provides an overview of the textile sector in Tunisia by highlighting these main strengths-weaknesses / opportunities-threats through a SWOT analysis.

The desk research on the textile sector is providing answers on the following subjects:

- Macroeconomic data on the textile sector in Tunisia
- The main stakeholders in the sector
- The needs of the sector from an industrial point of view and from an academic point of view
- The different sector development strategies that have been put in place.

On the other hand, Field research takes the form of questionnaires and focus groups to understand the learning needs, the relevant skills of people working in textile centers and the most relevant training methods. Primary target groups and experts have been involved in the activity. This field research is based on the Delphi approach which makes it possible to seek a consensus on a subject of study in order to prospect the future directions of the sector and these learning and skill needs to lead innovation projects. It used an iterative suite of questionnaires sent to target groups (researchers, academic staff, trainers, innovation experts, BIOs, manufacturers, etc.) on specific subjects in order to generate ideas and identify the expectations and needs of the various stakeholders for development and innovation in the textile sector.

Two target groups are identified:

- Academic experts: directors of research structures in the textile sector where having research activity in the textile field, directors of competence centers (HEI, sector centers),

representatives of support structures (Ministry of high education and scientific research, Ministry of industry)

- Industrial experts: entrepreneur, investor, BIOs.

At the mid and end of the DELPHI process, the selected ideas have been analyzed and validated by Focus Groups representing the main stockholders. In the first time, the Focus Group has validated and analyzed the output of desk research and possible exploitation in the following rounds of questionnaires.

The following graphic (Figure 1) summarizes the methodological process conducted in this study. However, Templates for the field research have been prepared and detailed on the annex 1,2,3 and 4.

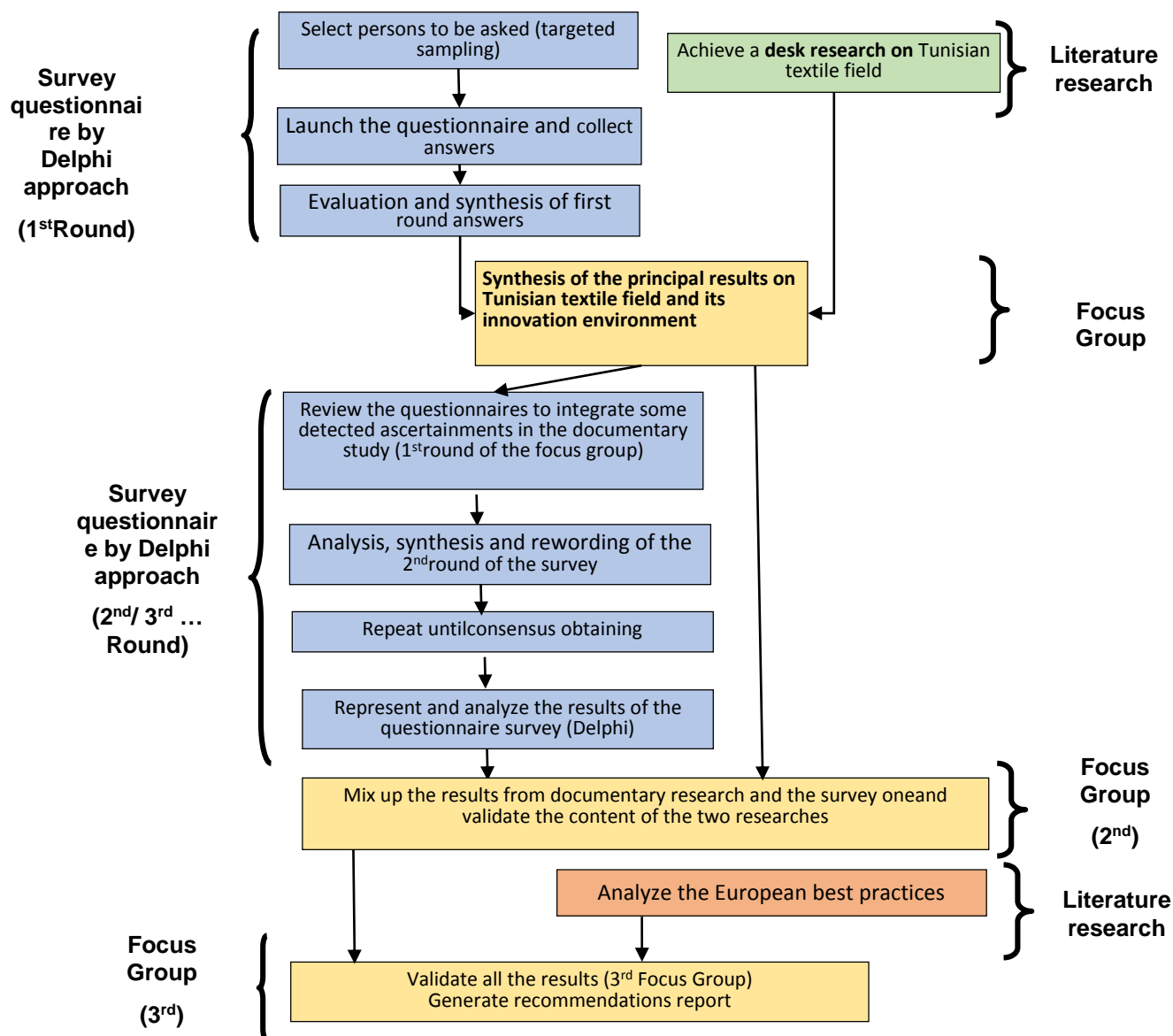


Figure 1. Methodological steps

1.2.2 Field research methodology

1.2.2.1 Questionnaire survey methodology

The survey has been addressed to the Relevant stakeholders such as companies, BIOs, policymakers, training centers, investment and development agencies, investors, business associations, researchers among others

Three types of questions have been included:

- Questions for complementing the collection of data and facts documented by the published reports used in the desk research
- Questions for identifying the specific needs of the stakeholders to be covered
- Questions for consensus making on forecasts on the expected evolution of the textile sector in Tunisia and the possible contribution of WINTEX with the specific solutions to the identified needs.

Indeed, the textile is a multidisciplinary sector; it is an activity which requires skills in materials, chemistry (organic, polymers, mineral), physics, mechanics, management, supply-chain, etc. Often, the research themes differ from one structure to another depending on the vocation (discipline). Several research structures work on textile applications or materials without being classified as a specialty laboratory. For this reason, and based on the requirements of the Delphi method, it was proposed that questionnaires will not be only limited to researchers working in laboratories and establishments specialized in the textile field, but also integrate other research structures working on products and techniques intended for textile and para-textile applications.

The industrial population targeted in the questionnaire is carried out according to several criteria such as geographic cartography (region of Tunis, North, Cap-Bon, Essahel, Elwast and the South), the business activity (Clothing, technical textiles, etc.) as well as to the nature of the company management (subcontractor, co-contracting and brand bearer).

Based on the Delphi method, we called upon the judgment of a group of specialists and intervening in the field of textile research, a real panel of experts. These experts are specialists in the field studied, professionals, researchers, etc. whose identifications remain anonymous.

Several successive questionnaires are addressed to various experts by adopting the Delphi method. The Delphi method steps are:

- Carry out a preliminary questionnaire to gather a first glimpse of the opinions of the various questioned persons concerning the themes. The aim is to encourage the people interviewed to express themselves openly and freely.

- The responses were then processed, divided into three groups and then presented in the form of a distribution. Each part is associated with a summary of the main arguments used by the group to justify its assessments.
- The results accompanied by their arguments were sent to each expert. Based on this new information, they were asked to review their first assessments and answer the second questionnaire.
- These steps were iterated until the dispersion of responses becomes minimal. The goal was to reach a consensus, and, if not, a quasi-consensus, on the subjects investigated.

2.2.2.1.1. Academic expert survey

The academic expert survey approach includes the questionnaire preparation and the selected sample.

a. Questionnaire preparation

Two rounds of questionnaires have been prepared:

- The first questionnaire of the first round: The developed questionnaire consists of three sub-parts. The first sub-section aims to identify the qualities of the researcher questioned. The second sub-section deals with the researcher's judgments concerning the current state of research in Tunisia. The third part is devoted to the opinions of researchers on innovation in the textile sector. The questionnaire is composed of 20 questions with multiple choices and sometimes comments possibility.
- The second questionnaire of the second round: As recommended by the DELPHI method, the second questionnaire presents a summary of the main results of the first questionnaire (of the first round). The objective is to have the opinions of the various participants of the first round on the results obtained. In this new questionnaire, the results of the first questionnaires asked to industrialists have been grouped with those asked to researchers.
The questionnaires are composed of 12 questions with multiple choices and sometimes comment possibility.

b. Sample description

For the choice of researchers, a representative sample of the current distribution of researchers has been carried according to:

- Researchers working in a research structure specializing in Textile (LGTex and MPTex)

- Researchers working in laboratories where one of their research themes is textiles (URCAE, LESTE, LIMA)
- Non-textile researchers working on Textile subjects.
- Researchers working on different subjects: Clothing, textile chemistry, Textile manufacturing, composite, comfort, technical textiles, supply chain, etc.
- The geographical distribution of research structures and higher education establishments.

The Questionnaire has been sent to 100 researchers, with an email explaining the purpose of this questionnaire. Attempts have been made to increase the number of survey participants through reminders and sometimes direct contact by phone or message. According to this, In the first round, 41 responses out of 100 emails have been received whose distribution is illustrated by the following diagram. In the second round, the questionnaires were sent to the 42 participants of the first round; 28 responses were received.

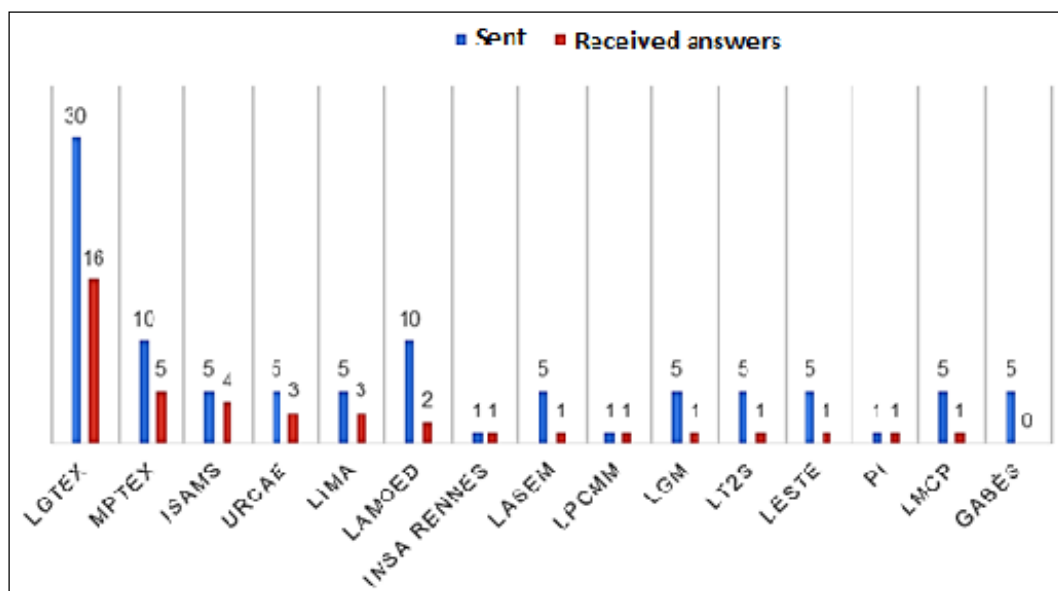


Figure 2. Sample of survey participating researchers

2.2.2.1.2. Industrial expert survey

a. Questionnaire preparation

Two rounds of questionnaires have been prepared:

- The first questionnaire of the first round: The developed questionnaire consists of three sub-parts. The first sub-section aims to identify the qualities of the industrial expert questioned.

The second sub-section deals with the industrial's judgments concerning the current state of research and development in Tunisia textile sector. The third part is devoted to the opinions of industrial on textile campagny's innovation area and main needs. The questionnaire is composed of 18 questions with multiple choices and sometimes comments possibility.

- The second questionnaire of the second round: As recommended by the DELPHI method, the second questionnaire presents a summary of the main results of the first questionnaire (of the first round). The objective is to have the opinions of the various participants of the first round on the results obtained. In this new questionnaire, the results of the first questionnaires asked to industrialists have been grouped with those asked to researchers. The questionnaire is composed of 12 questions with multiple choices and sometimes comments possibility.

b. Sample description

For the choice of industrial expert, a representative sample of the current distribution of industrial sector activity has been carried according to:

- Company type: Subcontracting, Co-contracting, having own brand, European supplier representative, Start up, raw materials manufacturer
- Activity sector: dyeing, technical textile, clothing, testing services

The Questionnaire has been sent to 100 industrials, with an email explaining the purpose of this questionnaire. Attempts have been made to increase the number of survey participants through reminders and sometimes direct contact by phone or message. According to this, in the first round, 40 responses out of 100 emails have been received whose distribution is illustrated by the following diagram. In the second round, the questionnaires were sent to the 40 participants of the first round; 30 responses were received.

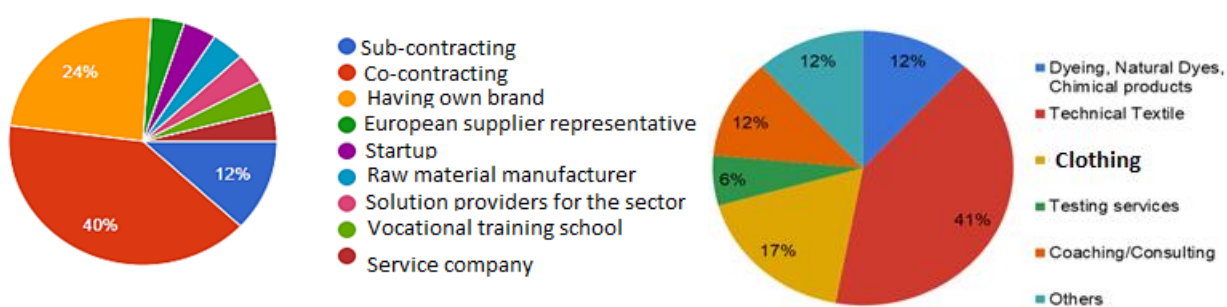


Figure 3. Distribution of survey participating companies by type and activity

1.2.2.2 Focus group Methodology

In order to identify the needs of the textile industry in Tunisia, focus group discussions approach has been adopted as the qualitative approach. The objective was to Collect the input of groups in relation with the textile sector needs in Tunisia. For this, two focus group discussions have been organized by the Tunisian partners in the WINTEX project on the 20th of July on line and the 13th of October 2020 on line. Total number of participants in the two focus groups is twenty tree participants (as shown in annex II).

- **First round:** it was used to validate some of the first results of the desk research and the interviews before their presentation. This first round was held in Tunisia online the 20th of July 2020. The number of participants for this focus group was 17 participants. This focus group discussion took about 120 minutes.
- **Second round:** it was used for a final evaluation and to a first definition of the answers and solutions WINTEX should develop to face the identified needs. The second round was held in Tunisia online the 13th of October 2020. The number of participants in for this focus group was six participants. Each focus group discussion took about 120 minutes.

The focus group was conducted with participants who have been selected according to these criteria:

- Having particularly good and broad expert knowledge and experience of the research topic on textile sector needs in Tunisia.
- Being textile staff teaching, technical staff, students, trainees, companies, BIOs, policymakers, training centers, investment and development agencies, investors, business associations, textile researchers

The discussion focused on identifying the status of the Textile industry in Tunisia, areas of collaboration between textile industry and academia, and recommendations to help and promote the textile industry sector in Tunisia and summarizing the strengths, weakness, opportunities and threats in the industry.

The formal analysis of focus-group data adapted is the thematic content analysis. The analysis has been beginning immediately after focus group closure, and for each focus group question, summarized the “big ideas” or “themes” that were discussed.

2. MACROECONOMIC DATA ON THE TUNISIAN TEXTILE SECTOR

2.1 International context

2.1.1 International economic activity

On a global scale, the textile sector generates a trade of more than 395 billion dollars per year (more than 7% of world trade) and employs more than 40 million people in the world, mainly in the countries of the South. World textile-clothing exports reached 728 billion dollars in 2016, of which 284 for textiles and 444 for clothing. They declined respectively by 23 and 4 billion dollars compared to 2015¹.

In textiles, China held 37% of world imports in 2016, down 3% from 2015 followed by the European Union with a share of 23% and by India with 6%. More recently, statistics for the years 2018-2019² have shown that China dominates textile exports with 110 billion euros (Table.1). The main Asian suppliers of clothing are, in descending order of importance, China, Bangladesh, Vietnam and India (Table 2.).

Table 1. Major textile exporters (2018-2019)²

Textile exporters (Billion euro)	
China	110
Extra EU (28)	21
India	17
United States	14
Turkey	11

Table 2. Main clothing exporters (2018-2019)²

Clothing exporters (Billion euro)	
China	158
Extra EU (28)	31
Bangladesh	29
Vietnam	27
India	18

In terms of imports, the European Union remains the leading textile importer. With its 508 million inhabitants, the European Union is the world's largest market and importer of clothing, ahead of the United States. In 2014, its clothing imports amounted to 73 billion euros. They cover more than three quarters of European clothing consumption. In 2018-2019³ the European Union's clothing imports will reach 99 billion euros.

¹ Share of World Textile Exports by Country 2015, Published by Statista Research Department, July 15, 2016

² Evalliance's textile press review n° 107 (October 21, 2020)

³ Value of Textiles and Clothing Exports from the European Union, Published by Statista Research Department, Feb 4, 2019

Table 3. The main importers of textiles

Textile importers (Billion euro)	
Extra EU (28)	31
United States	28
China	17
Vietnam	14
Japan	9

Table 4. Import of clothing

Clothing importers (Billion euro)	
Extra EU (28)	99
United States	88
Japan	28
Hong Kong, China	12
Canada	10

In 2019, a contraction in textile, clothing and leather activity is observed (-3% vs. 1.5%) and this is related to the contraction in demand from the Euro Zone.

Tunisia has lost its market share of goods against a development of Asian countries and that of Central and Eastern Europe. However, its share of the global market has evolved following the participation of the main exporting sectors namely the textile clothing and leather (TCL) and mechanical and electrical industries (IME)⁴.

2.1.2 Global economic trends: sustainable development, circular economy

The textile industry is the second most polluting industry in the world. The current system of production, distribution and use is linear with negative environmental and social externalities at all stages of the value chain. Despite this, clothing production has doubled in the last 15 years because of fast fashion and the rise of the middle classes. The total amount of clothing consumed in the EU in 2015 amounts to 6.4 million tons. In France, 2.6 billion TLC (textiles, household linen and shoes) are put on the market every year, i.e. about 9.5 kg per year and per inhabitant. In 2017, 3.4 kg of TLC per inhabitant were collected, i.e. only 36% of the potential deposit⁵.

In this context, the circular economy is one of the current global trends in the sector. The circular economy includes the notion of recovery overcoming several sustainable development models revolving around "doing more with less". In terms of sustainability, it would be incomplete to confine the circular economy solely to respect for the environment.

Thus, the integration of the circular economy is a current imperative in the textile sector since the textile industry is the second most polluting industry in the world. Clothing is, in fact, a complex

⁴ Assessment of the external competitiveness of the Tunisian economy, ITCEQ 2015

⁵ The circular economy in the textile industry, September 2018

product, made of different materials (natural, artificial, synthetic), metal accessories, and which undergoes treatments (dyeing, finishing). This complexity does not facilitate recycling during production and at the end of life. 80% of textiles used in the European Union are not recycled. Recycling possibilities vary from one fiber to another. Mechanical recycling of cotton degrades the quality of the fiber and new garments can only contain 20% recycled fiber. On the other hand, wool can be recycled several times and it is possible to transform cotton into a material close to lyocell (artificial fiber) with recycled cellulose. Textiles made from mixed fibers (e.g. cotton/polyester/elastane) are more difficult to recycle because the processes are not the same for different fibers that cannot be chemically recycled without separation. However, these blends are more and more widespread in fast fashion clothing: the current system therefore favours disposable fashion. Closed-loop recycling solutions are therefore still in their infancy. In open loop, the easiest fiber to recycle is polyester: the polymer is transformed chemically into a monomer before retransformation into fibers, which are most often recycled into insulation. In order to recreate textiles, recycled polyester provided from other sectors, in particular from polyethylene terephthalate (PET20) bottles. It is also necessary to remain vigilant about the amount of energy required to recycle fibers, while ensuring that toxic products potentially present in clothing (dyes, finishes) are not put back into the loop. Thus, a large investment is needed, particularly in Tunisia, to develop recycling technologies so that recycled materials become as profitable as virgin materials. Existing recycling solutions therefore do not compensate for the environmental damage caused by the textile industry. There is an urgent need to slow down the extraction of materials and to rethink the use of mobilized resources. The circular economy can then provide answers to the challenges currently facing the textile industry.

From there, the circular economy aims to decouple value creation from our impact on the environment. It implies the implementation of new modes of design, production (eco-design, industrial and territorial ecology, economy of functionality, etc.) and consumption that are more sober and efficient. It also invites us to consider waste as a resource. Styling choices can considerably limit the environmental impact of a garment and improve its circularity. In fact, in production, cutting the pieces of each garment generates between 20 and 30% of fabric offcuts⁵. It will then be interesting to create zero-waste patterns without fabric waste. In addition, 3D printers can be a track to adjust the garment as close as possible to the customer's needs. The choice of fabric, accessories (buttons, rivets...) and patterns also have consequences on the end of life of the product (disassembly and recycling). In the same vein, favouring single-material fabrics facilitates recycling, as does the fact of substituting prints based on synthetic inks with woven or embroidered patterns. On the other hand, sustainable sourcing also reduces the environmental impact and facilitates the circularity of the product. Indeed, conventional cotton is the second most used material after polyester. Its environmental impact can be reduced by the use of organic cotton using less chemical fertilizers and pesticides. Other less widespread natural fibers are much more virtuous for the environment, for example, flax does not require irrigation, few inputs, no OGMs. This plant grows in northern France, Belgium and the Netherlands. Hemp also has similar properties. Among artificial fibers, lyocell is

manufactured with eucalyptus cellulose and is preferable to viscose because the natural non-toxic solvents used to transform wood into fiber are 99% recycled. Thus, pollutants are not discharged into wastewater. The use of synthetic fibers should be reserved for products for which they are not substitutable, such as sports equipment and outdoor clothing. The use of recycled fibers is more virtuous, even if it does not solve the problem of plastic microfibers and must be therefore accompanied by a strategy for recovering microfibers from wastewater at all stages (production, use, waste).

In addition, new practices can reduce the impact during the finishing phases, for example, integrated dyeing prior to spinning would save 90% of water. It is also possible to use vegetable dyes or even bacteria dyes.

Not escaping this global imperative, Tunisian textile companies are in close contact with many of the world's brand suppliers. The evaluation of these brands therefore involves assessing the performance of the Tunisian company at this level. Collaboration is one of the keys to success towards a circular economy. A powerful innovative ecosystem is necessary to ensure the scaling up of the right existing solutions.

2.1.3 Global consumer trends: Fast fashion, consumer ethics and mass customization

The textile industry today is governed by the model of "fast fashion" which is based on very fast collection cycles where styles are constantly renewed. The volume of production and sales is the priority.

It is an approach to fashion that rests on three fundamental pillars:

1. Time: a quick response is needed;
2. The consumer: we must rely on the consumer's wishes;
3. Design: we must always be in tune with demand and fashion.

The consumer is a key element of the "fast fashion" strategy. In about twenty years, this model has considerably modified the relationship to textile consumption, generating the phenomenon of "compulsive buying". This is why Europeans consume much more textiles than before. Another trend is that consumers keep their clothes half as long as 15 years ago, leading to a wasteful behavior where throwing away becomes a habit⁶.

The rise of fast fashion has been profitable for Tunisia. Indeed, all textile branches and more specifically the garment industry related to washing and special treatments enjoys, in Tunisia, multiple

⁶ Alternative offers to fast fashion: actors, projects and strategies An analysis in the Brussels-Capital Region, Joséphine Compaoré, Master in Environmental Sciences and Management, 2018-2019

assets making them the most competitive, with the rise of fast fashion, and making the Tunisian site one of the most favorable to foreign direct investment:

- Geographical proximity to Europe favouring just-in-time delivery;
- Good quality level compatible with the customer's requirements;
- Short and respected delivery times, strong reactivity with regard to small series and restocking;
- Competitive production costs;
- Qualified human resources and confirmed know-how;
- Training and support structures ;
- Modernization and computerization program ;
- Compliance with social and environmental standards.

Some Tunisian manufacturers are beginning to specialize in certain niches that require knowledge and high technical skills such as high-end underwear: with a frequent replenishment of the market it meets the imperatives of fast fashion by manufacturing in small series. They are also able to deliver to the European market (and sometimes the Gulf and North African countries) in a few days thanks to a favorable geographical proximity, thus respecting the following fast fashion calendar:

- Prototyping: 3 days;
- Industrialization of the product: 3 days;
- Production cycle : 3 to 4 days ;
- Transport time: 3 days;

However, recent studies have tried to study the drawbacks of fast fashion, proposing to move towards the aspect of responsible fashion⁷.

For example, the French Fashion Institute has carried out a study of 5,000 consumers, as part of the IFM- Première VisionChair⁸, which constitutes a representative sample for France, Germany, Italy and the United States. For the first time, this study provides a better understanding of how consumers perceive the market for responsible fashion and its products, as well as deciphering their motivations for purchasing and the obstacles they face. The results obtained from this study show that :

- Nearly half of European consumers' report buying eco-friendly fashion products in 2019
- In France, consumers who have bought them have spent an average of 370€ on them.
- Second-hand purchases are on the rise: 56% of American women and 42% of French women

⁷ MARCH M-C. MENVIELLE L. and L. CARRASCO, "Being trendy and committed? Une étude exploratoire sur les déterminants de consommation de mode responsable ", Proceedings International Marketing Trends Conference 2015.

⁸ Fashion markets in Europe and the United States: towards sustainable consumption? (Published December 27, 2019) by the French Fashion Institute

The main lessons learned from this study is that eco-responsible consumption is no longer a fad, but a fundamental movement that now impacts the entire industry, from material sourcing to the consumer, through the textile industry and clothing. Tunisia must also surf this wave and show its commitment to eco-responsible.

2.1.4 Positioning of Tunisia in the international sphere

In Tunisia, trade openness has increased sharply over the last two decades. The gradual easing of tariff and non-tariff barriers, the signing of free trade agreements and the creation of an attractive regime for fully exporting companies - the so-called offshore regime - have played an important role. Historically, Tunisia joined the World Trade Organization in 1995. In 1996 it signed an association agreement with the European Union aimed at the gradual dismantling of tariff and non-tariff barriers and obtained the status of privileged partner in 2012; negotiations on the Comprehensive and Deep Free Trade Agreement (ALECA) are also underway. With Turkey, a free trade agreement was signed in 2004 and fully implemented in 2014. The tariff regime has been also simplified, with a reduction in the number of tariff bands from 54 in 2003 to 3 in 2017.

In the end, the share of exports and imports in GDP in 2016 was close to the OECD average, and higher than in many emerging countries.⁹

Thus, the strategic studies conducted in 2008¹⁰ confirmed the need for Tunisia to display a new positioning. Indeed, Tunisia has been identified among the pivotal countries of the Euro-Mediterranean space with a 7th place in 2008 (however shared by many other countries). Tunisia must therefore strengthen its role as a hub and trade within the Euro-Mediterranean, by demonstrating a strong connectivity of knowledge, goods, services and financial flows.

More recently, at the level of competitiveness, Tunisia has unfortunately lost its place. Indeed, after being ranked among the top 50 until 2011 (according to the competitiveness index), Tunisia's ranking has only deteriorated to be 87 in 2018¹¹. Although it has improved at the level of the pillars "Institutions", "ICT Adoption", "Health" and "Goods Market", it has suffered a decline in the ranking of the remaining 8 pillars, namely "Infrastructure", "Macroeconomic stability", "Skills", "Labor market", "Financial system", "Market size", "Business dynamism" and especially "Innovation capacity".

Moreover, an analysis of Tunisia's comparative advantage reveals that the sector with the largest number of products with a comparative advantage is that of textiles followed by the mechanical and electrical industry. Out of 148 products for which Tunisia has a RCA greater than unity, 39 products

⁹ Tunisia in 2025: The foundations of growth and economic development, THE NATIONAL INITIATIVE 4.0: 10 ACTION PLANS FOR INDUSTRIAL AND TECHNOLOGICAL ACCELERATION IN 2025, December 2016

¹⁰ National Industrial Strategy to 2016, Industry Promotion Agency, 2008

¹¹ Global Competitiveness Index Davos 2019, Tunisian Institute of Competitiveness and Quantitative Studies

are part of the textile sector and eight of the leather and footwear industry. This responsiveness of the textile and clothing sector has been well observed by passing from 2018 to 2019 at the level of investment and exports compared to all sectors of the manufacturing industry. The declared investments in the textile and clothing sector went from 83.8 MD for the first 9 months of 2018 to 115.6 MD for the same period in 2019 (+37.9%). For the same period in 2020, the declared investments reached 103.9 MD looking at a decrease compared to the year 2019 of -10.12%. This decrease is due to the global economic situation of COVID-19.

According to APII data (September 2019¹² and 2020¹³), TCI sector exports represent nearly 20% of industrial exports (respectively 20.1%, 19.48% and 19.43% in 2018, 2019 and 2020). As for imports, the sector imports about 12.2% of industrial imports all sectors combined (Table 5.).

Table 5. Percentage of TCI Sector Export and Import Values

Year	Export share (%)	Share of import (%)
2018	20.01	12.19
2019	19.48	12.35
2020	19.43	12.45

The sector of textile and clothing industries has not been the rest with exports that rose from about 5355.7 MD for the first nine months of 2018 to 5756.1 MD for the same period in 2019 recording an increase of 7.5%. In 2019 and for the same period the export value of the textile and clothing industry is 4831.8 MD with a 16% decline. In terms of balance, we note a balance of 1176.6 MD in 2018 then 1235.1 MD in 2019 and 1227.4 MD. This positive trade balance shows a high export potential of the textile and clothing sector.

2.2. National context

2.2.1 Textile Industrial tissue

2.2.1.1 Economic activity

The textile and clothing sector is a pillar of the Tunisian economy; it represents in 2010 more than 4% of the Tunisian GDP and employs nearly 200,000 people. Indeed, TUNISIA is among the world's leading

¹² Bulletin de Conjoncture September 2019, Agence de Promotion de l'Industrie et de l'Innovation (Agency for the Promotion of Industry and Innovation)

¹³ Bulletin de Conjoncture September 2020, Agence de Promotion de l'Industrie et de l'Innovation (Agency for the Promotion of Industry and Innovation)

suppliers of clothing. It enjoys a position of fifth supplier of Europe and second supplier of France in the field of textiles and clothing¹⁴. More broadly, the Agency for the Promotion of Industry and Innovation and concerning its strategic studies conducted until 20259 the textile sector will be the first growth sector followed by the food sector and then the mechanical and electrical industries. These sectors together account for nearly 30% of GDP and concentrate 70% of FDI and 80% of jobs.

Although, several studies have shown variability in the number of firms and the number of employees, which can be explained by the changing economic context that induces a change in the data. It should be noted that the number of companies operating in the textile sector, generally varies between 1598 to 1986 units with a workforce greater than or equal to 10 between the years 2010 to 2020¹⁵, 84% of which are fully exporting. It is to say that the largest share of these companies operates in the manufacturing industry is 31% to 35%, ensuring an employability of 34% to 37% of the sector.

SMEs are highly concentrated in the textile and clothing industries (28.0%)¹⁶.

Thus, one of the strong points of the textile and clothing sector in Tunisia is that it is a sector with high employability in which more than 85% of its total workforce are permanent jobs. However, two elements of reflection accompany these findings. The first is that the largest share of employees is low skilled, the second is that it is mostly composed of female labor.

Tunisia is also ranked 18th in the textile industry and 13th in clothing. Thus, the sector has a very significant impact on the country's trade balance by contributing to more than 20% of Tunisian exports. Indeed, and according to UNTCTAD statistics, Tunisia is among the 20 countries with an economic dependence on textile and clothing exports. Exports include clothing in warps and wefts, knitwear, fabrics and sewing thread. A significant progression is also recorded in jeans, baby clothing, men's underwear and sportswear. According to estimates made by the Agency for the Promotion of Industry and Innovation, this growth may reach 10 billion by 20259.

Textiles and clothing comes immediately after agriculture in terms of added value produced: it is the source of 7% of GDP. The flow of Foreign Direct Investment (FDI) in 2014 amounts to 28 MTND, of which 11 MTND is for new creations and 17 MTND is in the form of project extensions. 6,461 MTND of exports from the TCI sector in 2014. Wages distributed by the sector represent 7.8% of the total wage bill and 12.5% of wages in the market sector alone, a share that has increased slightly since 1994. The trade balance of the sector represents 4.7 percent of GDP and is provided by the offshore sector. The contribution to the current balance is lower because part of the (untaxed) profits of offshore

¹⁴ The textile and clothing industries remain a key sector of the Tunisian economy, APII. Center for Documentation and Industrial Information, 2017

¹⁵ BDI, APII, July 2020

¹⁶ Characteristics of the Tunisian Industrial Fabric in 2011: Institutional Framework and SME Financing, Tunisian Institute of Competitiveness and Quantitative Studies, ITCEQ/N°22/2012

2010 to 2016) and a decline in investment (-5.6% between 2010 and 2015). Fortunately, the sector has been experiencing a recovery since 2017 and offers a significant potential to recover the 2 points lost in the European market, knowing that each point represents nearly 40,000 new jobs.

Despite this rebound, it is clear that the textile sector is still focused on low value-added activities. The current economic context has not been conducive to innovation, the dynamism of the private sector and the move up the value chain, levers for creating value added.

Finally, let us note that the international pandemic context of Covid-19 has not spared Tunisia as well. It has indeed destabilized the global value chain of the textile and leather sectors. International trade exchanges have experienced a drastic drop because the world supply and demand suffer simultaneously. Clothing imports from the European Union, the main export markets of our neighbors, have fallen sharply by 17.3%, while they fell by 30.7% in the United States in the first half of 2020¹⁹ compared to the same period in 2019, Turkey (-21%), Cambodia (-21.3%), India (-26.6%), the United Kingdom (-27%). Similarly, hit by the same economic situation, Tunisia recorded a decline of -29.7%.

2.2.1.2 Sector activity evolution

a. Typology of companies operating in the textile and clothing sector

Referring to the industrial database of the Agency for Industrial Promotion and Innovation¹⁵ (July 2020), the textile industrial sector counts 1585 companies and employs 162,359 people.

¹⁹ Press review n° 107, October 21, 2020

Table 6. Distribution of the Tunisian textile sector by activity group

Activities	TE	ATE	Total
Spinning	5	15	20
Weaving	12	16	28
Finishing	28	11	39
Hosiery	117	35	152
Warp & weft and knitwear	1051	169	1220
Other textile industries	196	81	277
Total	1299	286	1585
Spinning	5	15	20
NB: Some companies operate in several activities at the same time.			

In terms of preponderance of activity, it is to be noted that the warp and weft and knitwear represents 76.9% of the total number of companies, followed by hosiery with 9.5% in number of companies.

In terms of international partnerships, it is worth noting that among the 1,299 units totally exporting in the sector, 543 are in partnership with mainly European companies. France occupies the 1st position with 245 units, followed by Italy with 160 units. Next come Belgium and Germany with 74 and 64 units respectively. Subsequently, the textile and clothing industry is the sector where the Euro-Mediterranean partnership is the most developed. The sector is in direct contact with the companies of the priority countries which are France, Italy, Belgium and Germany. The activity of clothing is dominant with an importance of the hosiery activity.

Table 7. Distribution of the Tunisian textile sector according to foreign partnership

Activities	Foreign partnership with Tunisian textile companies								
	France	Italy	Belgium	Germany	The Netherlands	Great Britain	Switzerland	Luxembourg	Portugal
Spinning	1	2	0	0	1	1	0	0	0
Weaving	5	2	1	1	1	1	0	1	0
Finishing	10	8	0	1	0	0	0	2	1
Hosiery	14	24	5	2	0	2	3	0	1
Warp & weft and knitwear	186	110	60	57	7	9	8	10	10
Other textile industries	53	31	16	8	6	2	2	2	0
Total	245	160	74	64	14	14	13	13	12

In addition to the hosiery activity, the finishing activity, mainly in direct relation with French and Italian companies, is developing more and more.

In terms of employability, the textile and clothing industry sector has 1,585 companies employing 10 or more people. Among them 1,299 produce totally for export. Companies employing 10 people and more employ 162,359 people, of which 147,019 are totally exporting companies and 15,340 are partially exporting companies. Mentioning that the majority of employees operate in the garment sector followed by other industries that include the technical textile activity, hosiery activity shows a high rate of employability.

Table 8. Distribution of Employment by Activity and Plan for Firms Employing 10 or More People (July 2020)

Activities	TE Jobs	ATE Jobs	Total
Spinning	1 128	954	2 082
Weaving	2 205	832	3 037
Finishing	8 631	756	9 387
Hosiery	15 509	1 614	17 123
Warp & weft and knitwear	121 029	9 200	130 229
Other textile industries	28 102	4 739	32 841

The majority of companies, 78.9%, operating in the textile and clothing industries employ between 20 and 200 people. This shows that the majority of companies are small or medium sized.

Table 9. Distribution of Firms Employing 10 or More People by Employment Size Group

Slice	TE	ATE	Total
[10 ; 20[	113	91	204
[20 ; 50[	345	105	450
[50 ; 100[	393	63	456
[100 ; 200[	288	14	302
[200 ; 500]	130	11	141
> 500	30	2	32
Total	1299	286	1585

Finally, in terms of geographical distribution, the governorate of Monastir is the first concentration of industrial companies in the textile and clothing sector (366 units), representing 28.1% of the total number of companies in the sector followed by the Grand Tunis with 222 companies, or 17%, Nabeul, Sousse and Mahdia with respectively 14.13 and 7% (Table 10.).

Table 10. Regional distribution of companies employing 10 or more people (July 2020)

Region	TE		ATE		Total	
	Number	%	Number	%	Number	%
Monastir	366	28%	60	21%	426	27%
Grand-Tunis	222	17%	72	25%	294	19%
Sousse	174	13%	13	5%	187	12%
Nabeul	176	14%	7	2%	183	12%
Sfax	78	6%	73	26%	151	10%
Mahdia	86	7%	14	5%	100	6%
Bizerte	72	6%	5	2%	77	5%
Other regions	125	10%	42	15%	167	11%
Total	1299	100%	286	100%	1585	100%

b. Clothing activity dominance

Warp & weft and knitwear manufacturers represent more than 68% of the total number of companies in the sector. The Tunisian offer is dominated by clothing products. The other links, such as the supply of components, are unable to provide the downstream. The sector lacks a textile industry that allows the upward movement of the sector. For example, in 2012, warp and weft clothing accounted for 62% of TCI sector exports, 23% are knitwear and 15% are other products (household linen, second-hand goods, special fabrics, threads and yarn, accessories, etc.). For the clothing sector (year 2019)²⁰: Clothing in warp and weft evolve by +14.18% in TND and -5.16% in tons. The knitted garments grow by +13.21% in TND and +2.41% in tons.

Thus, the fields of specialization of Tunisia on these various branches are as follows:

- Knitwear: sportswear, tee-shirt, lingerie and corsetry with a representation in 2004 of 19% of Tunisian production.

²⁰ La lettre économique de la cettex, March 2019

- Manufacture warp and weft: Jean, city pants and work clothing with a representation of 72% of Tunisian production and an excessive concentration of exports to the European Union.

In addition, the analysis by activity of the textile sector¹⁵ (BDI, APII July 2020) shows that garment manufacturing has the largest weight in the textile and clothing sector with 62% of companies and more than 64% of jobs in the sector, followed by hosiery and production of underwear (Table 6.).

Two observations are obvious at this level on the one hand, the activities of technical textiles and work clothing, considered as the most profitable activities in the textile and clothing sector, due to their high added value and low competition in this field of activity, represent only 11% of the total number of companies in the sector and 18% of jobs.

On the other hand, luxury and children's fashion, considered as two niches with interesting potentialities, not sufficiently taken into consideration by the Tunisian industrial fabric. The Tunisian textile sector is, in fact, led to focus on these niches. The luxury market comprises first and foremost the fashion segment representing the most important weight (27%), followed by the beauty segment (25%). Fashion includes ready-to-wear, shoes and leather goods. The large share of the luxury market is taken by Europe with almost 41% and more precisely France and Italy. France is the 3rd European exporter for fashion and this sector is the first product exported by this country in Asia. Exports of French clothing, supported by the significant support of the Défi de la mode, have experienced strong growth outside Europe: +8% per year since 2010, and +26% per year to China. Observing that while women's ready-to-wear made 1.8 million euros in exports in 2008, it will make 2.3 million in 2016, an increase of nearly 30% in 8 years... Luxury and ready-to-wear export 36% of their products, the "French mass market" 28%. In the study carried out by the IFM in 2013 on the economic weight of creative brands in France, 87% of the turnover of the companies surveyed is made from exports. Thus Tunisia with its first French partner is led to exploit all these strong points. Also, children's fashion is a very interesting niche in the world, for our European partners and for Tunisia. This segment is a privileged axis for the major clients. The global children's market is worth more than four billion euros.

In terms of exports, the analysis by market of warp and weft clothing exports shows a growth in TND during the first quarter of the year 2019 in the main markets, apart from Spain (-18.56%). It also shows a penetration on the Irish market. Exports of knitwear recorded significant increases in TND from Italy (+22.52%) and Spain (+44.59%). A breakthrough in sales was also recorded in the Netherlands and Austria.

In terms of imports, during the first quarter of the year 2019 and compared with the same period of 2018, the analysis by branch shows the following trends:

- Fiber imports increased by +87.43% in TND and +19.39% in tons. Turkey, the leading supplier, tripled its exports to Tunisia in value and weight.
- Yarn imports increased by +28.79% in TND and +29.03% in tons.

- India, the leading supplier, recorded growth of 56.98% in TND, followed by Italy (+46.70%), then China (+91.58%) and Turkey (+59.25%).
- Imports of fabrics evolve of +26.27% in TND and +15.71% in tons. China and Turkey are increasing their sales to Tunisia respectively by +20.30% and +42.67% in TND.
- Imports of clothing fell by -17.02% in TND and -24.62% by weight. Those from Turkey and China are down respectively by -0.56% and -54.38% in TND and by -23.86% and -49.38% in weight.

c. Emergence of low-cost countries and departure of European contractors

Tunisia presents handicaps of attractiveness due to competition from other countries with similar economies (Morocco, Turkey) and Asian countries in sectors that are pillars of Tunisian industry (textiles, food processing and mechanical and electronic). China combines, indeed, the major factors of competitiveness: low labor costs, a high level of training, a high level of research and development, as well as an advanced infrastructure. What is at issue is less China's strategy, which plays the economic cards at its disposal, than the inconsistencies in the policies of firms and states in industrialized countries, which respectively benefit from short-term rents on the one hand, and give up their regulatory power on the other. European principals have turned to China because it produces relatively well, quickly and benefits from particularly competitive labor compensation and working conditions for employers. But China cannot be put on the same level as the usual subcontracting countries such as Tunisia, Morocco or Turkey. China has the capacity to transform this phase of international subcontracting into an autonomous production capacity, including at the level of creation and at the level of extension, through multinationalization, of its companies on the European markets. And the rent currently enjoyed by European companies can change hands. China needs a strong surplus in this sector. China has the means to increase it and to perpetuate it.

China, an emerging country, is the big winner in the offshoring movement. This country has become the world's leading producer. Its exports, both in Asia and worldwide, account for more than a quarter of world exports. It should be noted, however, that Chinese clothing exports are concentrated in the low and middle range, with prices 20 to 50% lower than world prices, thus playing on the price competitiveness advantage. In addition, the contribution of Textile Clothing to the trade balance is considerable: 2.5 times greater than the balance of trade for all sectors combined. One observation is obvious at this level, the rise of China, which combines the major factors of competitiveness low labor costs, high level of training, high level of research and development, and an advanced infrastructure) has changed the game of the textile and clothing sector at the international and national levels. Indeed, European principals have turned to China because it produces relatively well, quickly and benefits from particularly competitive labor compensation and working conditions for employers. Although it cannot be put on the same level as the usual subcontracting countries such as Tunisia, Morocco or Turkey ..., China has been able to generate its own demand by pulling itself away

from European principals to Tunisia, attracted by its low production costs. Moreover, China has led the principals to seek a new typology of suppliers who can coordinate the sourcing of raw materials, logistics and fast deliveries.

Among the causes of this radical transformation, three factors deserve reflection. Firstly, the extremely low hourly costs, an important cause, although alone it does not explain the extent of the phenomenon. Secondly, China's accession to the WTO in 2001 is another major explanatory event. In accordance with the ATCs, the positive effects for China of the progressive elimination of quotas were not long in coming. Thus, according to a study by the Commission of the European Communities, European imports of product categories liberalized for China have increased by 46% in value and 192% in volume. For these same products, European imports from the rest of the world fell by 13% in value and 11% in volume with a decrease of only 2% in unit prices. In terms of value, China's share of these products rose from 25% in 2001 to 38% in the first half of 2003. In volume terms, China's share for the same period increased from less than 14% to 37%. Finally, the third major cause of China's rise in the global textile and clothing market is the importance and contribution of clusters and supply chains. These factors have enabled the advantage of low wage levels to be fully exploited. China's Textile Clothing industry is indeed based on 38 textile clusters and 48 clothing clusters, all on the Chinese coast, and mainly in 4 regions. More than 80% of Chinese exports come from these clusters. For example, the children's clothing cluster in Zhili in Zhejiang includes 5,700 companies specializing in children's clothing; 80,000 people are employed there - more than all French employees working in clothing - and 70% of households earn their income from this activity. Also, the cluster located in Pinghu in Zhejiang around the garment and export industry has helped to frame the activity and improve the value chain, resulting in an effect of attracting investors from around the world with the presence of 200 foreign-owned companies and an export of 95% of its production to 56 countries²¹.

In addition, in this context, the rise of fast fashion has, fortuitously, regularized the market especially between Asian countries and traditional suppliers of the European Union, including Tunisia. The fast fashion has introduced a new segmentation of the product portfolio of brand names divided between basic products, core collections and news. This tripartite portfolio helps boost sales and encourage consumers to renew their purchases frequently. As a result, the principals of the European brand names are increasingly favoring major sourcing from Asian countries for basic products, thus benefiting from economies of scale in terms of production and logistics costs. On the other hand, they have favored small sourcing from neighboring countries for core collections and news. Tunisia as a country bordering Europe offers the advantage of quality/time (control of small series production and reactivity in lead time) which has enabled it to reposition itself among European brand names in this era of fast fashion where speed and time to market are the key words.

²¹ Gumisai Mutume, Textiles: Loss of opportunities costs Africa jobs: Diversification and productivity are essential for economic recovery, Africa Renewal: April 2006.

Let us note that in the niche of basic products, Tunisia has little chance of being competitive against China. On the other hand, in the niche of collectible hearts and news, Tunisia has every chance to strengthen its position by consolidating its image as a specialist in small series. It has become necessary for Tunisia to develop the "Time to market". This is in order to better meet the expectations of customers in terms of quality, speed, technicality and competence, especially those of "Fast Fashion" who are looking for suppliers who can coordinate the sourcing of raw materials, logistics and fast deliveries. Efforts still need to be made to better position itself in this fast fashion value chain by seeking to optimize the time to market for its principals, European brand names, particularly by improving logistics management and by absorbing design and development activities. The Asian experience is, in this sense, to consider for Tunisia, including the operation and contribution of clusters to the performance of the textile value chain.

d. Emergence of consumer clothing Tunisian brands

The landscape of the clothing market has changed in recent years by seeing the emergence of new brands of Tunisian mass distribution, adopting new marketing techniques. These companies have managed to move from the status of a simple craftsman working in the textile sector (garment maker), to a distribution leader (retailer), mainly citing the example of Zen and HA chains.

Zen is a family business created by the Zouari family who has been working in the textile sector since 1978. This small company, founded in Sfax in 2003, has been very successful. Zen's reputation then spread beyond the borders of its city, giving birth to several stores spread over several cities in Tunisia. Moreover, the story of Hammadi Abid-HA began in the late 80's with a love for the textile industry passed on as an inheritance from father to son. It is by working as a young craftsman in a fabric store located in the Medina of Sfax that the founder of the most famous Tunisian brand made his first steps in the trade ... He was able to develop in time as one of the first signs of distribution of ready to wear and out of the label of a manufacturer.

These two pioneering brands in the field, cited as examples, were followed by others such as Sasio, Blue Island, Exist... These brands have helped to boost the market on a national scale through newly introduced marketing strategies and techniques. However, efforts and learnings remain to be seized at this level to improve the competitiveness of these brands and ensure their national and international scale.

Moreover, it is interesting to reflect on this maneuvering, albeit timid but uphill, towards own brands in Tunisia. This rise of own brands of ready-to-wear distribution brands in a country traditionally known as an industrial area of clothing, is not unrelated to the rise of China and the market disruptions that Tunisia has suffered. Traditionally operating in the garment industry, and with the departure of customers to the new low-cost countries, these brand names have found themselves with a know-how of over twenty years not capitalized and recognized on the market pushing them, thus, to launch

their own brands as an imperative to capitalize on a viable brand name in a national and international market known by its movements and the attraction of low prices. This passage demonstrates a new market orientation of the sector, traditionally based on technicality and wanting to be impregnated with marketing approaches. The low price label cannot guarantee the viability of a sector since it is dependent on geopolitical and geosocial factors (political regime, social regime ...). Long considered as a low cost country, Tunisia has been removed this label to be attributed to China; this label can be reassigned to other countries with new geopolitical and geosocial data. Hence the search for a label based on more stable and sustainable differentiation elements such as quality and the willingness to capitalize on them under brand names are new issues on which Tunisia is betting.

e. Expansion of the informal market and its impact on the clothing sector

According to the confederation of corporate citizens of Tunisia (study conducted May 04, 2017) the subdivision of the Tunisian economy is carried out according to the scheme presented below:

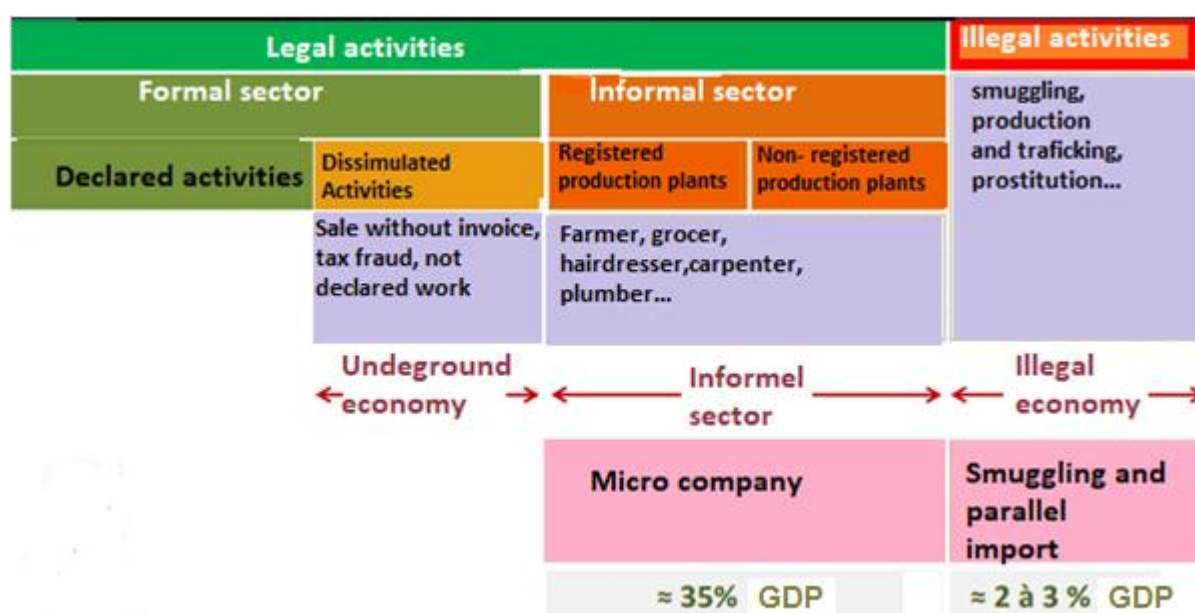


Figure 4. Subdivision of Tunisian economy: formal and informal sector

Thus, the informal sector continues to weigh on the national economy in Tunisia. A total of 1.598 million people worked there in 2019. This is what emerges from a survey conducted by the INS (National Institute of Statistics) and published on September 18, 2020. Formally, there are 1.967 million according to the same source. Thus, the informal sector accounts for 44.8% of jobs in Tunisia.

If we remove the workers in the agricultural and fishing sector, the share drops to 38.3%, which is still, in any case, substantial. It is the male population that works the most in this sector. In fact, according to the INS, 81.2% of workers are men, which represent 1.297 million people.

On the other hand, again according to the INS²², it is the agriculture and fishing sector that remains the most affected by the informal sector. In fact, 85.6% of employees are not declared. It is the same trend for the construction and public works sector (69.2%), followed by trade (64.7%). The textile sector does not escape this trend and suffers from informality.

f. Development of co-contracting

The majority of Tunisian industrialists operating in the textile sector do not export finished products but sell a service, the shaping, to customers. The export flow is the same but the value created is very different. The response to customers takes several forms that can be classified according to their degree of autonomy. This position is quite similar to that of the "fashioning" subcontractor who receives the yarn and fabrics in deposit and makes them from the patterns sent to him by the client. These fabrics are sometimes pre-cut, as the smaller fabric makers do not have automatic cutting equipment that limits offcuts. A common practice within the same region or country, the use of fabricators has developed across borders. The subcontractor has limited knowledge of his market and in many cases only knows the client with whom he negotiates working time and cost per minute. Manufacturers regularly call on a subcontractor to handle a larger order (capacity subcontracting) or to reduce costs (outsourcing of the most labor-intensive operations). When the client is a distributor, the distributor must perform the same functions as an industrialist with the subcontractor: he is responsible for the choice and purchase of materials (yarns and fabrics), he designs the models and controls the subcontractor's work. These are all functions that are not part of his job. The manufacturing activity of the co-contractor does not differ from that of the subcontractor except by the fact that he always ensures the cutting of the fabric and the packaging of the articles. The difference lies in the supply. It is indeed the co-contractor who chooses the fabric. In order to do so, he must have a good knowledge of the tissue market in order to choose one that meets the specifications of the client. He must be able to finance this purchase and this considerably increases his working capital requirement.

Co-contracting is more easily implemented in a country with a diversified industry, as in the case of Tunisia where weaving, knitting, garment making, dyeing, finishing and washing facilities exist, because manufacturers are then assured of quickly finding the supplies (especially fabric) they need. In this case, the autonomy of the co-contractor opens up possibilities for local manufacturers who have not been "referenced" by the foreign client. But when the national textile offer is non-existent, the co-contractor must turn to foreign suppliers without having more information than the client. In

²² In Tunisia, the informal sector has 1.5 million workers, INS, September 19, 2019

this case, far from signifying greater autonomy, co-contracting appears only as a transfer of charges: the co-contractor ensures the financing of the principal's working capital.

The difference between the co-contractor and the manufacturer of finished products lies in the design of the articles - he has his own collection - which is proposed to the client, thus generating an added value superior to their manufacturer. Finally, when the manufacturer succeeds in promoting its brand, it can seek to sell directly by establishing its own marketing network.

In practice, principals simultaneously practice subcontracting, co-contracting and trading. These modalities are sometimes put in competition. Nevertheless, there are national "specificities": in Europe, Northern countries practice more co-contracting, while France, Italy and Spain (potential customers in the textile sector) do more subcontracting. The latter is done more by industrial clients and, conversely, co-contracting is more practiced by distribution. When the client has subsidiaries, an initial arbitration can oppose the department, which wishes to "charge" its subsidiaries, to the trading department, which wishes to place orders with manufacturers of finished products, often Asian. Once the choice to produce within the group has been made, a second negotiation will lead to the choice of a production site. On the side of subcontracting or co-contracting companies, all functions are sometimes performed simultaneously. An industrial company with its own brand name can subcontract. Even if these situations coexist within the same country, there are significant differences between countries. Subcontracting is very little practiced between European (American) principals and Asian manufacturers. On the other hand, it is frequent between Asian companies: they offer their clients finished products that they have manufactured by Asian subcontractors. Subcontracting, which is very little practiced in Turkey, is the main export method for North African, Central European and Caribbean countries. This typology suggests the existence of a continuity from subcontracting to export under own brand name through co-contracting. However, a look back at the history of the international integration modalities of the different countries shows that this is not in fact the case.

In any case, the shift from subcontracting to the end product can only be beneficial for Tunisia. Indeed, the marketing of finished products is more profit-generating than that of subcontracting services for the manufacturer. It also allows the absorption of skilled labor, on a national scale. Finally, it is better suited to the global fast fashion orientation since it allows brand names to better control their lead to market (taking charge of the fashion and design research component by the manufacturer).

g. Technical textile development

The branch of technical textiles is one of the sectors of the future for the textile and clothing sector worldwide and particularly in Tunisia. Technical textiles are often integrated with other materials and used for their technical performance in almost all industrial sectors, particularly the automotive, aeronautics, electronics, civil engineering, medical and paramedical sectors, ...

In 2011, the global market reached \$133 billion with an estimate that this value could reach \$160 billion in 2018¹⁸. The fastest growing industries are mainly the non-woven goods branch followed by the composite materials branch. These two segments are the main drivers of the technical textiles industry worldwide. As such, the share of the European market is split between 20% for technical textiles, 25% for non-woven items and 33% for Composite Materials. The share of non-woven fabrics increased between 2007 and 2013 by 25% in Europe, 14% in North America and 191% in China. Internationally, China has overtaken the United States and the European Union as the main producers of nonwovens and has a global market share of nearly 30%.

In Tunisia¹⁸ the activity relating to technical textiles represents only 9.6% of the total number of companies in the TCI sector and 15% of total employment in the sector, 85.3% of which are permanent jobs. Companies in Tunisia are already undertaking excellent research that is strongly focused on technical applications and therefore guided by the requirements of the end user. The technical textile sector is also characterized by a high rate of supervision. However, technical textiles remain one of the future sectors for the textile sector in Tunisia with currently 250 companies, of which nearly two thirds are active in the clothing, furniture, personal protection and sportswear markets. In addition, the emergence of activities related to the automotive and aeronautics industries and the development of demand in the field of health shows an evolution in terms of the number of companies and the volume of Mobil Tech markets.

The current know-how of Tunisia in technical textiles is around the following products:

- PROTECH: Manufacture of protective clothing, uniforms and accessories, safety gloves and vests, etc. (the global market for work and protective clothing has grown from a volume of €14.7 billion in 2009 to a total volume of €24.5 billion in 2015).
- HOMETECH : Household linen, tarpaulins and blinds, upholstery fabric and floor covering, etc.
- MOBILTECH: Airbags, car covers, car seats, sails, airplane seats, pneumatic drive wheels, seat belts, etc.
- PACKTECH: Films and plates, bags and pouches for textile packaging, etc.
- CLOTHTECH : Work clothing, overalls, industrial clothing, elastic knit sleepers and ankle pads, etc....
- MEDITEC: Protective masks, orthopedic prostheses, surgical salts, splints, orthoses, dressings, etc.
- SPORTECH: Ski suits, water sport suits, sweatwear, specialized sportswear, etc.,
- INDUTECH: Automotive filters, industrial machine filters, etc.
- AGRITECH: Fishing nets, ropes, alpha ropes and twine, etc.

h. Challenge of the textile business digitizing

The Tunisian textile sector is strongly export-oriented. Thus to improve its performance and better manage its information and material flows, it is led to exploit the pillars of digitalization, in particular:

- E-business: Managerial use of information technology. Its fields of application: relations with upstream suppliers, internal production and communication processes, relations with downstream customers and distributors.
- E-commerce: Commercial transactions taking place remotely through electronic and digital interfaces.

With regard to digitalization, Tunisia occupies a position of regional leadership in the ICT sector following the example of the international rankings of the World Economic Forum in Davos in ICT (1st in Africa, 3rd in the Arab world and 35th in the world according to the Network Readiness Index 2016)²³. It achieved a score of 3.9 on a scale ranging from 1 to 7 which allowed it to rank 81st worldwide at the same level as in 2015. Tunisia ranks second in North Africa just after Morocco.

The ICT sector also accounted for nearly 8% of GDP in 2007 and employed more than 6,000 people in 2007. Exports from this sector reached nearly 50 million dinars. The textile sector is one of the sectors that contributed to this performance and can better exploit digitalization. However, the small size of Tunisian ICT service companies remains an obstacle to the sector's development.

i. Challenge of the textile industry harmfulness

The textile industry is the second most polluting industry in the world. The current system of production, distribution and use is almost entirely linear with negative environmental and social externalities at all stages of the value chain. In fact, the production of garments requires different resources, starting with water for cotton cultivation and dyeing processes, between 7,000 and 11,000 liters of water are needed to make a pair of jeans. As an example, the water impact of all clothing consumed in the EU in 2015 amounts to 46,400 million m³.

On the other hand, the textile sector is highly dependent on fossil fuels, since synthetic fibers (polyester, polyamide...see box on textile fibers) are derived from oil. Polyester today represents 60% of the fibers currently used and its use is expected to double by 2030. The textile industry also generates various types of pollution during the production of fibers (use of pesticides and fertilizers for cotton, which represents 26% of the fibers used) during production (dyeing water loaded with toxic products) and during use (plastic microfibers).

The production and transportation of textiles also generates 1.2 billion tons of greenhouse gases per year, more than all international flights and shipping combined. The value chain is long to produce a garment and each step can take place in a different country: a pair of jeans can travel up to 1.5 times around the world, from the cotton field to the shop. It seems that the use phase has the highest carbon impact (machine washing and drying) while production is responsible for about a quarter of CO₂

²³ The Networked Readiness Index 2016

emissions. This strong strain on resources and the associated pollution will worsen as garment production is expected to triple by 2050.

Tunisia is no exception to this environmental observation. Indeed, the industrial sector is the largest consumer of energy with a share of 36% of overall final consumption, ahead of the sectors of transport (31%), buildings (27%) and agriculture (6%). The industrial sector is the largest consumer of electricity, with a share of about 46% in 2010 and the Tunisian textile sector consumes about 4%²⁴.

Concerning environmental degradation in Tunisia, in 1999, the annual cost of environmental damage was estimated at between 1.5 and 2.7% of GDP with an average of 2.1% (broken down into 0.61% for water, 0.58% for air, 0.52% for soil and forests, 0.26% for the coast and 0.13% for waste). In 2004, a specific analysis of the damage corresponding to the insalubrity of water still estimates it at 0.6% of GDP (with the following breakdown of impacts: 0.2% for agriculture, 0.1% for fishing, 0.1% for health, 0.1% for tourism, 0.1% for the over-exploitation of groundwater). Thus, it will be strong to note that the textile sector is energy and water consuming sector and especially the finishing sub-sector (dyeing, finishing, washing...). In addition, the cost of treatment of one kilogram of material is higher compared to France and India on both indices of water and electricity consumption.

Under the combined pressure of increasingly strict regulations, more demanding customers, more responsible consumers and general awareness, the turning point has been reached. The textile industry, especially the Tunisian one, is now committed to sustainable development, which integrates both the preservation of the environment, fairness in economic exchanges, and social ethics. Energy savings, the development of innovative materials, biodegradable or recyclable, alternatives to chemical additives and traceability of the various stages of manufacture are a challenge to succeed. Sustainable development labels are flourishing, such as Oeko-Tex, which guarantees textiles free of chemical elements dangerous to health, or Naturtextil, which certifies organic farming and breeding, fair working conditions, and respect for the environment and mankind at every link in the manufacturing chain.

Table 11. Cost of Water and Electricity Consumption in the Textile Sector²⁴

	Cost (TD) of treatment of one Kg of material		
	Tunisia	Tunisia	Tunisia
Water	0.190	0.035	0.010
Electricity	0.075	0.03	0.050
Water	0.190	0.035	0.010

²⁴ Strategic Study of the Energy Mix for the Production of Electricity in Tunisia, Wuppertal/Tunis, April 2012

Water consumption in the textile sector varies greatly from one Mediterranean country to another. For example, Egypt has an important consumption compared by Tunisia (annual consumption of 400 Mm³ /year of water from the supply network and 100 Mm³ /year of groundwater). However, Tunisia consumption is about 3.4 Mm³ /year of water from the supply network and 1 Mm³ /year of groundwater.

In relation to the production and treatment of wastewater, it should be noted that for Tunisia, almost all companies in the dyeing and finishing and printing subsectors carry out at least one type of wastewater treatment at source. In the case of the other countries, the percentages of application of this measure vary between 10 and 65%, and, more specifically: Albania, 10%, Algeria, 31%, Bosnia and Herzegovina, 25%, Egypt, 65%, Spain, 30%, France, 65%, Morocco, 40%, and Syria, 30%. Tunisia, in fact, makes a classification of the total waste produced (consisting of various chemicals) in the sub-sector of finishing (11,175 t/year) and in that of washing jeans with pumice stone, which generates 17,103 t/year of this stone.

The effective percentages of reuse of dyeing or finishing baths correspond to Spain (50%), Egypt (15%), Morocco (60%), Syria (1%) and Tunisia (10%).

In addition, currently, the use of uncontrolled groundwater and drinking water in the process of washing "jeans" by a dozen companies in the region (the bay of Monastir, Oued Hamdoun and the Sebkha of Moknine) requires 550,000 cubic meters of water per year. This further illustrates the excessive exploitation of water in this region where water cuts are frequent; both for household consumption and for irrigation¹⁹.

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2.2.1.3 Company Innovation potential

a. Diagnosis of the Tunisian textile sector

Tunisia is today marked by an industry highly exposed to the international context, which is both its main opportunity and its main risk. It is very export-oriented and remains dependent on foreign direct investment (FDI), which is its main provider of new capacities, capital and technology. Moreover, its competitiveness is vulnerable due to the aggressive positioning of lower cost countries on the one hand, and territories that have a more structured communication of their own assets on the other. Tunisia's current positioning is perceived as the European Back Office or Nearshore of industry and services. While this positioning has enabled Tunisia to "build" a high-performance and competitive

industry, it seems certain today that this positioning must evolve and differentiate itself in a much stronger way from competitors who put forward certain competitive advantages (salaries, operating costs, logistics capacity, taxation and market entry costs). Moreover, the Free Trade Agreement with the European Union and, more broadly, the emergence of a Euro-Mediterranean reality, a space recognized by a growing number of investors, prescribers and international decision-makers, is a source of new challenges. Indeed, this new space, a place of potential markets, fluidity of trade, demanding methods, but also more frontal competition between neighboring countries on both shores, sets the new strategic framework for Tunisia. This course should take into consideration Tunisia's current competitive positioning and the challenges to be met over the next decade. It is summarized in the following key points:

- Tunisia's competitiveness will be accentuated in view of the rising cost trends of Eastern European countries: currently, more than 20% cost savings are observed compared to Romania. There is a recent trend of relocation of FDI from Eastern Europe to the Mediterranean region.
- There is always a lower cost country in the world: the positioning in large series and the availability of large industrial capacities in these countries means that Tunisia could not sustainably make the argument of cost competitiveness. It gains by putting more emphasis on qualitative arguments: stability, innovation and surplus service, business environment, product quality, logistics capacities, environment and quality of life.
- The race for FDI is increasingly exacerbated: competitor countries on the southern shore of the Mediterranean and Eastern Europe have gambled on foreign direct investment, particularly in high value-added activities. Eastern European countries are currently benefiting from considerable flows of European FDI. The challenge of attractiveness thus remains a burden on the development of Tunisian industry.
- Euromed, a vital market of more than 800 million consumers: The European Union market, encompassing more than 80% of Tunisian exports, has become highly competitive. An increasingly regional competition is established there between the countries of the Mediterranean region, Eastern Europe and Asia.
- Tunisia has turned the corner of the knowledge economy: the latest settlements and extensions of FDI confirm it. The national orientation is to promote the attraction of FDIs with high added value and knowledge intensity: R&D, embedded electronics, technical textiles, health and nutrition products, ICT, service centers, ...
- Global competition in terms of innovation that leaves room for countries with limited markets. Indeed, many countries with limited markets have succeeded in the challenge of innovation and have implemented an environment conducive to this end: education to international standards, developed clusters, a tertiary economy, ... The successful example of Singapore confirms this strong challenge for Tunisia.

The national strategy must be based, therefore, on a three-dimensional positioning, allowing the creation of a true innovative Euro-Mediterranean center with a high level of competitiveness. The aim

is to go beyond the simple back-office / near-shore industrial positioning of Europe. The challenge is to integrate and combine differently the dimensions "Back office / Nearshore industrial", which corresponds to the current positioning, "hub" and "innovation": Support for innovation in the Tunisian textile sector.

A summary of this analysis from the area study and group discussions (Round 1) is shown in the following SWOT table.

Table 12. SWOT analysis of Tunisian T&C sector

Strengths	Weakness
<ul style="list-style-type: none"> ✓ Availability of bilateral Trade agreements ✓ Strategic geographical location bordering EU countries ✓ Competitive brand image and good referencing (Supplier to EU 2nd importer of clothing textiles and to France, the country of fashion) ✓ Long history and expertise (well-known industry based for many years) and control of the textile manufacturing process ✓ Strong competitiveness and mastery of the management setting offer on the international fast-fashion market, particularly in terms of small series production, deadlines respect and customization of the offer. ✓ Large pool of skilled labor and confirmed know-how ✓ Availability of manpower with high quality expertise ✓ Compliance with social and environmental standards and the possibility of building a clean image of production companies that can be sold alongside international brands (very exploitable competition factor between international brands) 	<ul style="list-style-type: none"> ✓ Insufficient funds available to Manufacturers intended to innovation actions ✓ low emphasis is placed on logistical activities ✓ Strong dependence abroad for raw material needs fabrics, supplies and accessories ✓ Sector highly dependent on foreign direct investment ✓ Dominance of low value-added activity: clothing subcontracting ✓ Loss of market share on the production of basic products requiring mass sourcing as a result of the uncompetitive minute cost ✓ Undeveloped managerial and marketing potential ✓ Difficulty of many subcontractors in the transition to full package (reluctance to change) ✓ Tunisian ready-to-wear market (own brands) boosted by price reductions

<ul style="list-style-type: none"> ✓ Trend in the development of high added value activities and shift from subcontracting to full package ✓ Development of Tunisian ready-to-wear brands ✓ The niche strategy adopted in the technical textile market and the resulting specialist image (in particular the work wear market) ✓ Strong market responsiveness to crises, particularly the emergence of Chinese low-cost competition in production, COVID crisis ✓ Tunisia is one of the only countries in the region to have a policy framework developed for eco-efficiency and eco-innovation 	<ul style="list-style-type: none"> ✓ Minor technological advancements in textile processes. ✓ Lack in quality procedure in all supply chain sector activities ✓ Difficulty of several subcontractors in the transition to full package (reluctance to change) ✓ Toxicity of certain textile waste
Opportunities	Threats
<ul style="list-style-type: none"> ✓ Opportunity to explore new markets in America, Africa and other potential countries (given Tunisia's strategic geographic location) ✓ Tunisia is perceived as the European Back office or Near-shore for industry and services ✓ Rise of fast-fashion and the lead to market imperative ✓ New segmentation of the ready-to-wear market (basics, collectors' hearts and news) and the orientation of European brands towards supplier diversification (orientation towards geographically close suppliers) ✓ Possibility of exploiting various niches on the luxury market, children's ready-to-wear and technical textiles ✓ International trend in ethical and green consumption encouraging brands to engage 	<ul style="list-style-type: none"> ✓ Political instability since the revolution and little economic visibility ✓ Social demands poorly controlled in certain areas ✓ An industry very exposed to the international context ✓ Increased competition from Asian producers ✓ Risks of price increases for fabrics and supplies purchased abroad ✓ The investment incentives presented by Morocco and Turkey and the Risks arising from the loss of foreign investors to the benefit of these countries

<p>with suppliers whose work procedures are respectful of the environment</p> <ul style="list-style-type: none"> ✓ State encouragement to relocate activity to regions with a low rate of employability to meet the demand for low-skilled labor (tax benefits in the investment encouragement zones) ✓ Willingness of the state to encourage the sector in view of its high employability potential ✓ New investment law and tax benefits in the investment encouragement zones ✓ The establishment of the new three innovation centers. ✓ The state considers the textile sector as priority sector and has signed a public-private pact (2019) for the revival of the sector 	<ul style="list-style-type: none"> ✓ Increased activity of the parallel market and contraband in the textile and clothing sector
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b. Image development as a supplier of small series and complete packages

Faced with Asian competition, Tunisia has successfully turned the corner of value added and is entering a second stage of growth and innovation based on the following key concepts: Design, Technical Textiles, Finishing, Restocking, Small and Medium Series and Logistics Services. The Tunisian textile industry is already focused on the niche markets of high-end clothing, technical textiles, hosiery, finishing and finishing of fabric and design and pattern making. It is to cover the entire value chain beyond clothing. Upstream, this involves weaving and finishing, particularly of increasingly technical textiles. The examples of target activities for technical textiles are numerous: fireproof, antiseptic, antibacterial, biodegradable, climatic, composite, waterproof and breathable (membrane) to name but a few. Downstream, it is a question of having more responsive logistics services to continue to seize the markets for small and medium series and custom-made products. This will enable Tunisia to position itself more in the "Fast Fashion" and restocking markets, where flexibility and responsiveness are key driving concepts. Finally, the strategic direction is to continue to succeed in the process of transition from subcontracting to the finished product.

c. Strengthening the green image (waste recycling and waste treatment)

Tunisia is one of the only countries in the region to have a policy framework developed for eco-efficiency and eco-innovation. The National Strategy for Sustainable Development defines priority actions in key sectors, including industry. In addition, specialized institutions have been created, such as the National Committee for Sustainable Development, the National Agency for Environmental Protection and the Tunisian Observatory of Environment and Sustainable Development, which provide for more specific actions and objectives. Information on environmental issues and tools for SMEs is made available mainly by the Tunis International Center for Environmental Technologies (CITET) through its environmental upgrading program and technical assistance to SMEs to comply with national and international environmental standards such as ISO 14001. It provides technical assistance including detailed environmental diagnosis and training on profitable environmental management. The Centre is linked to academic and research institutions, but also to industries and international partners. A specific program for the reduction of waste in companies' production processes through the use of green technologies and materials is offered by the National Agency for Waste Management (ANGed).

Since 2015, the textile and clothing industry in Tunisia has been trying to adapt to a new world situation where environmental quality standards are increasingly required. This adaptation began within the framework of a regional programme " Switchmad ", as well as its subsidiary oriented towards the textile sector in Tunisia, Morocco and Egypt " Med Test 1, 2 and 3 ".

The objective of this program is to help the largest number of companies active in the sector (100 companies initially) to adopt the recycling and management of textile and clothing waste, post-industrial and pre-consumer, but also to eliminate potentially toxic chemicals. The ultimate goal is to create more circular and developed value chains. This programme was funded by the European Union and is implemented in cooperation with the United Nations Industrial Development Programme (UNIDO). This program has enabled many Tunisian companies or exporters to engage in a sustainable production process. For example, one of the major Tunisian textile companies, SITEX, was able to reduce, in 2019, the percentage of its carbon dioxide emissions by 17% and managed to achieve a saving of water of 34%, energy of 14% and 3.2% of raw materials.

Likewise, New AMICO, a company active in the washing, dyeing and processing of textile products entirely exported to Europe, managed to reduce its carbon dioxide emissions by 27% and save water and energy equivalent to an annual investment of more than 366 thousand euros. At the same time, NOEL, which operates in the leather and dyeing sector, achieved, in 2019, a reduction of its CO2 emissions by 33.5%; as well as a saving of 20% in wastewater and 34% in energy.

In addition, the Tunisian initiative officially started in April 2015 in Sfax by launching an educational action around the values of sustainable fashion for young children from 8 to 15 years old. And since 2016 the fashion institute of Monastir collaborates with its partner IZEM to develop Sustainable Fashion in Tunisia by conducting training activities and practical workshops to raise awareness and innovation and creativity as was the case of the "Workshop Fashion Upcycling" & "Fashion Contest

Sustainable". Its actions have been conducted in collaboration with some textile and clothing companies such as DEMCO, DND Confection, SITEX, SARTEX.

Considering the case of DEMCO, sound environmental management practices result from a strong and two-decades-long commitment of the top management. In 2019, a new momentum has been initiated with the creation of the DEMCO eco team whose mission was the co-design of a complete environmental strategy 2019-2025 and its implementation and monitoring. Climate neutrality, efficient use of natural resources and waste recycling are embedded principles to this strategy. More concretely, 17 specific goals turned into 25 innovative and cost-effective actions to reinforce DEMCO practices to achieve a high level of environmental protection.

Among these actions, we pinpoint the DEMCO latest innovations:

- NEW BUSINESS MODELS: "CIRCULAR ECONOMY" An Upcycling project which is DEMCO unique and innovative program to reuse and upgrade DEMCO own waste and customer garment waste. The recycling of DEMCO fabric waste into new fabrics in partnership with a Tunisian spinning factory. The new fabric containing recycled yarn will be used by DEMCO.
- Latest DEMCO development: upgrading of its waste water treatment unit: End of 2019, DEMCO successfully implemented a reverse osmosis system to purify 1,200 m³/day of process waste water. This high performing technology delivers pure water that can be reused into the plant. 100% of its wastewater is now treated of which 80% is recycled into the process. Thanks to the recycling of its wastewater, DEMCO consumes less than 7 litres/jeans against 100 litres/jeans 10 years ago. This constitute a major achievement for its Water Stewardship programme.

Such examples of successful collaboration between industry and educational institutions have enabled the dissemination of the culture of sustainable development and circular economy in Tunisia. These experiences still need to be democratized near new companies in the sector; other actions will also be welcome to entrench this culture among the various stakeholders.

d. Towards the development of a technical textile manufacturer's image

Technical textiles are one of the future-oriented sectors for the textile and clothing industry worldwide. As previously mentioned in this report, there is an increased demand for textile products for technical use in the global market and in the partner countries of Tunisia. Indeed, Tunisia's exports of technical textiles increased from 50.8MD in 2007 to 119MD in 2011. However, exports of this branch of activity have experienced a decline from 2012 (67.2 MD in 2016) due to the economic problems experienced by Tunisia following the revolution, but it is still the least affected branch in textiles and clothing²⁵.

²⁵ TCI Note, 2017 (Note ITH,2017)

Thus, the recovery plan for the textile and clothing sector, published by FTTH in 2019²⁶, which was adopted as part of a public-private pact, has focused on a project of integration in the field of technical and intelligent textiles. This measure is a reading of the importance given by the sector for the development of this branch with high added value and high potential for innovation. The results of the SME surveys carried out within the framework of this study, confirm these potentialities since 41% of the companies participating in this survey claim to carry out activities in the technical textile sector (for medical and paramedical use, connected textiles, automotive industry, protection...). It emerges a rising trend towards the creation of new opportunities and promising market niches for textiles for medical, paramedical and technical sports applications...

It should be noted that Tunisia has many assets to become a hub of technical textiles in the Mediterranean region. On the one hand, it abounds in multidisciplinary talents that the university trains every year. On the other hand, it continues to disseminate the culture of start up and help its establishment; it is one of the most active African start-up ecosystems, interesting in its diversity and approach.

It is in this context that the COVID-19 pandemic was a great opportunity to highlight the potential of this branch in its responsiveness to international and national market demand (production of bibs, gowns, smocks for personal or medical use). The Tunisian textile sector and particularly that of technical textiles must better understand this context to better position itself and strengthen its image in this sector, inviting several European countries to review their relocation policies and their relations with China. French companies and officials, for example, are in favor of relocating these productions to France and the Maghreb countries. It is therefore up to the national textile sector to seize this opportunity, to evolve and show its technical, logistical and managerial capacities to adapt to the new international market.

2.2.1.4 Support structures for innovation: description and offer of programs

The Textile and Clothing Industries sector is considered strategic for the National Economy. It is the main sector of the manufacturing industry in terms of exports, employment and added value. It represents one of the flagship sectors of economic growth.

Improving the competitiveness of this strategic sector remains an important axis for its sustainability and development. Indeed, in a global climate of industry 4.0 and target market for high value-added products, the Tunisian textile sector is called upon to improve its innovation system. This system is

²⁶ Recovery Plan for the Textile & Clothing Sector (2019-2023), Public Private Partnership Sector Pact January 2019

supported by several actors: political decision-makers, training (competence centers) and research structures, support and interfacing structures and financing structures.

a. Support structures for innovation

✓ Textile training and research structures

In order to maintain the level of competitiveness and know-how of the Tunisian textile and clothing industry, the Tunisian State has set up a system of university and vocational training covering almost all sectors and putting on the market increasingly advanced qualifications.

In this context, higher education offers training courses in textile engineering and similar (textile design) for different qualifications: Bachelor's degree, professional Master's degree, research Master's degree, engineering degree and doctorate.

Several institutions of higher education, located mainly in the region of Monastir, are set up to train these technical skills in favor of the textile sector: the engineering school of Monastir (textile department), the higher institute of fashion of Monastir and the higher institute of technological studies of Ksar Hellal and some institutes of arts and crafts (ISAMS as an example). The philosophy behind the establishment of these different institutions is to compensate for the lack of skills that hampers the development of this sector. Thus, the first schools introduced offered courses on textile technicality; they were then reinforced by institutions offering practical and theoretical courses in fashion and design and recently by those offering managerial courses in textiles and clothing. However, the orientation of teaching in textile and clothing remains primarily oriented towards technicality. In fact, Tunisia enjoys a good image on the scientific sphere and that of the labor market. Efforts still need to be made in design and management to position this education, particularly among industrialists who are increasingly demanding skills in this field.

In addition to training institutions, there are several public research structures dealing with research topics in the textile and para textile field and contributing to the development of the sector through applied research. We cite the research structures conducting the majority of research work in the field:

- Textile Engineering Laboratory (LR11ES42): LGTex- ISET KH
- Mechanical Engineering Laboratory (LR99ES32): LGM-ENIM
- Thermal and Energy Systems Studies Laboratory (LR99ES31): LESTE-ENIM
- Research Unit in Textile Materials and Processes (UR17ES33): MPTex-ENIM
- Research Unit in Applied Chemistry and Environment (UR13ES63):URCAE- FSM

✓ Scientific associations and professional networking

Scientific associations and professional networking actively contribute to the support of innovation and research in the textile sector.

- The Tunisian Association of Textile Researchers²⁷ (ATCTex): founded in 2007, with the aim of promoting research in the textile field and supporting researchers.
- Clusters 2TS: Sahel Technical Textile Cluster: created in 2015, it is an association with the objectives of promoting the technical textile sector, aiming at enriching the value chain associated with the technical textile industry and developing the strategy of the sector at the national level.
- Tunisian Federation of Textiles and Clothing (FTTH): created in 2017 and aims to revive and regain the sector's place on the international market, especially after a long period of insecurity, political instability and social unrest. It has signed with the Tunisian state a sectoral pact of public-private partnership for the revival of the textile and clothing sector 2019-2023.
- The Monastir-Fajja Competitiveness Cluster (MFCpole)²⁸: The Monastir-El Fejja Competitiveness Cluster, founded in October 2006, is composed of a technopole in Monastir dedicated to textile and clothing (including a business incubator, a technological resource center) two industrial parks (one in Monastir and another in El Fejja which includes an area dedicated to textile finishing) and a network of In'Tex partners.

✓ Business incubators

The network of business incubators set up in the network of ISETs and certain competitiveness clusters acts as an incubator for innovative projects and start-ups. That of innovative initiatives located in ISET KH plays an important role in supporting the carriers of innovative projects or ideas in the textile and para-textile field because of its presence in the first region of textile in Tunisia.

✓ Public structures for supporting innovation in the textile sector

- ✓ APII: The Agency for the Promotion of Industry and Innovation with its various support and willfunding mechanisms supports the textile and clothing industry to improve its competitiveness and innovation. The APII is responsible for supervising and helping textile and clothing companies to identify their needs in terms of technological innovation and work to promote the results of research and technology transfer. It is responsible for disseminating the culture of technological innovation through the popularization of programs and mechanisms related to innovation and the valorization of research results.
- ✓ Technical center of textile (CETTEX)²⁹: An establishment of public economic interest under the supervision of the Tunisian Ministry of Industry and SMEs. Created in 1991, it provides

²⁷ www.atctex.org

²⁸ www.mfcpole.com.tn

²⁹ www.cettex.com.tn

advice and expertise to manufacturers and public authorities in the Textile and Clothing sector. CETTEX offers operators a complete range of services: technical assistance in textiles production, research and development, analysis and testing in laboratory, professional training and competitive intelligence. It supports Tunisian textile companies in their technical, managerial and organizational development and assist them in their growth and innovation process.

- ✓ National Agency for the Promotion of Scientific Research (ANPR): An agency under the supervision of the Ministry of Higher Education and Scientific Research. It provides textile research structures to companies as well as support to carry out their research programs.
- ✓ National Institute for Standardization and Industrial Property (INNORPI): Researchers in the textile field use INNORPI to register their patents. This action will protect the inventor's intellectual property. Another important mission of INNORPI is to provide researchers with national testing standards.

b. Programs Innovation offer

In terms of tools for encouraging and financing innovation, Tunisia is positioned among the southern Mediterranean countries with the most numerous and diversified financing mechanisms. Public financing tools are available upstream at the level of research laboratories, as well as for companies with R&D programs.

- Incentive programs and innovation funding ³⁰

Tunisia's innovation financing system includes a wide range of financial support instruments. These instruments cover the entire process, from the project idea to commercialization and, if necessary, the creation of the company. These instruments, implemented in stages, are constantly evolving. These instruments are managed by public structures, private structures or non-governmental organizations.

These funds or funding mechanisms can be grouped into three broad categories: individualized support, incentives for collaborative research, and equity support for entrepreneurial developers (Figure.5).

Research incentive programs are funds intended mainly for research structures. They include, as for example the following programs: federated research projects (PRF), projects to encourage young

³⁰ Innovation Guide, APII

researchers (PEJC), projects to encourage young teacher-researchers (PEJEC), the POST PFE program, ... These funds are managed by the Ministry of Higher Education and Scientific Research.

The implementation of Federated Research Programs (PRF) aims to mobilize skills and create synergies between research structures and their partners, public or private, concerned with the development of the scientific research and technology sector. The PRF deal with national priority themes defined in consultation with the various operators in the sector concerned. The objective of the programs for the encouragement of young researchers is the promotion of diplomatic research in strategic areas through the establishment of incentive mechanisms for the benefit of student researchers.

There are other incentives, particularly in the context of higher education modernization projects such as the PAQ d'appui à la qualité d'enseignement supérieur project published by the MHESR, namely PAQ post PFE and PAQ collabora. These incentives aim to finance the best end-of-study projects in order to move from study to realization.

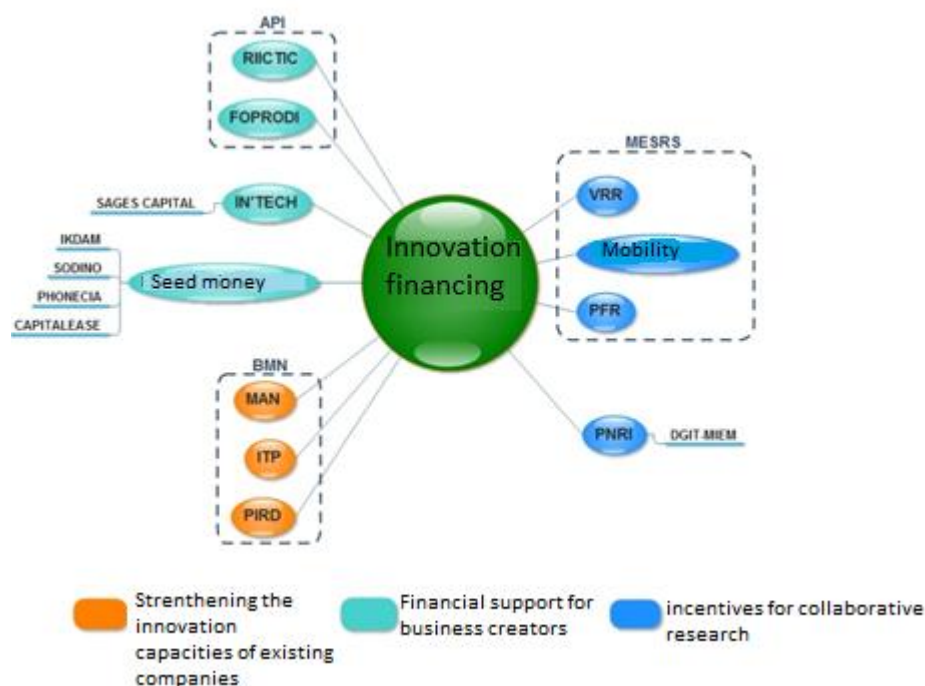


Figure 5. Mapping of research and innovation mechanisms in Tunisia

A second set of incentive programs is aimed at cooperation between companies and research structures, namely: The National Program for Research and Innovation (PNRI), the Research

Valorization Fund (VRR), and programs for the mobility of researchers (MOBIDOC, POSTDOC). These programs aim to strengthen collaboration between the industrial and research sectors in the field of research and innovation.

Existing companies benefit from several innovation incentives programs such as the Upgrading Program (PMN), Priority Technology Investment (ITP), the Research and Development Investment Premium (PIRD) and the Service Vouchers.

Support for the creation of innovative companies are intended to support the creation of innovative companies by financing certain stages of the innovation process. They intervene at the level of the constitution of equity capital or the consolidation of the financial structure of the "start-up" by means of bank loans. In this 3rd category, we distinguish the following instruments: the funds for industrial promotion and decentralization (FOPRODI) and the incentive scheme for creativity and innovation in the field of ICT (RIICTIC), seed funds (IKDAM, Phenicia Seed Fund,...), venture capital mutual funds (FCPR) spin-offs, venture capital investment companies (Sicar), the Banque de financement des PME (BFPME) and the Société tunisienne de garantie (Sotugar), the tunisian solidarity bank (BTS - microcredit).

2.2.2 Contribution of competence centers in the textile sector innovation

2.2.2.1 HEIs

Over the last two decades, the Tunisian innovation system has grown in terms of size and complexity. The country has numerous research centres, higher education establishments and a vast network of innovation intermediaries (technopoles, clusters, technology transfer offices, incubators, etc.). The higher education system includes several establishments operating in the training of skills in the textile domain which contribute strongly to meeting the needs of the textile industry in terms of engineers and technicians. These establishments also perform the role of scientific research and participate in innovation.

- The engineering school of Monastir - Textile engineering department³¹:

The textile department of ENIM is a specificity of the school within the network of national engineering schools; it ensures the training of engineers in textile engineering in the following options: Textile Clothing, Textile Finishing, Technical and Logistic Textiles and Management. In 2018, the number of students enrolled in the textile engineering engineering training cycle is 195. The number of textile engineering graduates reached 64 engineers in 2017.

³¹ www.enim.rnu.tn

The training of textile engineers at ENIM is provided by a multidisciplinary teaching staff consisting mainly of textile research teachers. The following table shows the composition of the members of the textile engineering department.

Table 13. Distribution of DGT teacher-researchers

Grad	Number	%
Professor	4	17%
Assistant professor	3	13%
Assistant teacher	14	58%
Contracted	3	13%
Total	24	100%

The National Engineering School of Monastir, specifically its textile engineering department, offers a research master's degree course entitled "Engineering of textile and para-textile materials and processes". The main educational objectives of the research master "Engineering of materials and textile and para-textile processes" are:

- To have an enlarged vision of the different classical and technical textile materials, transformation and treatment processes of textile materials;
- To deepen the basic knowledge of materials (natural materials for classical and technical textile use), mechanics, thermics, transformation, modification and shaping processes, etc. ;
- To understand the relations between the structure, the properties of textiles and the different shaping processes;
- To train graduates capable of innovating in textiles, optimising processes and designing new products;
- Introduce students to the principles and methods of scientific research allowing them to approach a doctoral thesis with serenity.

- Doctoral school in STI-ENIM³²:

Created within the University of Monastir in 2006 and accredited in 2008. It is institutional, multidisciplinary, and is supported by the 9 research structures of ENIM (7 laboratories and 2 research units).

³² <http://www.enim.rnu.tn/fra/s1229/pages/399/%C3%83%E2%80%B0cole-doctorale-Pr%C3%83%C2%A9sentation>

It covers all the specialities developed at the ENIM by offering 4 PhDs and 2 university habilitations including the PhD in textile engineering. Statistics show that 73 candidates have had their PhD theses in textile engineering from 2009 to 2018, of which 75% are at university and 10% unemployed.

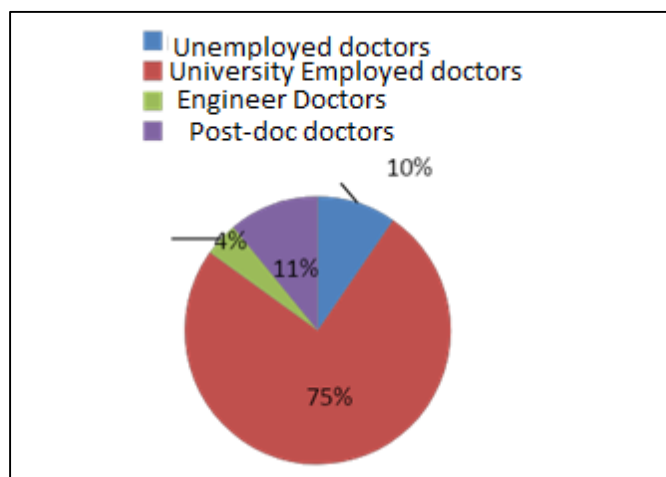


Figure 6. Distribution of textile doctors according to their professional situation (2018)

- Monastir Higher Institute of Fashion, IS2M³³

The pedagogical staff is composed of 40 permanent teachers and more than 50 lecturers divided between experts and temporary teachers. The institute has two departments whose training is focused on textile and fashion design and management disciplines and targeted on promising niche markets that are perfectly in line with the needs of the job market.

- Textile and Fashion Management Department containing 3 courses:
 - Bachelor's degree in Management Science (Marketing)
 - Degree in Textile Engineering (Clothing Industry)
 - Bachelor's degree co-built in Production Methods,
 - Professional Master's Degree in Textile and Fashion Management
- Textile and Fashion Design Department.

³³ www.ismmm.rnu.tn

- Bachelor's degree in design (pattern making, textile design and accessories design).
- Bachelor's degree co-built in Arts and Processing of Made-up Articles.
- Joint degree in design and industrialization of lingerie, corsetry and swimwear.
- Professional Master's Degree in Fashion and Textile Design

The Monastir Fashion Institute integrates around 180 technicians into the job market, ranging from bachelors to master's degrees.

Table 14. Evolution of the number of IS2M outlets

Academic year	Number of diplomas
2016	173
2017	187
2018	190
2019	151

- The Higher Institute of Technological Studies of Ksar hellal (ISET KH)³⁴:

The Higher Institute of Technological Studies of Ksar-Hellal provides a 3-year scientific and technological education leading to an Applied Bachelor's degree and a 5-year professional Master's degree.

The Textile Engineering Department of the Higher Institute of Technological Studies in Ksar-Hellal was established in September 1996. The objective is to train technical executives specialised in the piloting and control of processes and technologies for the manufacture, finishing and marketing of textile products.

A graduate in "Textile Engineering" must be capable of: mastering the processes and technologies specific to the textile sector with a specialisation in textiles other than clothing (furnishings, textiles for technical use); provide a global vision of the profession and management (organisation of companies, strategies specific to the sector); integrate the constraints linked to the international context (logistics, quality assurance, computerisation, new communication techniques).

The textile engineering department provides training in three different sub-disciplines (courses): Clothing Industry, Finishing Industry and Textile Industry

Each course has specific objectives:

³⁴ www.isetkh.rnu.tn

- The aim of the Clothing Industry (IH) is to manage, organise, plan production (method, quality, and logistics), integrate new IT resources to optimize methods, workshop time, production, quality, etc...
- The Ennobling Industry (IE) is a training course which prepares for management and optimisation of techniques for the preparation, dyeing, printing, washing and finishing of all-purpose textile products. A graduate in this discipline will be able to master the formulation of recipes and to control and reproduce colour by colorimetric measurements and to manage the resulting effluents.
- The "Textile Industry(IT)" course missions is to propose solutions to improve productivity, reactivity and production quality, define production planning, planning and scheduling of tests on new products or processes and to deal with production process problems as well as the control and monitoring of the manufacturing process.

The role of the professional master's degree in production management in clothing and in the management and development of textile companies is to strengthen the technical and managerial skills of future managers of textile companies. Graduates of these professional masters are full of skills in the field of innovation and industrial development.

Around 90 bachelors' and 30 professional masters' new graduates of ISET KH look for a job in the textile sector every year. The evolution of the number of graduates per year is represented in the following histograms.

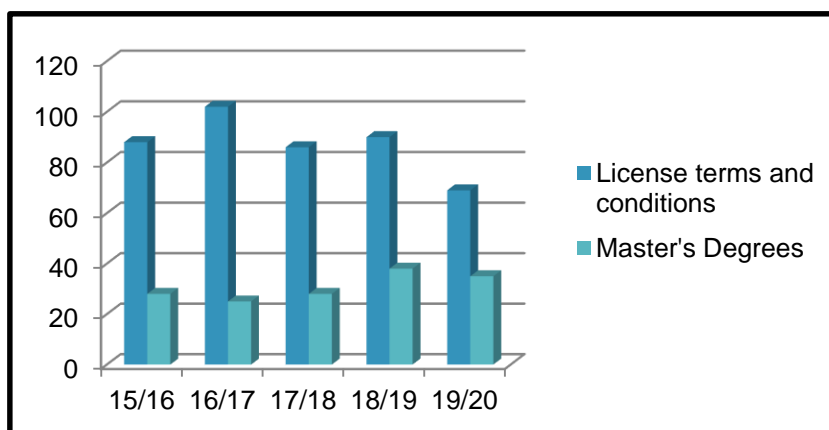


Figure 7. Trend in the number of ISET KH textile graduates

The multidisciplinary teaching staff is composed of 45 teacher-researchers in textile engineering, 39 of those are permanent staff and 6 contractual staff, as shown in the Table 15.

Table 15. Distribution of the textile research staff at ISET KH (2020)

Grade	Number	%
Professors	5	11.11
Assistant professors	34	75.55
Contractuals	6	13.34
Total	45	100

- Higher Institute of Arts and Crafts of Sfax (ISAMS)

The Higher Institute of Arts and Crafts of Sfax was created by the law n°95-40 of April 24, 1995.

This institute contains three departments, one of which is the department of design with specialities in space design, image design and product design. It delivers two bachelor's degrees related to the textile-clothing field, the first one is the bachelor's degree in clothing design (styling-modelling) and the second one is the licence in textile design, both produce creators of fashion and of textile design. For each promotion there are about thirty new graduates in textile-clothing design bachelor's degrees.

This institute also has a commission for research masters and professional masters, one of which allows the master's degree to be awarded to professional in clothing design. For each promotion there are about ten new graduates in professional masters.

There is also a thesis commission in Art and Mediation where some graduates in textile design access to continue their doctoral studies. Some of them are registered at the GEMTEX Textile Engineering Laboratory in Roubaix, France.

2.2.2.2 Research structure

Attached to the University Establishments and Research Centres, 630 Research Structures (329 Laboratories and 301 Units) are at the heart of the National System of Scientific Research in Tunisia. They include more than 11500 permanent researchers (including 30% of college A and 70% of college B) and about 14000 doctoral students and 3000 students in research masters, not to mention the administrative staff, research engineers and technical managers.

In favour of the textile and clothing sector, several public research structures deal with research subjects in the textile and para textile domain.

• Laboratories

• **Textile Engineering Laboratory (LR11ES42): LGTex- ISET KH³⁵**

- By being the only research laboratory in the speciality in Tunisia and in the network of ISETs, it ensures the link between the industrialists of the trade and the Tunisian university.
- By hosting the largest number of researchers with high-level managerial skills, it implements research and development actions that meet the current needs of the sector as well as innovative ones.
- By positioning itself at the heart of the Tunisian textile region, it ensures the transfer of technology and know-how.
- By having a network of national and international cooperation, it promotes Tunisian research and researchers by organising renowned scientific activities.
- By having a quality scientific production, it contributes to improving the international visibility of Tunisian research and university.

The objectives of LGTex are:

- Characterisation and study of the textile potential of local natural fibres and valorisation in textile, para-textile and technical applications with high added value.
- Optimisation of the technical and construction characteristics of textiles for craft applications.
- Design, analysis and optimisation of the processes and performance of textiles based on chemical materials for technical applications.
- Control and optimisation of textile and clothing processes.
- Optimising and predicting the quality of textile products.
- Study and optimisation of clothing comfort of textile fabrics with its thermal, sensory and aesthetic components.
- Identification, study and optimisation of new innovative and ecological ways of finishing textiles in all their forms and of treating textile industry waste.

³⁵ <http://www.isetkh.rnu.tn/fra/pages/343/LGTex>

The human resources attached to the laboratory that contribute to its various research projects belong to various structures such as ISET KH, IS2M, ENIM, ISAMS, SITEX-KH and ISET-Sousse. In 2018, the number of laboratory researchers has reached 95 between PhD, Master, B and A college (Figure 8).

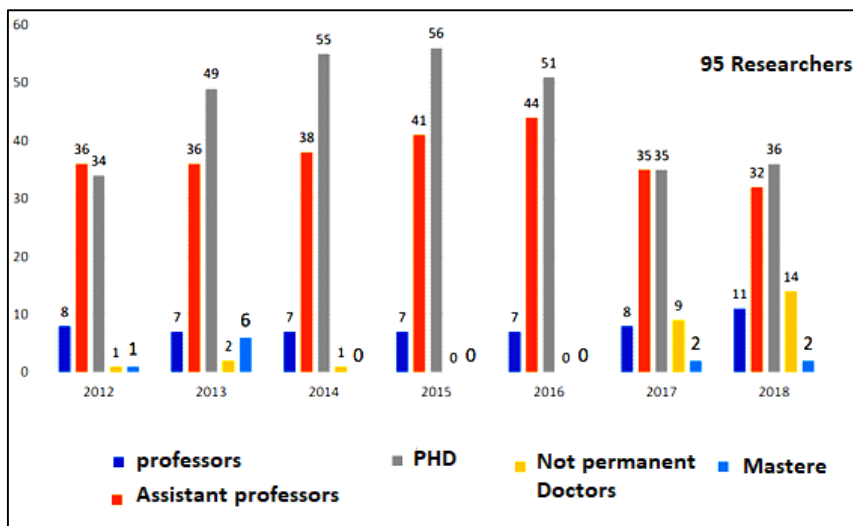


Figure 8. Evolution of the number of LGTex laboratory researchers

LGTex's close cooperation with the socio-economic environment is reflected in:

- 2 PNRI
 - Spinning of the fibres of Kénaf, CETTEX, SITEX de Sousse
 - Development of antibacterial soles, CNCC, Green Security Sfax
- 1 PIRD: Recycling of SITEX waste for the manufacture of ecological textile products, SITEX Sousse
- 1 Erasmus +: Enhancement of the Mediterranean heritage in intelligent textile design, West Attica University, Greece
- 7 MOBIDOC on different themes with GITEX, SITEX, SARTEX, TEXPRO, GHETLAB, Clinique Souani, Plastiss
- 1 Mobidoc PostDoc : Dyeing of technical PE fibres, LA SOIE, BodheurBennane

It should be noted that the textile engineering laboratory (LGTex) has filed 25 patents since 2008 at INNORPI, including one sold and one exploited. These patents concern either products, processes or new devices developed during the research work.

• **Mechanical Engineering Laboratory (LR99ES32): LGM-ENIM**

The Mechanical Engineering Laboratory (LGM) brings together the teacher-researchers, technical staff and doctoral students of the National Engineering School of Monastir (ENIM) who carry out their research in the fields of mechanics, design, manufacturing, robotics, vibration and materials mechanics. It occupies premises located in the mechanical engineering department of the ENIM.

Created since 1999, the ENIM's mechanical engineering laboratory has more than 100 members organised in two teams:

- Mechanics of materials and structures
- Mechanical and energy systems

• **Thermal and Energy Systems Studies Laboratory (LR99ES31): LESTE-ENIM**

The Laboratory for the Study of Thermal and Energy Systems (LESTE) is a research laboratory of the Ecole Nationale des Ingénieurs de Monastir located on the university site of Skanes-Monastir (Access map).

The laboratory is directed by Professor A. Jemni and brings together researchers on the general themes of Aerothermodynamics, Metrology and Inverse Methods, Heterogeneous Media, Modelisation and Optimisation of Energy Systems and Combustion.

• **Research units**

• **Research Unit in Textile Materials and Processes (UR17ES33): MPTex-ENIM**

Created in 2017 at the National Engineering School of Monastir and directed by Professor Saber Ben Abdessalam. It is made up of 3 "A" college, 11 "B" college and 13 PhD students.

The research carried out at the research unit in textile materials and processes is mainly within the framework of textile chemistry, materials science and textile processes. This research is carried out in three projects:

- Development of textiles for technical use
- Textile materials and functionalization
- Performance improvement and characterisation

• **Research Unit in Applied Chemistry and Environment (UR13ES63): FSM**

UR13ES63, formerly UR1204, is a research unit founded and directed since 1995 by Prof. Mohamed Farouk Mhenni. Since July 2015, the unit has been directed by Hatem Dhaouadi, Professor at the Department of Chemistry of the Faculty of Sciences of Monastir, permanent at the UR since 1998.

The official name of UR is: Applied Chemistry & Environment.

The main activities of our unit are focused on:

- Textile Engineering and Chemistry
- Environmental Engineering and Chemistry
- Organic, Basic and Applied Chemistry

UR has 15 permanent staff: two emeritus professors, two professors, four lecturers, five assistant professors and two assistants. It also has eighteen PhD students and an average of about fifteen students between research masters, professional masters and PFE engineering cycle.

• **Research centre: Monastir textile science and technology research centre (in progress):**

Given the importance of the textile sector in the Tunisian economy and the importance of research and innovation to improve the competitiveness of companies, the Tunisian R&I system is enriched by this research centre. Management and operational problems hinder its availability to textile researchers and companies.

• **ATCTex (Tunisian association of textile researchers)**

The Tunisian Association of Textile Researchers (ATCTex) is a scientific association which was founded in 2007 by a team of professors and researchers from the ISET of Ksar Hellal.

This association was founded in order to:

- Promote research and scientific studies in the textile field.
- Publish and promote the results of scientific research in the field of textiles.
- Participate in the organisation of activities, seminars, conferences, congresses and all kinds of scientific events at national and international level.
- Supervise researchers and monitor all research and training activities in the textile field.
- Favour links between economic and industrial actors through the exchange of information, participation in training seminars

In 2014, the ATCTex with 110 members in direct or indirect relation with the research community in the textile field and from different horizons (ISET, ENIM, ISMMM, ISAM Sfax, Industry, CETTEX ...).

- ATCTex works in close collaboration with the actors involved in textile research (Textile Engineering Laboratory, MFCPôle, CETTEX, Monastir University, GIZ, universities, etc.) in order to organise training sessions and workshops for researchers, seminars for researchers and students, conferences and activities for students from partner academic institutions.

- The ATCTex also collaborates with the LGTex, since 2006 for the organisation of the International Congress of Applied Research in Textiles (CIRAT). This collaboration has been fruitful since 2016 with the organisation of the International Textile Competition (CITT). The aim of this competition is to popularise the culture of innovation and sustainable development.
- ATCTex publishes an online international scientific journal on textile research, The International Journal of Applied Research on Textile (IJARTex), first published in December 2013.

All ATCTex activities can be followed and consulted on the ATCTex online platform: www.atctex.org

3. STRATEGIES IMPLEMENTED FOR THE DEVELOPMENT OF INNOVATION

3.1. Strategies presentation

3.1.1 Evolution of innovation policy in Tunisia³⁶

The innovative entrepreneurship system in Tunisia could only be understood, in all its dimensions, by going back to its origins and to the changes it has undergone for more than 30 years. Indeed, the desire to improve the business environment in Tunisia dates back to the financial crisis of the mid-1980s, when the Government decided in 1986 to initiate a "Structural Adjustment Plan", accompanied by a policy facilitating the creation of companies to boost investment.

Two important facts mark this policy, and their impact continues until now:

- Establishment of the "one-stop shop" for business creation within the APII, recommended in April 1989 and officially created in January 1991³⁷;
- Establishment of a Presidential Grand Prize rewarding administrative innovation initiatives³⁸, by a 1989 decree, still in force.

If the one-stop shop has had an indisputable impact on the performance of the business creation process - which can be done today even remotely³⁹ - the same cannot be said for the improvement of the business climate (which was weakly impacted), as one cannot speak of genuine innovative achievements within the Administration, for lack of a far-sighted and daring policy in this area.

Furthermore, if the government of the time relied on innovation as an accelerator of administrative reforms, it was not a forerunner in making innovation a factor in the competitiveness of companies and therefore a lever of economic growth.

See above, despite the new orientations of the Government's policy adopted in the Economic and Social Plan of the time - targeting the development of competitiveness and technological development - innovation was not one of the priorities of the Single Code of investments in 1993⁴⁰, neither one of the Upgrade Program (PMN) launched in 1995⁴¹ and aimed at modernizing industrial companies to

³⁶Mustapha BOUBAYA, State of play in Tunisia: Actors, legislative framework and financial instruments to encourage SMEs to innovate in Tunisia; September 2014.

³⁷Decree No. 92-126 of 20 Jan. 1992 establishing the organization of the API (arts. 15 to 19).

³⁸Decree No. 89-1958 of December 23, 1989, establishing the Grand Prize of the President of the Republic for administrative innovation. (JORT n° 88 of December 29-31, 1989).

³⁹Law n° 2004-89 of 12/31/2004, relating to the procedures for the incorporation of online companies.

⁴⁰Investment Incentives Code promulgated by Law No. 93-120 of 27 Dec. 1993.

⁴¹Law n° 94-127 of 26 Dec. 1994 (art.35 and s) creating the Industrial Competitiveness Development Fund (FODEC) organized by decree n° 95-2495 of 18 Dec. 1995 (repealed by decree n° 99-2741 of 06 Dec. 1999).

face external competition following the association agreement with the European Union concluded in July 1995.

Nevertheless, these orientations constituted a 1st pillar in the building of a national SNI innovation system, since it was the first time that economic orientations were supported by financing instruments that specifically targeted them.

Indeed, technological development was supported by a special fund, FOPROMAT⁴², That was consolidated two years later in 1992 by the Investment Incentives Code and supplemented by incentives for R&D⁴³. On the other hand, the Upgrade Program (PMN) was equipped by the FODEC⁴⁴Fund which subsequently absorbed the FOPROMAT.

Both funds (to encourage R&D and the development of competitiveness) paved the way for the launch of new innovation support instruments, since technological development was also enshrined in the new Law of January 1996 on scientific research⁴⁵, which has focused on the valorisation of scientific research results (VRR) and provided significant incentives for this purpose: budget for valuation projects, mobility of researchers to assist or createt themselves innovative projects, patenting of research results and exploitation by researchers of their own inventions.

Thus, although innovation was not expressly targeted by any text until the end of the 1990s, it has become embedded in most support instruments, in particular for:

- Product development projects (PMN-FODEC);
- Projects for the promotion of research results (VRR);
- Priority technological investment projects (ITP-FODEC);
- Technological investments linked to the creation of companies (ITP-creation);
- Design studies for new products and processes (PIRD).

This rather slow evolution, combining the need for technological mastery and the companies' concern for competitiveness, was not the result of a real strategic vision, not even the result of a clear and planned policy to promote innovation in the entrepreneurial landscape.

On one hand, this slow evolution can be partially accounted to the product of the globalization of trade (liberalization agreements oblige). On the other hand, it is an effect of the acceleration of technological changes in the economies (European in particular) on which Tunisian economy is based. It has been anchored since the 1995 free trade agreement.

⁴²Fund for the promotion and control of technology, created by Law n ° 90-111 of 31 Dec. 1990 (art. 63).

⁴³Article 42 of the Investment Incentives Code, establishing an R&D Premium (PIRD).

⁴⁴IndustrialCompetitivenessDevelopmentFund.

⁴⁵Orientation law n ° 96-6 of January 31. 1996 relating to scientificresearch and technologicaldevelopment.

Moreover, in this evolution of the system, one may detect a clear orientation towards "technological innovation". This applies to all the financial support instruments, whether it concerns technological mastery in general, collaborative research or the creation of innovative companies.

The construction of the innovation system has continued over the past two decades, during which 4 new instruments have been put in place:

- The mobility of MOBIDOC researchers, in 2002, to enable them to assist or create "innovative projects": a term expressly used for the first time⁴⁶;
- The PNRI National Research and Innovation Program, set up in 2003⁴⁷ by the Ministry of Higher Education, to finance collaborative research projects aimed at promoting technological development;
- The "seed funds" created following the promulgation of 2 laws in July 2005⁴⁸;
- The "IN'TECH" Fund created in 2009 under the Law of Dec. 2005 on FCPRs⁴⁹.

Finally, the national innovation system benefited, from the mid-2000s, from 3 support programs which mainly benefited industrial companies and industry-related services, namely:

- The Industrial Modernization Program, PMI funded by the European Union during the years 2004-2009, which introduced innovation in the coaching component;
- The Entrepreneurship and Innovation Support Program, PAEI funded by GTZ-GIZ;
- The Research and Innovation System Support Program, PASRI funded by the European Union.

These 3 programs significantly impacted the evolution of the system from 2010, a year which also saw the revision of 3 financial instruments to encourage innovation (RICITIC, PIRD and PNRI) and their transfer to the Ministry of Industry as well as the introduction of the IN'TECH Fund.

3.1.2 The national research and innovation system SNRI

Being one of the main ways to gain a competitive advantage, research / innovation has become a sine qua non for a successful economy. When an economy is innovative, it is more open to new ideas and technology, which requires a well-defined system.

Tunisia, aware of the difficult socioeconomic context, which sees the country increasingly face competition from Asia, has stepped up efforts to improve the national research and innovation system, both from the point of view of the attribution of responsibilities, and the one of the

⁴⁶Consecrated by Law n° 2002-53 of June 3, 2002 (amending the Orientation Law on scientific research) and organized by decree n° 2002-1573 of July 1, 2002.

⁴⁷Program governed by decree 2011-1084 of July 29, 2011 establishing the PNRI and setting its conditions and procedures for intervention.

⁴⁸Law n° 2005-58 of July 18, 2005 relating to seedfunds and Law n° 2005-59 of July 18, 2005 relating to tax provisions to encourage the creation of seedfunds.

⁴⁹Law n° 2005-105 of December 19, 2005 relating to the creation of risky mutual funds.

implementation of mechanisms for its development and promotion. The Tunisian national system is still a young system, but with interesting possibilities.

Implementation structures

- 13 Universities + DGET
- 203 Higher education and scientific research establishments
- 277 Research Laboratories (LR)
- 304 Research Units (UR)
- 70 Common Service Units for Research
- 37 Doctoral Schools
- 38 Public research establishments CR.

Support structures

- DGRS: General Directorate of Scientific Research
- DGVR: General Directorate for the Promotion of Research
- ANPR: National Agency for the Promotion of Scientific Research
- CNEAR: National Committee for the Evaluation of Research Activities
- INNORPI: National Institute for Standardization and Industrial Property.

The Tunisian student population has grown steadily over the past 50 years. Higher education in Tunisia has nearly 300,000 students, 90% of whom are registered in public institutions. Tunisia now has 203 public university institutions spread over 13 public universities and 63 private establishments with nearly 30,000 students.

In order to improve the university ecosystem, attract high-tech companies, improve innovation and offer quality employment opportunities; Tunisia has created specialized research centers (38 centers), technological parks as well as cyber workspaces across the country. In addition, Tunisia has well established research and education networks, including the RNRT for research and the RNU for higher education institutions.

The university ecosystem suffers, however, from a poor match between the number of university graduates (53,000 per year) and market needs (12,000 per year, of which 80% go to the public sector).

The need for highly qualified researchers in technical fields will continue to grow to support innovative capacities and the creation of companies operating in applied sciences, engineering, energy, environment, ICT and medical applications. Research networks represent an opportunity for young Tunisian researchers to join research communities abroad and to excel in the development of their innovation capacities.

3.1.3 Funding of scientific research

The state is the main body for funding scientific research in Tunisia with a budget representing 0.66% of GDP.

Table 16. Breakdown of the scientific research budget

Sector	%
Higher education and scientific research	71%
Agriculture	13%
Health	11%
Other	5%
Total	100%

Public funding for research almost doubled between 2000 and 2012, while private funding remains marginal.

3.1.4 Performance of scientific research

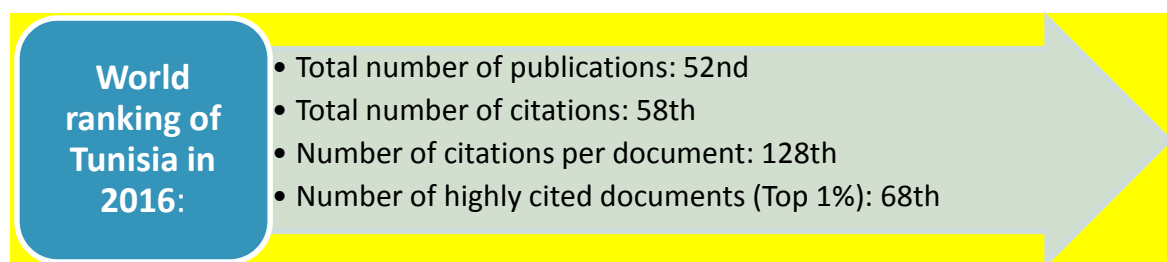


Figure 9. World ranking of Tunisia in scientific research (2016)

Tunisia counted in 2015, 58750 doctors and 11500 doctoral students. The scientific production's output in 2015 amounted to:

- 6228 articles published: best number of publications per capita in Africa
- 56 patents.

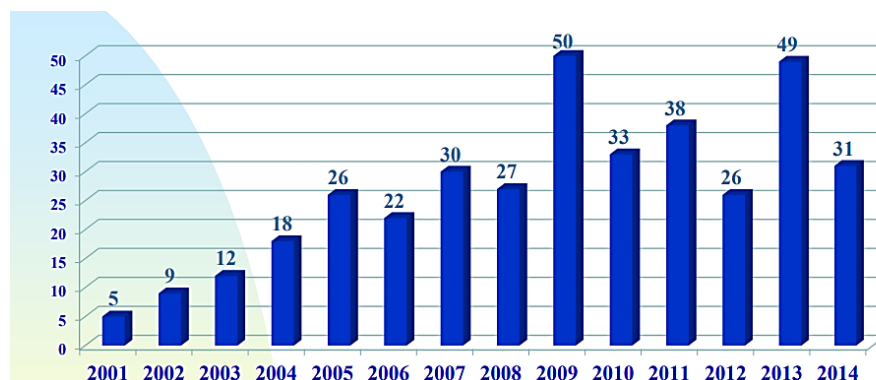


Figure 10. Evolution of the number of invention patents filed by public research structures with INNORPI

Table 17. Breakdown of patent applications by type of institution between 2009 and 2014

Year	ISSET	Faculties	Engineering schools	Research centers	Higher education institutes
2014	4	5	22	10	3
2013	13	5	18	10	5
2012	4	-	12	8	2
2011	2	2	3	18	4
2010	4	2	17	17	5
2009	6	9	10	14	9
	33	23	82	77	28

The Global Innovation Index (GII) ranks global economies based on their innovation capabilities. Published by the World Intellectual Property Organization "WIPO" in partnership with INSEAD and Cornell University in New York, the GI index focuses on the interaction between the various agents of an innovation system: businesses, the public sector, higher education and society.

Composed of around 80 indicators, grouped into innovation inputs and outputs, the GI aims to capture the multidimensional facets of innovation.

- Inputs of innovation (institutions, human resources and research, infrastructure, sophistication of the market and sophistication of the business environment);
- The innovation outputs (knowledge and technology, creativity) of the innovation system.

The following table presents Tunisia's ranking among 131 countries studied over the past three years, noting that data availability and changes to the GII model framework influence year-to-year comparisons of GII rankings. The statistical confidence interval for Tunisia's ranking in the GII2020⁵⁰ is between ranks 63 and 75.

Table 18. Global Innovation Index (GII) ranking of Tunisia (2018-2020)

Year	GII	Innovation inputs	Innovation outputs
2020 ⁴⁹	65	78	59
2019 ⁵¹	70	74	65
2018 ⁵²	66	77	63

Tunisia ranks seventh among the 29 economies in the lower middle-income group and seventh among the 19 economies in North Africa and West Asia.

Tunisia obtains the best results in terms of human capital and research and its weakest performance is the sophistication of the market.

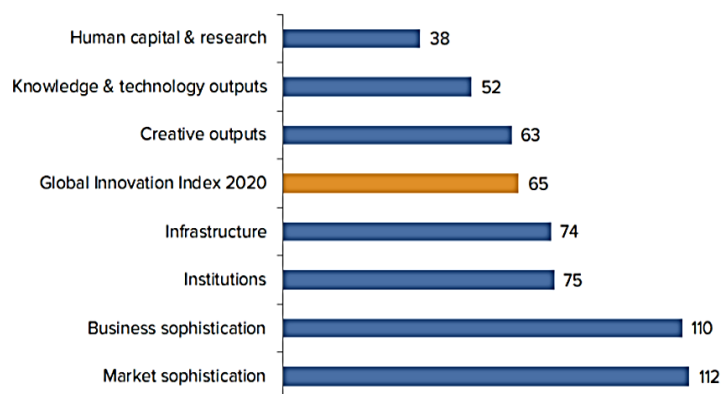


Figure 11. Overview of rankings according to the seven pillars of the GII

The strengths of GII 2020 for Tunisia can be found in four of the seven pillars of the GII.

- Institutions (75): presents the strengths of the Ease of starting a business indicator (18).

⁵⁰https://www.wipo.int/global_innovation_index/en/2020/

⁵¹ <https://www.globalinnovationindex.org/userfiles/file/reportpdf/gii-full-report-2019.pdf>

⁵² https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018.pdf

- Human capital and research (38): shows the strengths of the Education (9) and Higher education (21) sub-pillars and of the Education expenditure (8), Government / student funding (1) and Science graduates indicators and engineering (2).
- Knowledge and technology results (52): reveals the strengths of the Knowledge creation sub-pillar (38) and indicators Scientific and technical articles (13), Computer software expenditure (34), quality certificates ISO9001 (41), net technology exports (37) and net outward FDI (31).
- Creative products (63): demonstrates the strengths of the Creative goods exports indicator (29).

The weaknesses of the GII 2020 for Tunisia are found in five of the seven pillars of the GII.

- Human capital and research (38): presents weaknesses in the indicators of the PISA scales in reading, mathematics and science (74), global R&D companies (42) and QS University ranking (77).
- Infrastructure (74): shows weaknesses in the general infrastructure sub-pillar (117).
- Market sophistication (112): shows weaknesses in the Investment sub-pillar (117) and in the Tariff rate applied indicator (110).
- Business sophistication (110): demonstrates weaknesses in the Innovation links (118) and knowledge absorption (114) sub-pillars and in the cluster development status indicators (104), JV-strategic alliance (117), intellectual property payments (103) and research talent (72).
- Creative products (63): reveals weaknesses in ICT indicators and creation of organizational models (105) and Entertainment and media market (57).

Tunisia is recognized as the most innovative African country, occupying the first place for the quality of its entrepreneurial environment (Global Entrepreneurship Index) and having the best mobile internet connection on the continent (Speed test Global Index). The country has many assets to be a regional technological hub, ICTs represent 7.2% of GDP as much as tourism, 100,000 jobs (creation of 7,500 jobs / year), 1,200 established ICT companies, it produces around 10 000 engineers per year for a population of 11.6 million, ie as much as France proportionally, for a population of 67 million which trains around 32,000 engineers per year. It is one of the most active African start-up ecosystems, interesting in its diversity and approach⁵³.

3.1.5 The innovation ecosystem in Tunisia

Three initiatives have marked the current configuration of the innovation system:

- Commitment in 2008 of the "Innov" pilot project - within the framework of the PAEI program by the Ministry of Industry and GTZ – built around an innovation management model (inspired by the Oslo Manual of the OECD) to be promoted among industrial companies;

⁵³<http://www.smarttunisia.tn/la-tunisie-tout-pour-etre-un-hub-technologique-pour-lafrique/>

- Creation the same year, by the Ministry of Higher Education, of the National Agency for the Promotion of Research and Innovation in August 2008⁵⁴;
- Finalization in 2009-2010 of the PASRI Program with the European Union, one of the objectives of which was to "Strengthen the governance mechanisms of the SNI [national innovation system] governing the relations between institutional actors and companies"⁵⁵.

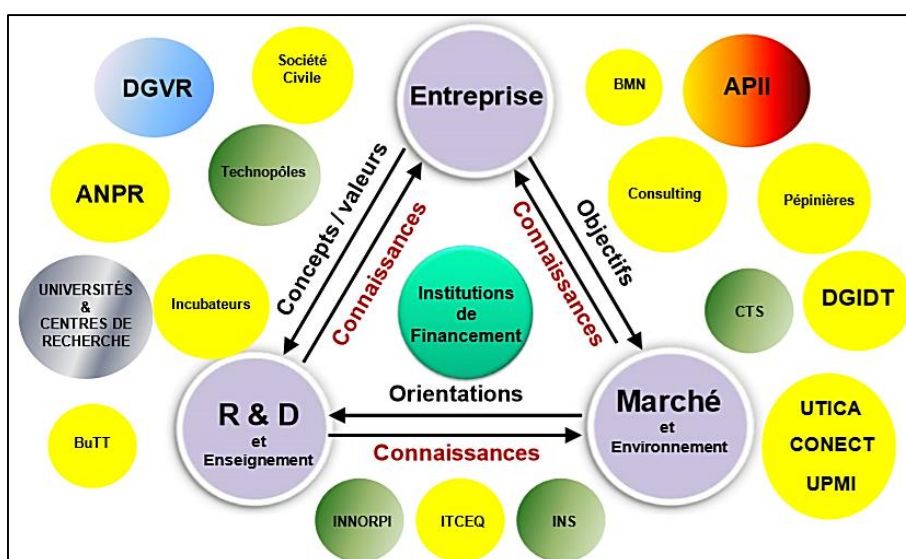


Figure 12. Configuration of the innovation ecosystem in Tunisia, developed by the PASRI Unit in 2012

3.1.6 Main financial instruments to encourage innovation

The following table summarizes the legal framework of the main financial instruments to encourage innovation and the creation of innovative businesses.

⁵⁴Law n ° 2008-60 of August 4, 2008 - which became ANPRS by Law n ° 2010-42 of July 26, 2010 following the transfer of innovation to API by Law n ° 2010-25 of May 17, 2010). <http://www.anpr.tn/>
⁵⁵<http://www.pasri.tn/> : PASRI section, Presentation.

Table 19. Legal framework of the main financial instruments to encourage innovation

Instruments	Management structures	Reference legal framework
National Research& Innovation Program (PNRI)	Directorate-General for Innovation and Technological Development - Ministry of Industry	<ul style="list-style-type: none"> - Organic law of the state budget n ° 67-53 Decree 2011-1084 of July 29, 2011 relating to the creation of the PNRI and setting its conditions and modalities of intervention.
R&D investment premium (PIRD)	Upgrade Office - Ministry of Industry	<ul style="list-style-type: none"> - Investment Code (article 42) & Orientation Law No. 96-6 of 31-01-1996 relating to scientific research. Decree No. 2010-656 of April 5, 2010 on the granting of the bonus.
Seed funds (IKDAM, PHENICIA, CAPITAL EASE)	Company IKDAM-GESTION Alternative Capital Partner Company UGSF Company	<ul style="list-style-type: none"> - Laws 2005-58 & 59 of July 18, 2005 on Seed Funds. Decree 2005-2603 of September 24, 2005 implementing Law 2005-58.
Venture Capital – SICARs encouraged to invest at least 30% of their resources in new technology projects	42 SICARs (Venture Capital Investment Companies), created to help make investments intended to promote technology or its mastery as well as innovation in all economic sectors.	<ul style="list-style-type: none"> - Law n°95-87 of October 30, 1995 - Law 2000-98 of December 25, 2000, on the 2001 Finance Law encouraging SICARs to finance innovative projects.
FOPRODI – Industrial decentralization promotion fund	Industry and Innovation Promotion Agency (APII)	Laws: <ul style="list-style-type: none"> - Law 73-82 of 31-12-73, on the finance law for 1974 - Investment Code (Law 93-120 of 27-12-1993) - Law 2007-69 of 27-12-2007 relating to economic initiative - Law 2007-70 of 27-12-2007 on the 2008 finance law.

		<ul style="list-style-type: none"> - Code of UCI Collective Investment Bodies (Law 2001-83 of July 24, 2001). - Law 2005-105 of 19 Dec. 2005 on FCPRs. <p>Decrees:</p> <p>19 implementing decrees (from that of June 9, 1978 to that of Sept. 28, 2009), including 16 decrees in force.</p>
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3.1.7 Innovation support programs

3.1.7.1 The PMN upgrade program

Objectives

- Improve the competitive positioning of companies and their ability to adapt.
- Provide businesses with the means to withstand competition, both in the local market and in target markets.
- Contribute to the export effort deployed by companies.
- Allow companies to modernize their means of production, adapt to new technologies and develop their human resources.

Actions

- Material investments
- Acquisition of material and equipment
- Hardware
- Control and laboratory equipment
- R&D equipment
- Intangible investments
- ICT (software / ERP, CAPM, CAO-DAO, CMMS, etc.)
- AT actions (SMQ / ISO-BRC-IFS, Marketing, productivity, etc.)
- Studies prior to material investments
- TA in terms of human resources qualification
- Studies relating to the organization of the company
- Technology transfer, acquisition of patents or licenses
- Recruitment of executives in technological functions
- Establishment of design offices and methods, etc.

Upgrade instruments:

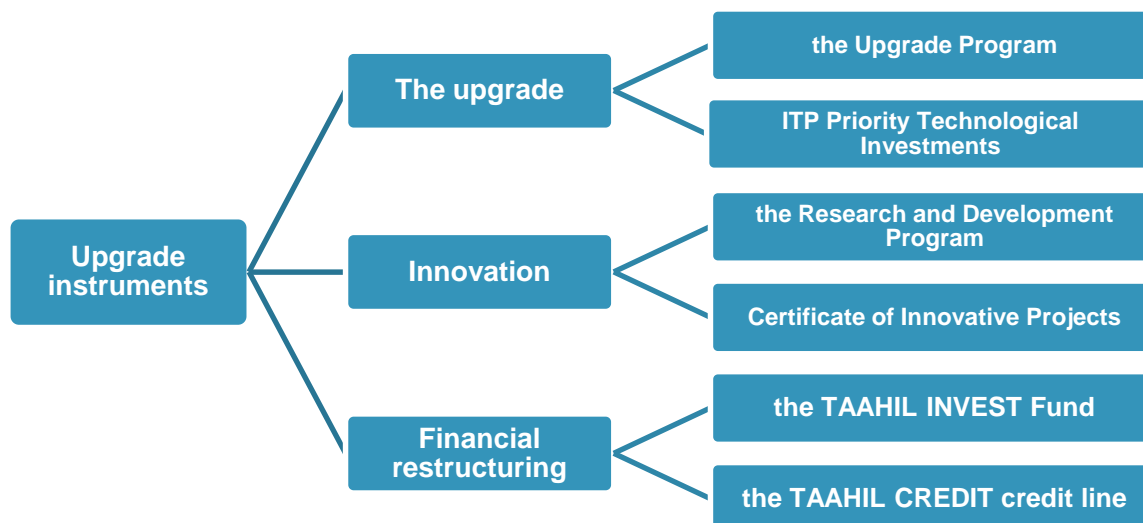


Figure 13. Upgrade instruments

A PIRD premium is granted for investments in Research and Development activities.

3.1.7.2 The support program for business competitiveness and the facilitation of market access: PCAM

The PCAM is part of the economic cooperation programs between Tunisia and the European Union, with a view to the establishment of a free trade area.

Endowed with an amount of 23 million euros financed by the European Union, the PCAM has the strategic objective of strengthening the competitiveness of Tunisian companies and facilitating the access of their products to the international market, especially the European one. The program thus provides companies with a wide range of actions that will be implemented with technical assistance and the supervision of renowned national and international experts.

Table 20. Actions carried out under the PCAM program

	Actions	Avantages
Support for companies	<p>A technical assistance, training and awareness program aimed at industrial companies and industry-related service providers. It revolves around coaching services relating to the strategic functions of the company: quality, R&D, marketing, production, information system, strategic watch.</p> <p>The actions supported by the PCAM are based on national and international expertise, both sharp and specific, which intervenes during the entire implementation process: diagnosis and previously defined action plan, implementation, monitoring and evaluation.</p>	<p>Technical support & accompaniment</p> <ul style="list-style-type: none"> - High-level national and international technical assistance - Relevant actions for strengthening the company's productivity - Support and monitoring of actions during their implementation in close collaboration with the technical centers concerned. - Co-financing of assistance missions <p>For each mission, the program contributes to the financing of 85% of the cost of the PCAM expertise.</p>
Support for quality infrastructure	<p>Technical support and supply of equipment to institutions in charge of quality: technical centers, analysis, testing and metrology laboratories.</p> <p>It concretely translates into the supply of equipment and expertise enabling the targeted organizations and institutions to be in phase with international standards and the needs of exporting companies, in terms of policy and quality control.</p>	<p>This component aims to prepare Tunisia for negotiations with the European Union in order to establish a mutual recognition agreement in the area of conformity assessment -aca- (agreement on conformity assessment and acceptance of industrial products).</p>

The PCAM offers industrial companies in Tunisia and service providers related to industry, technical assistance and support in carrying out strategic actions.

- Quality management system: This mainly involves the implementation of good practices and standards such as OHSAS 18001, ISO14000, ISO22000, ISO TS 16949, IFS / BRC

- CE marking for at least one product of beneficiary companies wishing to export under this label.
- Technical coaching: the PCAM provides the beneficiary company to help it improve its productivity. These include actions on production processes, R&D, etc.
- Non-technical coaching: PCAM supports beneficiary companies in strengthening their strategic functions, related to the marketing and marketing of their products and services on the international market.
- Sensitization& training of companies on technical and non-technical topics.

Industrial companies and industry-related service providers are eligible if they meet the following criteria:

- Not to be in financial difficulty
- Have at least one year of activity
- Allocate a dedicated resource to the mission.

3.1.7.3 The research and innovation system support project: PASRI

The Support for the Research and Innovation System (PASRI) project is a project funded by the European Union to the tune of 12 million euros and for eight years (2011-2018). The ambition of PASRI is to provide solutions to the main problems identified at the level of the different actors of the innovation chain. This identification starts from the company, which is in direct relation with the consumer and employment market and ends at the level of the research unit which accumulates scientific and technical knowledge, passing through the whole range of institutional, administrative, financial, technical and university players supposed to support the transformation of technical knowledge into a tangible product or service.

PASRI intends to improve the contribution of research and innovation to socioeconomic development and job creation in Tunisia, by strengthening the link between the system and production.

Areas of intervention of this program are:

- Governance component: Strengthen the governance mechanisms of relations between institutional actors, research structures and companies.
- Interfacing component: Boost the research community, considering the relationships between developed projects and technological demands of companies.
- Networking Component: Develop "networking" activities.

3.1.8 Funding for innovation

In terms of tools for encouraging and financing innovation, Tunisia is positioned among the countries of the southern Mediterranean where the financing mechanisms are the most numerous and the most diversified.

Public funding tools are available upstream at research laboratory level, as well as for companies with R&D programs. The following diagram shows the different tools and programs for financing innovation.

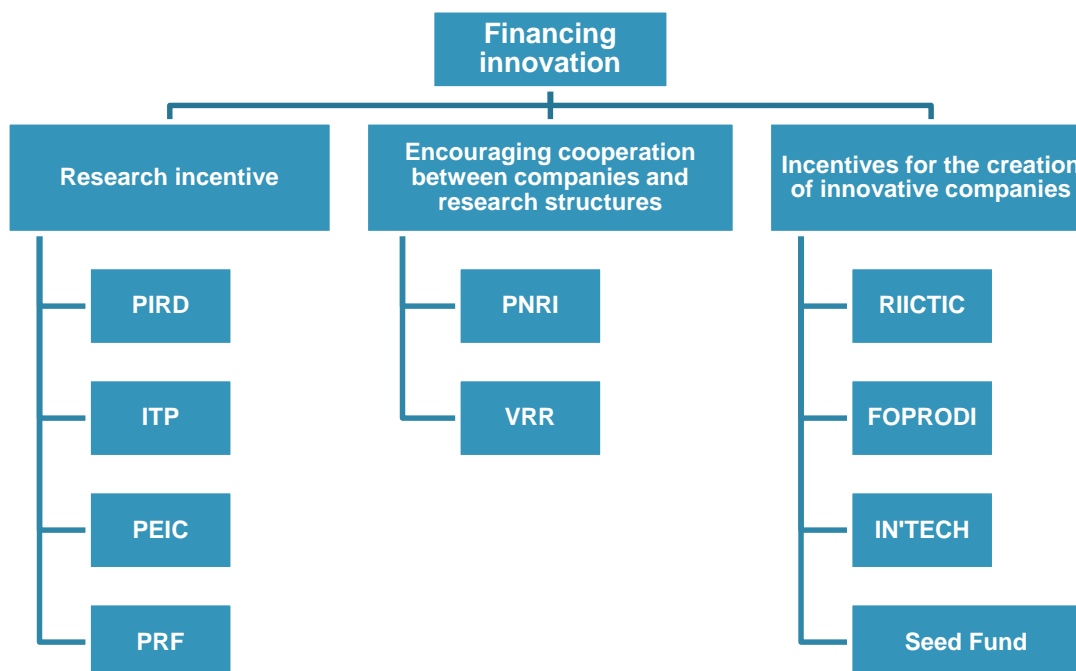


Figure 14. Tools and programs for financing innovation in Tunisia

3.1.8.1 Incentives for the creation of innovative companies

The IN'TECH risky mutual fund

This fund aims to finance the equity financing of innovative projects with high technological content.

This fund intervenes mainly to participate in the equity of companies within the framework of:

- New projects in promising niches
- Technological development and innovation
- Extension, development and modernization of SME members of the PMN.

This fund makes it possible to finance investments whose overall cost is between one hundred thousands TND and five million MTND according to a financings cheme based mainly on equity.

The industrial decentralization promotion fund: FOPRODI

The objectives of this fund are:

- The creation of a new generation of promoters
- The creation and development of SMEs
- Encouragement of regional development.

This fund makes it possible to finance creation and expansion investments in the fields of industry, crafts and services (new promoters and SMEs). These are projects whose investment varies between 100mTND and 5MTND.

The modes of intervention under this fund are as follows:

- Support the capital by repayable endowment or by equity participation: up to 60% of equity
- Grant an investment premium for: new promoter, SME, regional development zone
- Premium for investments in innovation and technological development
- Material investments: 50% of the cost of the investment (R&D equipment, IT equipment, CAD, DAO, GPAO, CMMS stations, etc.) with a ceiling of 100mTND
- Intangible investments: 50% of the cost of the investment (technical assistance, quality system, acquisition of method / process office patents, computer applications, etc.) (No ceiling).

The seed fund

The development of scientific and technological research in Tunisia is beginning to give birth to project ideas driven by Tunisian skills, not seasoned with the often grueling paths that separate the idea from its realization as a project.

Within the meaning of Tunisian law, the start-up fund is therefore a financing mechanism which intervenes, in equity, in innovative companies being created and which have a strong potential for competition before the actual start-up phase.

Seed funds are mutual funds in transferable securities intended to strengthen the equity of innovative projects before the actual start-up phase.

These funds mainly intervene to help promoters to:

- Exploit invention patents,
- Complete the technical and economic study of the project,
- Develop the technological process of the product before the marketing phase,
- Complete the financing plan.

3.1.8.2 Research incentives

PRF federated research programs

The establishment of Federated Research Programs (PRF) made it possible to take a substantial step towards the organization of the activities of the national R&D system, through the mobilization of

skills and the creation of synergies between the research structures and their partners, public or private, concerned with the development of the scientific research and technology sector.

These programs are financed within the framework of multi-year agreements which define the supporting structure of the project and the associated structures, the objectives and the expected results, the human and material resources to be mobilized as well as the monitoring and evaluation procedures. The PRFs deal with priority national themes defined in consultation with the various operators in the sector concerned.

PEJC young researchers' incentive programs

As part of promoting graduate research in strategic areas through the establishment of incentive mechanisms for the benefit of student researchers, a specific annual program "Encouragement Program for Young Researchers" (PEJC) has been set up with a view to offer doctoral students encouraging conditions allowing them to devote themselves effectively to their research work and by promoting their orientation towards research activities in priority specialties.

As part of this program (PEJC) and within the limit of the budget opened each year, full-time doctoral students attached to research structures (laboratories or units) can benefit from a "research contract" for a fixed period on condition of devote themselves fully and exclusively to their research.

The duration of the contract is 12 months at most, with the possibility of renewal upon call for applications.

The PIRD research and development investment premium

The PIRD is a grant that provides public and private companies as well as scientific associations with access to technology watch and innovation. It supports research projects in all their phases from study to completion. This mechanism covers all economic activities, namely the industrial sector, agriculture and services. The PIRD is part of the State's strategy to raise the technological level of the economic fabric and strengthens the panoply of means and incentives dedicated to this end.

Table 21. Objectives and actions carried out within the framework of the PIRD

Objectives	Actions
<ul style="list-style-type: none"> - Raise and strengthen the technological level of companies, - Support the R&D effort, particularly in all its components (Applied research, Experimental development: prototypes, pilot installations, etc.), - Design new products, - Improve existing products, - Establish new processes, - Develop the formulation, - Carry out laboratory tests, - Develop new technologies. 	<ul style="list-style-type: none"> - The studies necessary for the development of new products or new production processes, - Carrying out experiments and technical prototype tests as well as field experiments, - The acquisition of scientific laboratory equipment necessary for the conduct of research and development projects.

Priority technological investments: ITP

ITPs have two objectives:

- Strengthen the competitiveness of the company
- Allow the company to acquire advanced technology

Investments eligible for assistance from FODEC (Industrial Competitiveness Development Fund) fall into two categories:

Material investments:

- Design material: CAD: Computer aided design
- Research and development material
- Laboratory and control equipment
- CAPM (Capital Asset Pricing Model), CMMS (Computerized maintenance management system)

Intangible investments:

- Technical assistance related to material investments
- Establishment of a quality assurance and certification system: ISO, HACCP (Hazard Analysis Critical Control point), etc.
- Related software:
 - o Computer-aided design
 - o Control and laboratory equipment
 - o Information technology.

3.1.8.3 Incentives for cooperation between companies and research structures

The PNRI national research innovation program

The objectives of the PNRI national research innovation program are:

- Adapt the human and technological resources of public research structures to the needs of Tunisian companies, particularly SMEs, in the field of ICT.
- Strengthen collaboration between the industrial sector and the research sector in the field of research and innovation.

All projects participating in this program must meet a number of eligibility criteria:

- Associate with the industrial company at least one technical center and one public research structure (center, laboratory or research unit)
- Demonstrate significant innovation
- Must justify a minimum contribution from the industrial partner of 20% of the cost of the project (mobilization of personnel, raw materials, operation of company equipment ...)
- Have a maximum duration of two years.

The state participates in the financing of projects up to 80% with a ceiling of 200,000TND of project costs. The technical center is the supporting structure of the project.

The VRR research results promotion fund

The Research Results Valorization Fund (VRR) is intended for laboratory researchers who partner with an industrial company for the three-year duration of the project. It aims to promote a transfer of innovation that can lead to industrial exploitation.

This financial tool allows:

- The transfer and application of results from the national research system within the productive sector.
- The development of prototypes within research structures.
- The use of specialized skills to meet national needs (quality surveillance network, sectoral issues, public health, etc.)
- The research establishments and structures are the main beneficiaries. Their tasks will be:
 - o Project realization
 - o Management of allocated funds
 - o Partnership management
 - o Management of project actions and results
 - o Coordination with the Ministry of Scientific Research, Technology and Skills Development

Funding is granted to the research organization for a maximum period of 3 years. The expenses taken into account are often recruitment expenses (engineers, researchers, and technicians), feasibility studies, tests, patent filing costs and the production of prototypes.

3.1.9 Some examples of projects

3.1.9.1 PRF project: "Manufacture of aramid fibers reinforced with carbon nanotubes for safety applications"

Project support structure	CRTEn Borj Cedria Energy Research and Technology Center
Project title	<i>"Manufacture of aramid fibers reinforced with carbon nanotubes for safety applications"</i>
Achievement period	2020-2022
Total budget	2,171,500 TND
Teams involved	<ul style="list-style-type: none"> - Laboratory of nanomaterials and systems for renewable energies - Laboratory of composite materials and claymaterials - Research unit in textile materials and processes - Textile engineering laboratory - Mechanical engineering laboratory - Research structure of the Ministry of National Defense - Texmed International Company (Chammakhi Group) - Arabcom
Objectives	<p>The main objective is to install a pilot unit for the production of aramid fibers reinforced with carbon nanotubes. An analysis laboratory will also be set up within this unit in order to monitor the physico-chemical properties of the fibers produced in real time.</p> <p>The pilot unit as well as the analysis laboratory will be financed and built by the Chamakhi group on an area of 800 m² expandable to 6800 m².</p> <p>The role of the research structures associated with the project is to follow and lead the manufacturing protocols and particularly the way in which the carbon nanotubes will be attached to the aramid fibers. Once these fibers are manufactured to the required specifications, they will be used in the design of security items such as bullet proof vests and armor plates.</p>

3.1.9.2 Projects within the framework of MOBIDOC⁵⁶

The table 22. shows examples of Mobidoc projects developed by LGTEX with the industrial sector.

Table 22. Projects within the framework of MOBIDOC

N°	Years	PhD student	Supervisor	Research structure	Beneficiary company	Project title
1	Projet 1 2017-2020	LADHIRI Mourad	BABAY Amel	Textile Engineering Laboratory ISET Ksar-Hellal	TEXPRO Bouhjar	Contribution to the Optimization of Supply Chain Management in Textile Clothing Companies.
2	Projet 2 2017-2020	HAMILA Ghoufrane	BABAY Amel	Textile Engineering Laboratory ISET Ksar-Hellal	GHET LAB Monastir	Development of a Functional Posture Correction Textile Product Applicable to Well-Being, Health and Safety at Work.
3	Projet 3 2017-2020	JAMEL Salma	LADHARI Néji	Textile Engineering Laboratory ISET Ksar-Hellal	CLINIQUE ESSWANI Monastir	Development of a Functional Healing Textile For Surgical Operations.
4	Projet 4 2017-2020	STAMBOULI Mouna	MSAHLI Slah	Textile Engineering Laboratory ISET Ksar-Hellal	PLASTISS Sayda	Study And Optimization Of The Manufacturing Process For Coated Fabrics And Development Of An Odor And Fire Resistant Product.

⁵⁶Textile Engineering Laboratory Activity Report (LGTex), 2019.

5	Projet 5 (POST-DOC) 2017-2020	HADJ KHALIFA Imene	LADHARI Néji	Textile Engineering Laboratory ISET Ksar-Hellal	LA SOIE Bodher	Development of Technical Fiber Dyeing Processes in UHMPE.
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3.2. Evaluation of innovation strategies

3.2.1. Summary of strategies

Among the wide range of financial instruments to support innovative projects, only nine of them were used for projects involving the textile-clothing sector. Indeed, these instruments have been implemented in successive layers and are of unequal importance. These instruments are: MOBIDOC, PNRI, PIRD, PRF, VRR, PMN, ITP-MAN, ITP-creation and patents.

A typology of instruments allows them to be grouped into 3 main categories:

- Individualized support geared towards a single beneficiary, which is widely used; but their objectives and eligibility criteria go beyond innovation alone. There are 2 types of support:
 - Support geared towards industrial companies (PMN, ITP): they contribute to upgrading in general, and their fields go beyond the framework of innovation.
 - Support geared towards business creators, such as RICITIC or FOPRODI which has had a significant impact despite its complexity and cumbersome procedures.
- Incentives for collaborative research (VRR, PNRI, PIRD) which aim to encourage R&D and Research-Industry rapprochement.
- Equity financial support: intended for the promoter and creator of companies and intervene at the constitution of equity or the consolidation of the financial structure of the "start-up". In this category, the following instruments can be grouped:
 - FOPRODI and RICITIC (support for endowment to capital),
 - Seed risk investment fund (FCPR): IKDAM, PHENICIA, CAPITALEase,
 - FCPR specialized in industrialization (IN'TECH).

3.2.2. Typology of textile innovation projects undertaken

The following tables show examples of textile projects undertaken within the framework of innovation. This list is incomplete, but the lack of information prompts us to limit ourselves to these LGTex laboratory projects.

Table 23. Examples of projects under the MOBIDOC program

No.	Years	PhD student	Supervisor	Research structure	Beneficiary company	Project title
1	Projet 1 2017-2020	LADHIRI Mourad	BABAY Amel	Textile Engineering Laboratory ISET Ksar-Hellal	TEXPRO Bouhjar	Contribution to the Optimization of Supply Chain Management in Textile Clothing Companies.
2	Projet 2 2017-2020	HAMILA Ghoufrane	BABAY Amel	Textile Engineering Laboratory ISET Ksar-Hellal	GHET LAB Monastir	Development of a Functional Posture Correction Textile Product Applicable to Well-Being, Health and Safety at Work.
3	Projet 3 2017-2020	JAMEL Salma	LADHARI Néji	Textile Engineering Laboratory ISET Ksar-Hellal	CLINIQUE ESSWANI Monastir	Development of a Functional Healing Textile for Surgical Operations.
4	Projet 4 2017-2020	STAMBOULI Mouna	MSAHLI Slah	Textile Engineering Laboratory ISET Ksar-Hellal	PLASTISS Sayda	Study And Optimization Of The Manufacturing Process For Coated Fabrics And Development Of An Odor And Fire Resistant Product.
5	Projet 5 (POST-DOC) 2017-2020	HADJ KHALIFA Imene	LADHARI Néji	Textile Engineering Laboratory ISET Ksar-Hellal	LA SOIE Bodher	Development of a process for dyeing technical fibers in UHMPE.

Table 24. Other research and innovation projects developed by LGTex

No.	Project/Years	Research teams	Project structure support	Research structure	Beneficiarycompany	Project title
1	PNRI 2018-2020	MSAHLISlah BABAY Amel DHOUIB Sofiene ZOUARI Riadh CHAOUCH Walid BEN RAYANA Houda	National Center for Leather and Footwear CNCC	Textile Engineering Laboratory LGTex	Company GREEN SECURITY	Development of antibacterial, antifungal and ecological insoles.
2	JEC12-11 2018-2019	KHOFFI Foued	Textile Engineering Laboratory LGTex	Textile Engineering Laboratory LGTex	-	Development and optimization of textile heart valve prosthesis implanted non-invasively.
3	JEC12-22 2018-2019	ZOUARI Riadh	Textile Engineering Laboratory LGTex	Textile Engineering Laboratory LGTex	-	Thermal and sound insulation by a textile Ecological non- wovenfabric.
4	JEC12-04 2018-2019	KHORDHOUGHLI Bessam	Textile Engineering Laboratory LGTex	Textile Engineering Laboratory LGTex	-	Smart clothing for armed forces officers.

5	PRF 2020-2022	CHTOUROU Radhouane CHARBIB Kamel CHAMMAKHI Mohamed MARTINEZ Richard BEN ROMDHANE Ramzi MSAHLI Slah BEN ABDESSEM Saber MELINI Mezlini BEN AMEUR Tarek	Laboratory of Nanomaterials and Systems for Renewable Energies LANSER/CRTE Energy Research and Technology Center	Laboratory of Nanomaterials and Systems for Renewable Energies LANSER/CRTE Composite Materials and Clayey Materials Laboratory LMCMA of CNRSM Textile Engineering Laboratory LGTex Textile Materials and Processes Research Unit MPTex Mechanical Engineering Laboratory LGM	TEXMED International Company CHAMMAKHI Group ARABCOM company	Aramid fibers reinforced with carbon nanotubes for safety applications.
6	PHC-Utique 44182 PK	ZOUARI Riadh	Textile Engineering Laboratory LGTex University of Lorraine CETELOR	Textile Engineering Laboratory LGTex University of Lorraine CETELOR Center for Large-Scale Materials C2MA Textile Materials and Processes MPTex LERMAB	-	Thermal and sound insulation by an ecological non-woven fabric.

3.2.3. Results of the 8th survey concerning PMN's contribution to R & D & I

In the absence of established mechanisms for evaluating the impact of innovation financing instruments, we present below some results of the latest PMN⁵⁷ evaluation survey by beneficiary companies. This is the 8th survey on "The Upgrading Program: assessment, achievement and prospects" carried out by the Tunisian Institute for Competitiveness and Quantitative Studies (ITCEQ) with a sample of 361 companies and published in March 2017.

- According to the results of the survey, 79% of copied companies (companies that are members of the Upgrade Program) and 56% of non-copied companies declared having innovated.
- Organizational innovation is the widest spread in the two samples with a proportion of over 78%. The majority of the organizational innovations in the upgraded companies have been carried out outside PMN.
- Regarding cooperation, the survey reveals that only 53% of copied companies cooperate with other companies or organizations to carry out innovation activities.
- Upgraded companies, and more particularly SMEs, are not sufficiently encouraged to establish relationships with research organizations, customers, suppliers, etc., despite there being no difficulties in collaboration with external partners.
- As for the constraints on innovation, the results show that more than 50% of business leaders believe that the financial constraints as well as the obstacles relating to the market are very important.

⁵⁷"Results of the 8th Upgrading Program survey", March 2017, PMN website: www.pmn.nat.tn.

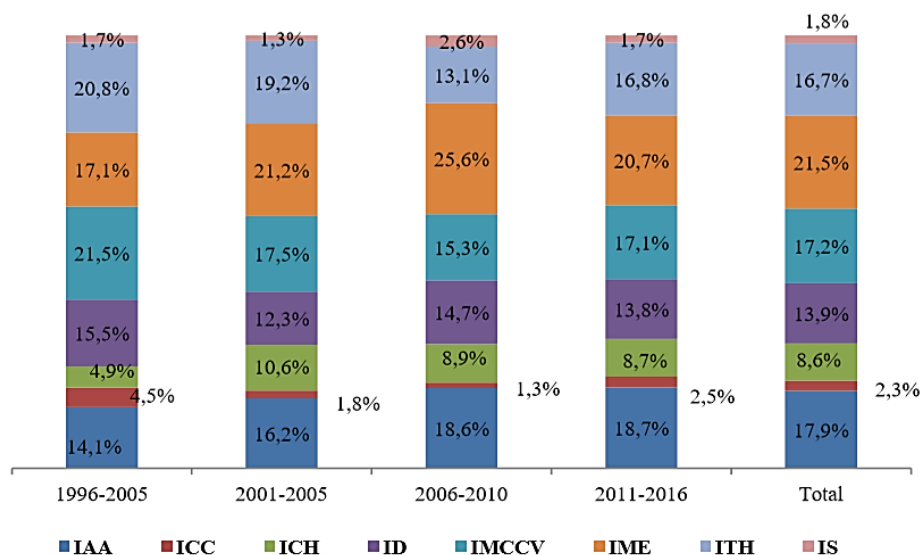


Figure 15. Sectoral breakdown of PMN investments

(IAA: agroalimentary industries; ICC: Leather and footwear industries; ICH: chemical industries; ID: Miscellaneous industries; IMCCV: Building materials, ceramic and glass industries; MEI: Mechanical and electrical industries; ITH: Textile-clothing industries)

In terms of investment, despite the decrease in its share, the TCI sector occupies an important place in the upgrading strategy in Tunisia.

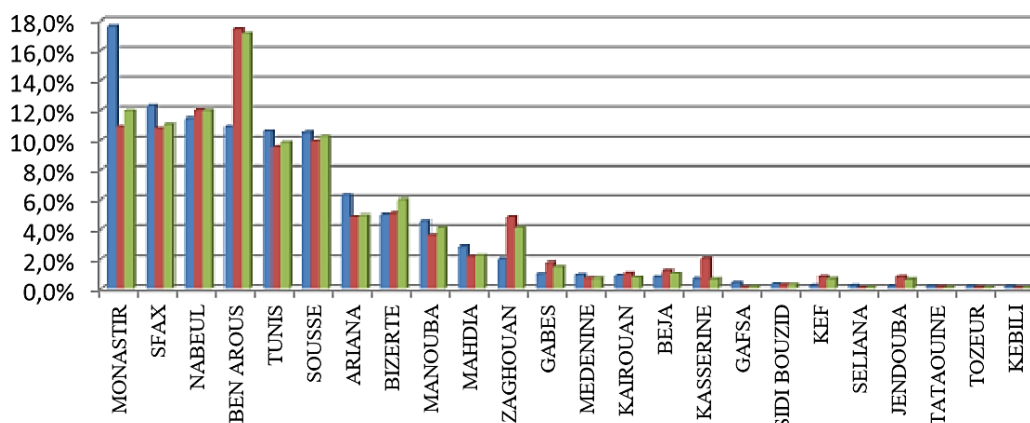


Figure 16. Evolution of PMN achievements by governorate for the period 1996-2016

The governorates of Monastir and Sfax seem to have benefited greatly from this program, all fields combined.

The survey makes it possible to identify companies' perceptions of PMN's contribution to various aspects of competitiveness.

The contribution of PMN in aspects relating to research and innovation, ICT and corporate cultures are presented in the following table.

Only 36% of upgraded Textile-Clothing (TCI) companies say that this program has provided them with a contribution to R&D and innovation, compared to an average of 73% across all sectors.

Research and development activity is considered to be a main source of innovation. The survey shows that among the companies operating in the Textile-Clothing sector, 21% of those upgraded declared having carried out a Research&Development activity while no non-upgraded company declared having engaged in this type of activity. It should be noted here that for other sectors, such as the mechanical and electrical industries, this percentage is four times higher (84%) for the copied companies.

Table 25. Contribution of PMN for companies in terms of R&D&I, ICT and organization

	R&D and Innovation			ICT			company organization and culture		
	Negligible %	Medium %	Important %	Negligible %	Medium %	Important %	Negligible %	Medium %	Important %
IAA	46	9	46	35	15	50	29	29	43
ICC	29	14	57	40	0	60	29	0	71
ICH	31	15	54	27	36	36	25	42	33
ID	47	24	29	21	21	58	32	26	42
IMCCV	20	13	67	7	21	71	6	18	77
IME	6	28	67	18	24	59	22	17	61
ITH	63	23	13	62	7	31	36	30	33
SME	42	20	38	37	18	45	30	22	48
GE	28	14	59	17	17	67	17	35	48
TE	47	21	32	52	10	38	32	23	46

Grand Tunis	28	13	59	21	10	38	15	22	63
Northeast	40	25	35	37	37	26	40	10	50
Center east	38	29	33	40	17	43	23	39	39
Others	57	5	38	41	14	46	46	18	36
Total	39	19	34	33	17	50	27	25	48

(IAA: agroalimentary industries; ICC: Leather and footwear industries; ICH: chemical industries; ID: Miscellaneous industries; IMCCV: Building materials, ceramic and glass industries; MEI: Mechanical and electrical industries; ITH: Textile-clothing industries)

Regarding R&D support and accompaniment measures, only 6% of copiled companies (companies that are members of the Upgrade Program) report having benefited from at least one R&D incentive compared to 4% for non-copiled companies.

A more in-depth analysis shows that the premium for investment in research and development activities (PIRD) is the widest spread among copiled and non-copiled companies at 5% and 3% respectively.

In terms of product protection against imitation, reproduction and counterfeiting, one may note that companies (copiled or not copiled) have recorded a low R&D effort as shows the decrease in the number of patents and licenses acquired, which is considered to be indicator of innovation and technological capacity. In fact, there are only 9% of copiled companies having acquired patents and licenses, 33% of which are in the framework of a partnership. Of the companies in the control sample, only 2% of companies have acquired patents and licenses in the past three years.

Also, there are only nearly 24% of copiled companies that have registered trademarks and models compared to 11% for companies in the control sample.

The results of the survey also reveal that the PMN is taking actions to encourage companies to innovate. Indeed, 47% of upgraded business leaders' say they have adopted innovation as a strategic focus to increase their competitiveness, compared to 23% of businesses in the control sample. In this context, the upgrading program plays an important role in strengthening innovation activity: nearly 43% of co-piloted companies consider that PMN's contribution in strengthening research activity and innovation is important.

According to the results of the same survey, 79% of copiled companies and 56% of non-copiled companies declared having undertaken an innovative activity. These rates vary slightly depending on the size of the business. For SMEs, these rates reached 73% and 54% respectively for copiled and non-copiled enterprises. As for large companies, whether they are upgraded or not, they are all innovative. This can be explained by the fact that SMEs have fewer resources than large companies to acquire and maintain scientific facilities and to employ qualified employees. In addition, SMEs do not have the ability to spread the risk of failure and they cannot absorb the fixed costs of innovation. It is the case with large companies.

Furthermore, an in-depth analysis of the context of the realization of the innovation shows that in the sample of upgraded companies, the innovations are not necessarily carried out under the PMN. In fact, unlike product and process innovations, the share of organizational and marketing innovations exceeds the innovations carried out within the framework of the PMN.

However, it should be noted that the TCI sector appears to be the weakest sector in terms of innovation with respective shares of 22.73% of the control sample and 58.82% of the sample of upgraded companies.

3.3. Main lessons learned from the strategies implemented

The innovation ecosystem, consolidating the place of actors in research and technological development, has established an approach centered on economic enterprise and on innovation financing institutions.

This ecosystem is characterized by the 6 following advantageous aspects:

1. Better institutionalized and enriched by actors specialized in innovation;
2. Better articulated in relation to funding institutions;
3. Framed by incentive texts and formal procedures;
4. More open to civil society, businesses and professionals;
5. Better endowed with a wide range of financial support instruments;
6. Served by better trained and recognized skills.

In addition to the APII⁵⁸, 8 sectoral technical centers⁵⁹ and the ANPR⁶⁰ - which are the most active institutional players in innovation, other players joined the system in 2010, namely:

- SAGES - Capital (www.essaimage-sagescapital.com) Fund management company which, in addition to spin-offs, manages the IN'TECH Fund created to help the promoters of innovative projects with high technological content, and support risks associated with these projects;
- Private start-up incubators, of which there are now half a dozen created by operators in the ICT sector, an investment fund, an employers' center, a financial advisory firm (www.wikistartup.tn) and recently (Sept. 2014) a private higher school for engineering training;
- Association of Business Angels for Innovative Entrepreneurship (www.cba.tn) which pre-finances innovative projects in their most critical and risky phase by pooling investment capacities and sharing risk with other investors;
- "Capitalease" private seed fund (www.ugfsnorthafrica.com.tn) which, unlike the 2 other funds (IKDAM and PHENICIA), supports talented promoters and investors in their innovative projects, by helping them to accelerate High Risk phases and provide personalized assistance and appropriate funding to Startups from the idea phase to the actual realization of Business Plans.

But this innovation ecosystem does not only have advantages, because it is:

1. Still heavily administered by the state;
2. Governed in a less participatory manner and in the absence of any public-private partnership;
3. Managed by fairly compartmentalized players without any means of promotional communication;
4. Driven without a vision of innovation and without medium and long-term strategic objectives;
5. Financed by instruments marred by many inefficiencies;
6. Marked by a notorious neglect of the 2 critical phases of innovative entrepreneurship: the pre-seed and post-start.

⁵⁸API (www.tunisieindustrie.nat.tn).

⁵⁹CETIME (<http://www.cetime.ind.tn>), CNCC (www.cncleather.nat.tn), CTMCCV (www.ctmccv.ind.tn), CETTEX (www.textiletunisia.com.tn), CTC (www.ctc.ind.tn), CTAA (www.ctaa.com.tn), CETIBA (www.cetiba.com.tn) & PACKTEC (www.packtec.tn).

⁶⁰ANPR (<http://www.anpr.tn>).

4. MAIN NEEDS OF THE TEXTILE SECTOR IN TERMS OF INNOVATION

4.1. Strategic vision of industrialists

Tunisia is committed to the shift towards added value and the current growth and innovation imperative. Its strategic vision is based on the following key concepts: Design, Technical Textiles, Finishing, Restocking, Small and Medium Series and Logistics Services. Indeed, the Tunisian textile industry is already focused on the promising niches of top-of-the-range clothing, technical textiles, knitting, fabric finishing as well as design and pattern making. It is in fact a question of covering the entire value chain beyond the clothing industry. Upstream this involves the weaving and finishing of more and more technical textiles. Through the old strategies¹⁰, the manufacturers have proposed performance indicators such as the development of finishing activities to increase from 40 millions of meters of fabrics (10% of the needs in 2007) to 140 millions of meters in 2018 (i.e. 40% of the needs).

Downstream it is a question of having more responsive logistics services to continue to seize the markets for small and medium series and customised products. This will enable Tunisia to position itself more on the "Fast Fashion" and restocking markets for which the driving concepts are essentially based on flexibility and reactivity. Finally, the strategic orientation is to continue to successfully complete the transition process from sub-contracting to the finished product.

In this sector, several industrial policies will be implemented, which are perfectly codified and specific to the sectors: Spinning, Weaving, Finishing, Clothing, and Knitting. We briefly indicate below the main common measures for these industries:

- Finishing integration plan: Increase from the level of 40 million meters (10% of fabric needs) to 140 million meters in 2018 (40% of needs) produced in Tunisia through funding, specific advantages and promotional actions.
- Programme to move from sub-contracting to the finished product: Reaching the threshold of 70 companies in 2007 to 300 companies in 2018 (20% of the companies) thanks to this programme piloted by CETTEX and financed at 70% by FODEC.
- Creation/design plan: increase the threshold from 500 to 1,000 companies equipped with CAD-CAD stations, financed at 50% by the FODEC.
- Quality/coaching plan: to ensure the upgrading of products, products based on technical fabrics...
- Promotion plan and control of international distribution channels.

Furthermore, the strategic studies carried out previously have shown that the industrialists of the textile-clothing sector agree on the sector's strategic and structuring orientations, i.e:

- Sector integration

- Upmarket & innovation
- development of an attractive package for clients and international investors
- Increased promotion for anchoring in both traditional (EU) markets and development in new markets.
- development of the Smart Textile sectors

According to these orientations, the survey launched among Tunisian industrialists to evaluate the current state of the T&C sector, has allowed to detect the main challenges to be taken up by the industrialists for the modernisation of the sector as well as the future prospects to be developed:

- Research in the T&C sector is qualified by the industrialists as mainly applied research (83% of survey respondents). They see themselves as the main initiators of the proposal of research subjects allowing the development of the sector. This expresses a need for industrialists and their willingness to innovate to develop their activities and compete on the international market.

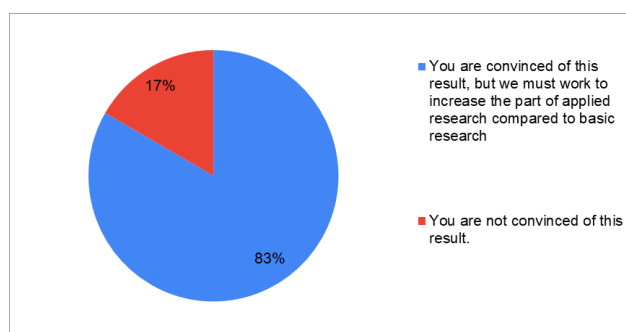


Figure 17. The results of the second round of questionnaires for industrialists: is textile research applied?

- The most used mechanisms for financing research and innovation in the textile and clothing sector are those with facilities for implementation and management. However, a large part of the industrialists is not familiar with these funding mechanisms and have never benefited from these funds. It shows that synergies between industrialists and researchers should be further encouraged through simpler and more effective programmes. Responding to the questionnaires, the industrialists declare that the MOBIDOC programme (48%) and PNRI (36%) are the most used (Figure.18).

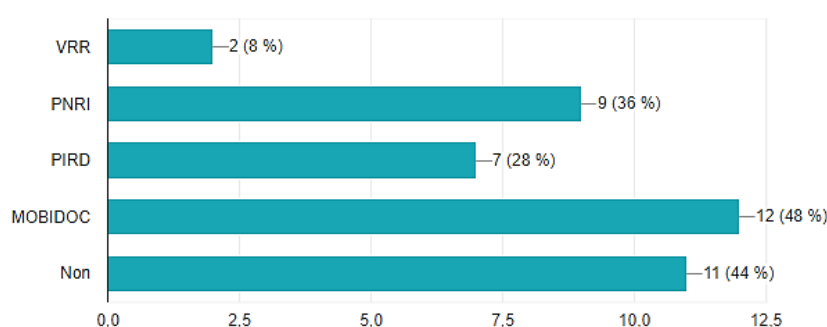


Figure 18. Results of the questionnaires for industrialists: Which are the most used research programmes?

- R&I equipments in companies and research laboratories are considered unavailable or not fully exploited. Thus, industrialists propose that equipment be either gathered in research centres whose management shall be entrusted to researchers, or kept in research laboratories with a collective operating authorisation to guarantee the proper use of this equipment. On this point, industrialists are in favor of better R&I equipment use and governance.

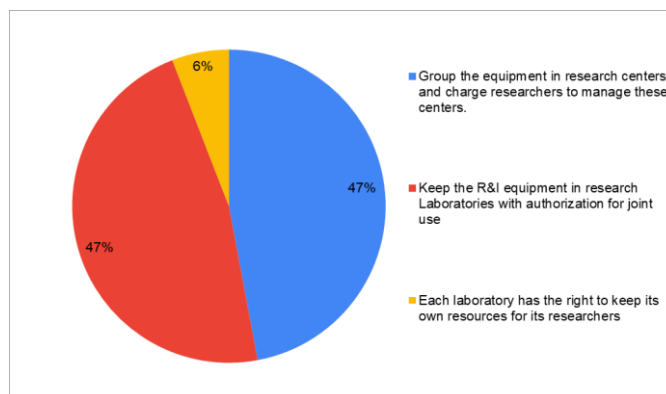


Figure 19. Questionnaire results for manufacturers: how to ensure a proper use of R&I equipment

4.1.1. Industrial needs in terms of innovation and technology transfer

4.1.1.1. Needs

The national orientation is to add a pillar consisting of the sectors of Information and Communication Technologies (ICT) and Business Process Outsourcing (BPO) which are two supporting axes for the textile and clothing sector.

In fact, according to the Davos world economic forum's ICT international rankings (1st in Africa, 3rd in the Arab world and 35th in the world according to the Network Readiness Index (2016)), Tunisia holds a position of regional leadership in the ICT sector.

The current analysis of the results of the questionnaires and the focus group showed that both researchers and industrialists consider that research in the T&C sector is applied research. This view is supported by 83% of the people surveyed. In the same way, the researchers confirmed the opinion of the industrialists about the initiative by the latter to propose research subjects stemming from problems in the field. The industrialists declared that this initiative should be reinforced and encouraged in order to propose more research topics in relation to their needs and responding to their development imperatives.

Industrialists stated that innovation is mainly linked to the availability of tools/equipment on the one hand and know-how on the other. The rest of the resources are required but not with the importance of these two factors. This is confirmed in the second round of the survey with a majority of 89% of the companies participating in the questionnaire. Some other conditions were cited by the rest of the industrialists who did not share this opinion, but who deserves attention: The Inefficiency of collaborations between industrialists and research structures, motivation of the actors involved, complicated and slow administrative procedures, lack of political will, financing of innovation and research projects with simplified management tools, importance of technological monitoring for

industrialists.... However, as an indication, industrialists justified the use of the MOBIDOC programme and the PNRI mechanism by the simplicity of setting up and managing these mechanisms on the one hand, and the most suitable duration of implementation on the other hand.

Furthermore, as stated during the first round of the survey, the most rewarding areas of innovation for industrialists are process innovation (91.7%) and management innovation (62.5%), this is confirmed by the majority of industrialists during the second round. Other areas suggested by industrialists are product innovation and integration of new technologies.

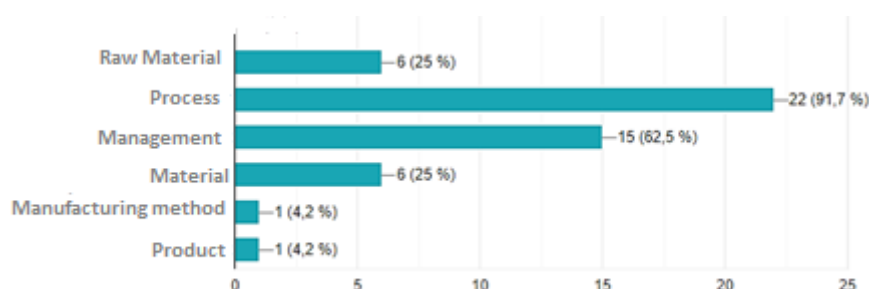


Figure 20. Results of questionnaires for industrialists on areas of innovation in companies

4.1.1.2. Marketing needs

France, Italy, Germany, Belgium and the United Kingdom are Tunisia's main partners; they participate in more than 70% of Tunisian textile exports.

The weak knowledge of the export markets and the absence of a marketing strategy justify this concentration. Indeed, the studies carried out² show a low level of use of information and communication technologies (ICT) in the textile industry and other professional fields. Even though Tunisia certainly has a solid industry in terms of ICTs having been a pioneer in the use of the Internet in Africa and the Arab world; Tunisia is on the margins in the techniques of acquisition, use as well as exploitation of ICTs as a work tool, marketing and commerce. In this regard, various parameters can be cited:

- First of all, the Tunisian dinar is not yet convertible.
- The difficulty of remote monetary payments for international transactions. Credit card holders being an exception to this rule
- Internet access remains relatively expensive and difficult for a large majority of Tunisians.

The massive use of the Internet in Tunisia has not, unfortunately, really translated into a wide practice of e-commerce. In fact, the 8th survey recently conducted in this direction shows that only 3% of the copied companies declared having used e-Commerce. The study carried out for this report confirms

this observation. Indeed, this rate is also very low for the companies in the control sample, i.e. 2%. The main reasons given by the copied companies for non-using e-Commerce practices are:

- Lack of staff with the necessary ICT skills (21%);
- Problems of security and trust (16%): security and reliability of e-commerce systems, uncertainty about payment methods, etc;
- High costs (16%): costs of ICT equipment, networks, software, etc;
- Regulatory issues (16%).

That said, in the current economic climate, the textile industry must make greater use of ICTs to develop more and more e-commerce.

4.1.1.3. Skill requirements

In order to develop innovation projects in the textile field, middle and senior managers in companies need to acquire advanced technical and managerial skills in innovation. Training programmes must respond to the needs of the sector and must be oriented to provide skills that support the development of the sector. Continuous training programmes must support innovation in companies. Among the skills required to create a culture of innovation in the sector are the following:

- Creativity
- Team spirit
- Innovation management
- Innovative techniques in textile/clothing

Moreover, the level of collaboration of the Tunisian universities and institutes with the textile and clothing industry remains timid and taken by personal initiatives. Some universities have made efforts to create an appropriate environment for collaboration, technology transfer and entrepreneurship, while others have not taken such measures. In addition to this, it should be noted that in Tunisia, the management of intellectual property is entrusted by the national agency for the promotion of research 'ANPR' to the Technology Transfer Offices which is supporting the exploitation of research results and the creation of partnerships between suppliers and users of technology since 2012. Although there are no exact figures on the capacity of the TTOs, it has not encouraged collaboration between the industrial manufacturers and research and academic institutions. Indeed, it has not yet produced the expected results, as TTOs are not sufficiently connected to markets due to the limited resources allocated to them.

The results of the questionnaires elaborated with the industrialists raised the fact that the majority of the companies questioned carry out their activities in the field of technical and finishing textiles

(natural dyes and chemical products). This explains the fact that 60% of the participating companies have R&D departments. This shows that the companies have skills that perform these functions.

Moreover, the TCI (2017) note²⁵ published by the documentation and industrial information centre of the Agency for the Promotion of Industry and Innovation (APII) stipulates that the field of technical textiles is characterised by a high rate of staff. In fact, companies in this field employ 56.2% of engineers, 24.4% of technicians and 23.3% of administrative staff in relation to the TCI sector as a whole (Figure.21).

Proportion of P&MS in the technical textile branch in relation to the total of the T&C sector

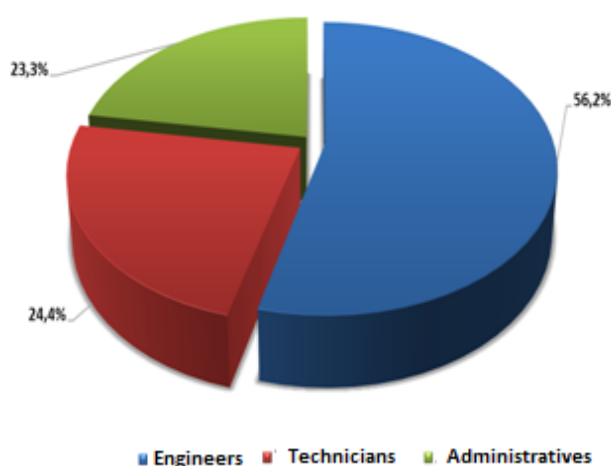


Figure 21. Proportion of P&MS in the technical textiles branch in relation to the total T&C sector

The functions related to the technical textile development require a high level of supervision. All the companies which have launched this type of business have employed P&MS with a high technical and managerial level. The needs for such skills have been taken into consideration by certain academic institutions such as the Higher Institute of Technological Studies of Ksar Hellal which has launched two professional masters courses mainly concerned with the development of innovative products and dealing their management.

Moreover, the survey conducted among industrialists showed that more than 73% of the research activities carried out within these companies are proposed by industrialists and not by researchers. This confirms that the research and development activities stem from a need on the ground (solving problems encountered by industrialists).

In the group discussion on the topic of competences required for innovation, participants proposed to focus on research and innovation, technological, environmental, quality and transversal

competences. They also stressed the need for a new profile of innovation project engineer armed with the skills needed for project set-up, project management and intellectual property management.

4.1.1.4. Material supply requirements

Besides the importation of all its raw material needs - fibres, filaments and cotton - which it lacks, Tunisia continues to import large quantities of high-quality yarns as well as special and fancy yarns. The rate of coverage relative to the branch is still low and this can be explained by the shortage of raw materials. Indeed, Tunisia does not have an industry which feeds the textile sector with the equipment necessary either to ensure production or development and research. For all that, Tunisia must follow the evolutions at the level of the process to produce ecological, technical, high added value products... These actions require development, creation, evaluation and of course the appropriate material and equipment.

On the other hand, 76% of the industrialists questioned stated that they need tools/equipment to be able to innovate and 68% need know-how. Indeed, only 24% of the companies participating in this survey stated that they have state-of-the-art equipment, 40% have innovation equipment but limited to certain works, while 32% do not have exceptional equipment.

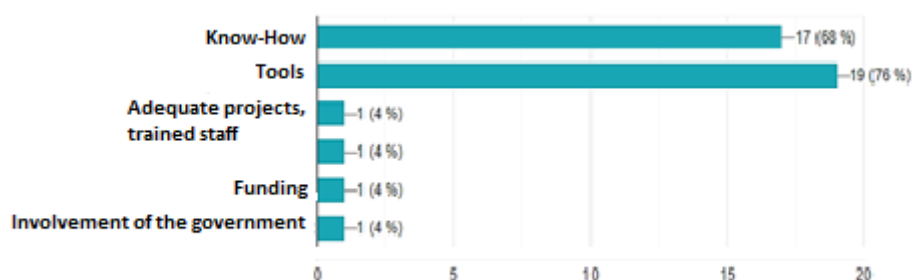


Figure 22. Manufacturers' needs to innovate

In this regard, the study I revealed that the majority of researchers stated that research equipment is either basic (54%) or difficult to use/access (26%). This is confirmed in the second round of the survey at 96% (Figure.23).

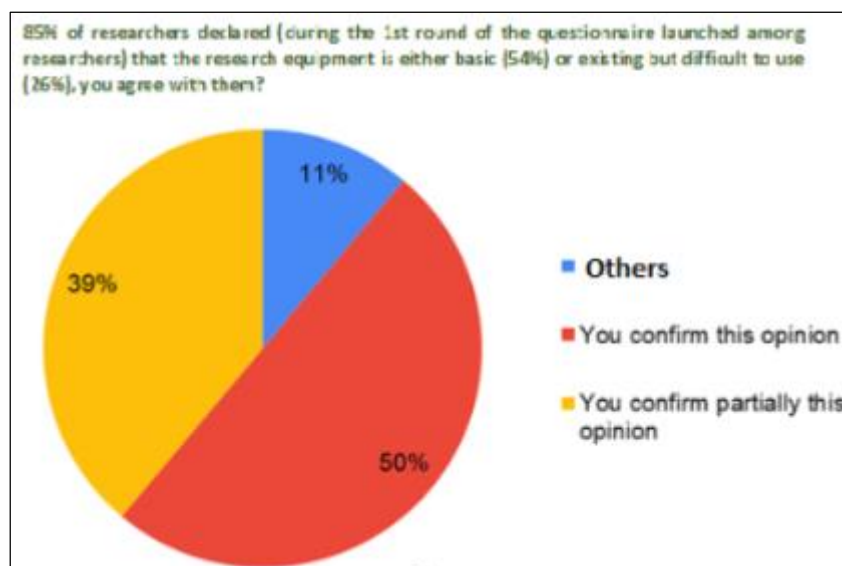


Figure 23. Industrialists' opinion on research equipment

Industrialists believe that, in the innovation process, the problem of equipment can be solved by improving the management of research equipment among researchers (innovation centres). However, it is necessary to focus on "innovators" and innovation structures (innovation centres) ... Others think that advanced equipment exists but scattered, without traceability, which is not allowing its exploitation. In this context, industrialists propose either to group equipment in research centres and to entrust researchers with the management of these centres, or to keep them in research laboratories with a common operating authorisation, in order to guarantee the democratization and good exploitation of this equipment.

4.2. Strategic vision of research and innovation structures

4.2.1. Needs of research structures in terms of innovation and technology transfer

The evolution of the economic context puts the problem of innovation in a central place in terms of performance of Tunisian textile firms. In recent years, Tunisia's economy has become more complex and knowledge-based while recording remarkable performances compared with those of similar countries. However, it has yet to realise its potential for innovation. The transition requires the generalisation of a productive model based on communication technologies and networks, coupled with internal knowledge resources and a creative organisation giving a central place to innovation-oriented Research and Development (R&D).

However, innovation in Tunisia is undergoing constant evolution and is of particular interest given its repercussions on economic growth and the development of enterprises. One of the most widely used indicators to assess the research effort is R&D investment which increased from 89 million dinars in 1997 to 430 million dinars in 2006. In relation to GDP (global domestic product), the rate of internal R&D expenditure rose from 0.43% in 1997 to 1.07% in 2006, a growth rate of 1.48%. In 2016, public expenditure on scientific research is 0.66% of GDP.

Indeed, this insufficient spending on scientific research by the state and the weak public-private partnership leave researchers with an adequate budget and funding to carry out their research projects. However, on a strategic point of view and in order to promote innovation and cooperation between industry and research, Tunisia has launched the monastir-elfajja competitiveness technopole which has the role of providing a link between business and university in order to help businesses to benefit from high end skills and know-how. Furthermore, the launch of a textile research centre which is currently being implemented will certainly reinforce the research and innovation infrastructure in the textile sector.

The establishment of innovation centres and skills training is therefore a definite necessity. The textile sector is a multidisciplinary sector including several branches which requires a wide range of skills and innovation that can affect several products, processes and procedures, thus requiring varied and highly technological equipment and specific multidisciplinary skills.

To summarise, there are two main points that can make a big improvement:

- Diversification of innovation centres
- Training of suitable skills

4.2.2. Diagnosis of the innovation environment by research structures

A survey of researchers and academics dealing with issues related to innovation, research equipment and the relationship between researchers and industrialists has led to the following observations obtained by figure 15:

- The majority of researchers have worked on applied research projects in textile companies.

Moreover, the majority of these experiences present good feedback.

- Most of the projects did not benefit from national research funding programs. MOBIDOC and PNRI represent the two programs most used by researchers who have been able to obtain funding for their projects.

- Researchers are convinced that the field of textile engineering research is an area of innovation, but the limitation of new technology and the availability of equipment create the two major limitations.

Several handicaps were noted by the researchers when carrying out the research work:

- Lack of specific research equipment
- Non availability of research funding
- Weak cooperation between research structure and industry to develop research projects

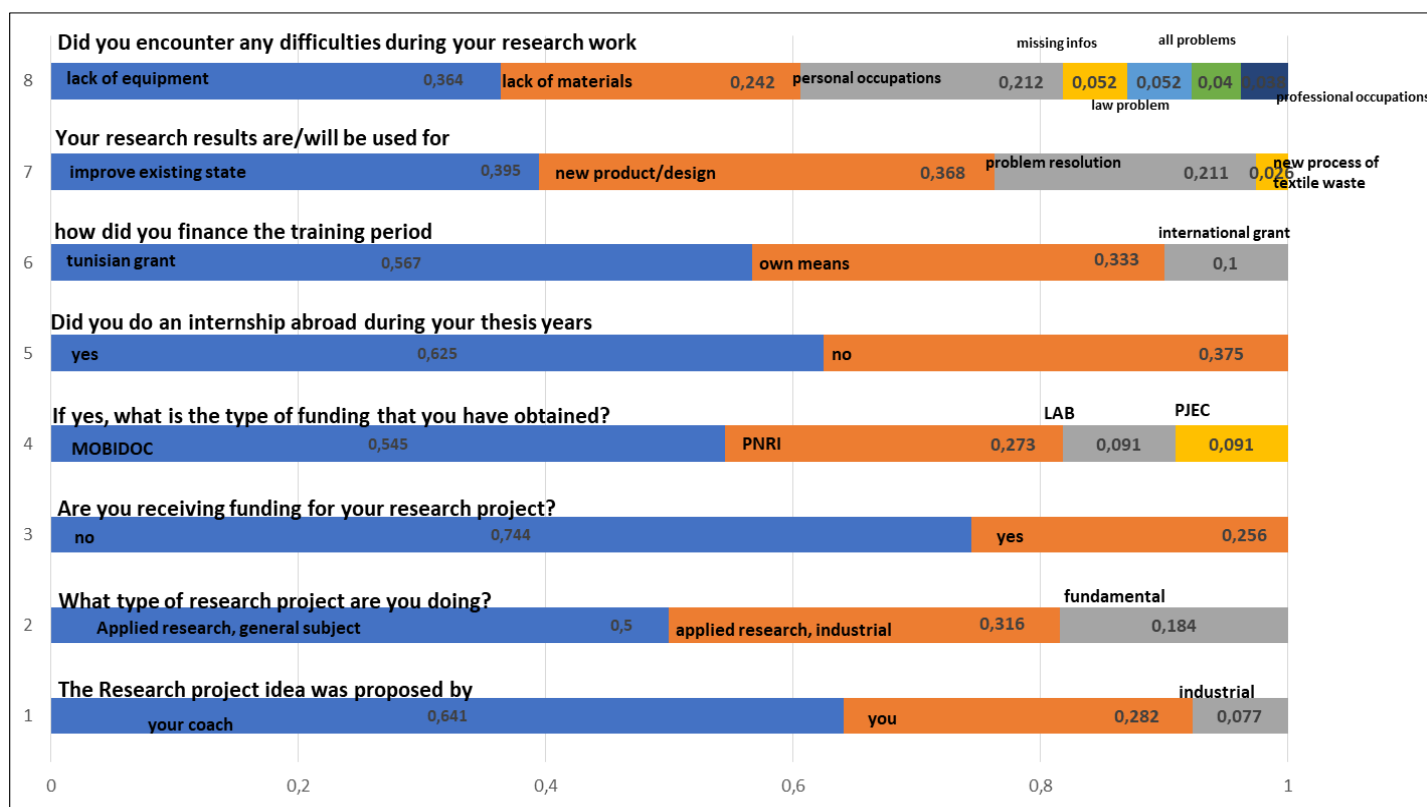


Figure 24. Diagnosis of research conditions in Tunisia

When asked about the type of equipment available in universities and research laboratories, researchers affirm that the equipment is basic(69%) or restricted to a few researchers(25%).

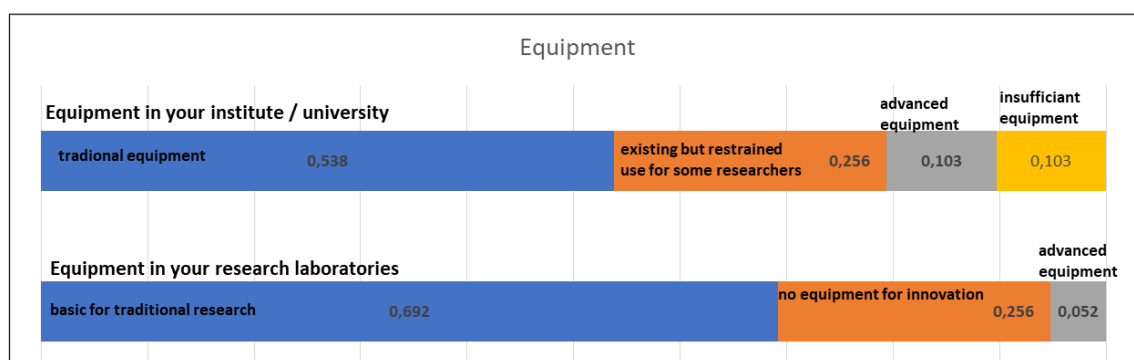


Figure 25. Results of researcher's survey about availability of equipment

4.3. Synthesis and reconciliation of needs and strategic visions

The analysis of industrialists' and researchers' strategic visions, as well as their needs expressed in the survey carried out in this study, allow us to reach the following observations and guidelines:

- The commitment and the need to lead research and innovation in the textile sector
- The need to strengthen industry-research cooperation to improve the sector's competitiveness through the establishment of an innovation culture and investment in research projects.
- Strengthening the openness of research structures regarding the socio-economic environment and dealing with subjects that meet the needs of industrialists.
- The need to rationalise the management of research and innovation equipment for better use.
- The need to promote and simplify research and innovation funding mechanisms
- The importance of setting up specialised innovation centres to better implement research and innovation work.
- Needs of industrialists for specialised skills in innovation (innovation expert)
- Specific training needs for researchers in management and management of innovative projects

The results of the surveys and focus group discussions allowed a diagnosis of the innovation environment in the textile sector. Strengths and weaknesses as well as opportunities and threats were identified. The following table presents this SWOT analysis.

Table 26. SWOT analysis of Tunisian textile innovation system

Strengths	Weakness
<ul style="list-style-type: none"> • A growing number of researchers working on innovative themes • Growth in the number of companies in the sector with the R&D department • National Research and Innovation System set up (infrastructure, strategic axis, etc.) • Establishment of various innovation support programs and financing mechanisms benefiting companies, research and higher education establishments • Considerable effort to popularize the innovation culture (seminars, round tables, competitions, etc.) • Publication of national status of student entrepreneurs in Tunisia (SNEE) • Strong growth in scientific production and scientific publications published in peer-reviewed journals of better quality • Strong motivation of actors in the textile and clothing sector for innovation 	<ul style="list-style-type: none"> • Absence of research centers directly involved in textile innovation • Lack of coordination and monitoring allowing a match between supply and demand for innovation in the sector • A weak effective autonomy of universities and Lack of a team specializing in setting up innovation projects and coordinating their management. • Still insufficient R&D and industrial innovation capacities, particularly in small, domestic, or little export-oriented companies • Interfacing structures between public research and business sector which are often inefficient and marginalized. • Absence of monitoring and evaluation of public innovation policies • Weak financial resources in favor of innovative projects • Lack of additional training in disciplines interacting with the textile specialty necessary for the implementation of innovative projects • Lack of control of lead to market for the implementation of innovative projects on the market

Opportunities	Threats
<ul style="list-style-type: none"> Cooperation with European clients in new branches of innovative activity with high added value such as technical textiles Good practices on R&D and innovation policies available from partner countries of Tunisia State encouragement for doctors to set up their own innovative projects and launch their startups. Evolution of innovation demand by contractors Available international funds and programs encouraging innovation (H2020, Erasmus+ ..) <p>Growth in global demand for hygiene and health equipment following the economic situation imposed by the COVID-19 pandemic</p>	<ul style="list-style-type: none"> Political and social instability constituting a brake on foreign investment for the development of innovation. Rising Chinese competition capable of reproducing innovations at a lower cost Lack of control over certain components of the value chain of innovative textiles An unfavorable regulatory framework governing private investment and competition

5. TOWARDS THE IMPLEMENTATION OF NEW INNOVATION STRATEGIES

5.1. Objectives of innovation strategies

The Textile & Clothing sector, a pillar of the Tunisian economy, has experienced in recent years, a situation of loss of speed or even crisis, materialized by: the fall in investments and exports, a loss of jobs (around 40,000 jobs) and a decline in the rank of EU suppliers overtaken by competitor countries in the Euromed zone. This situation results, among other things, from a delay in the implementation of the sector strategies previously developed. Such a delay is mainly due to a lack of execution, governance and management capacities to address the various challenges of the textile & clothing sectors in terms of integration, training, promotion, infrastructure and other changes in its environment.

In the recovery plan²⁶ for the Textile & Clothing sector (2019-2023), professional actors agree on strategic and structuring orientations for the sector, namely:

- Integration of sectors
- Upgrading & innovation
- Development of an attractive offer regarding contractors and international investors
- Development of smart textiles sectors (Smart Textile)

The objectives of the new innovation strategies will then be:

- Improve the performance of the SNRI in the service of innovation:
 - Promote good governance of the SNRI through the application of an appropriate public-private governance model: The proposed governance model is based on key steering bodies and a clear definition of roles between the various public and private stakeholders.
 - Establishment of a High Authority for scientific research and innovation: the academic council of the textile industry, a strategic level council whose main mission will be to discuss and validate the national research strategy and innovation. This council will also define the main orientations of the SNRI, approve the national priorities in terms of research and innovation, define general objectives and evaluation criteria for the SNRI and finally it will carry out a periodic evaluation to suggest areas of improvement to ensure consistency between ministries and sectors.
 - Establish a methodology and periodic process to identify national priorities for the SNRI

- Diversify the network of partnerships and international cooperation programs and identify clear objectives for the different cooperation programs to ensure their alignment with national priorities
- Establish a network of national contact points in charge of diversified topics and a professional coaching system so that researchers benefit optimally from the opportunities offered by innovation support programs.
- Develop the mechanism for promoting research results.
- Strengthen interactions between institutional players and manufacturers (interfacing, interaction and synergy)
 - Strengthen the policy of interfacing and networking between all stakeholders within the innovation system
 - Territorial diagnosis, diagnosis of actors, projects and resources
 - Analysis of needs and reformulation of current policy
 - Follow up
 - Drive the innovation ecosystem towards greater efficiency and attractiveness
 - Install an adequate technological infrastructure
 - Develop virtual research and innovation platforms
 - Strengthen the mobility of researchers towards the company
 - Promotion of research results
 - Implementation of collaborative projects
 - Develop a culture of valuing R&I and entrepreneurship
 - Develop support mechanisms
 - Funding of pilot initiatives: PAQ for RI pre-seed and scientific spin-off initiatives
 - Support PAQ for the RI-CG of the Research Centers
 - Strengthening the culture of intellectual property
 - Develop a culture of the circular economy and eco-processes
 - An industry that respects the environment
 - Fight against pollution and its effects

- Treatment and recovery of industrial waste
- Develop a culture of respect for intellectual property and the fight against unfair competition.
- Prospecting sources of evaluation and funding for research and innovation in the textile-clothing sector
 - Migrate to a transparent and competitive funding system focused on the 4 projects and aligned with the priorities
 - Increase funding for scientific research to 1% of GDP by 2023
 - Establish centers of excellence and strengthen their capacities
 - Improve the efficiency of evaluation and reporting systems
 - Diversify programs and initiatives to support innovation
 - Increase the proportion of competitive funding based on calls for projects compared to the share of recurring funding
 - Define objective and transparent criteria for the distribution of recurrent funding to laboratories and research units
 - Multiply joint research projects with the socio-economic environment
 - Draft a bill to encourage private companies to invest in research and innovation activities
 - Simplify the financial management of international projects
 - Create research consortia in the textile field and support the creation of centers of excellence
 - Improve the flexibility of the creation of a research unit / laboratory and modernize their management (acquisition, contracts)
 - Strengthen the capacities of the National Committee for the Evaluation of Scientific Research Activities and ensure its compliance with international best practices
 - Develop a governance dashboard and a reporting system to monitor the KPIs of research structures and researchers
- Access to large European funds and risk financing

- Encouragement of scientific excellence
- Large-scale call for projects
- Promotion of the scientist on the market
- Entrepreneurial potential in research& innovation
 - Scientific talents (niches of academic excellence, future and emerging technologies)
 - Favorable infrastructure
 - Industry with a capacity to absorb research & innovation
- International scientific positioning
 - Initiator of innovative projects
 - Networking by consortium
- Provide co-constructed training adapted to the needs of the sectors
 - Implement an approach to co-construct training paths between the profession and the training system (HEIs)
 - Promote the image of the sector and the attractiveness of the sectors to young people
 - Launch graduate retraining programs for the benefit of textile and clothing industries
 - Promote the great potential for innovation offered by the textile and clothing sector.
- Improve the system of internal governance and quality assurance of research structures
 - Improve the administrative and financial autonomy of establishments and structures and promote their management
 - Establish a quality assurance system in research structures
 - Ensure optimal use of heavy scientific equipment and develop a research infrastructure
 - Promote the quality of doctoral training programs
 - Promote incentives for research staff
 - Promote ethical standards in scientific research.
- Strengthen the promotion of scientific research work, technology transfer and the dissemination of knowledge

- Promote the mobility of research students towards the socio-economic world
- Promote the governance of technology parks and complete their missing components
- Accelerate the process of technology transfer and the creation of innovative startups
- Disseminate and promote SNRI research results and provide better information about its capacities
- Strengthen the links between research structures and their socio-economic environment
- Promote research and innovation in the private sector and in private higher education institutions.
 - Set up an online platform to link research and thesis projects to the needs of the socio-economic environment
 - Establish a national map of mature research results for transfer to the socio-economic environment
 - Develop a program to transfer research results and organize “national days for the valorisation of research”
 - Establish programs to develop skills in the textile sector in connection with the transfer of technology and the promotion of the results of scientific research
 - Develop incubation and support mechanisms to support the first phases of innovative projects with high potential
 - Examine the strategic positioning of technology parks, accelerate the completion of the planned components and improve their governance and their integration into regional development policies
 - Launch a national portal for scientific research and encourage Tunisian and regional scientific journals
 - Encourage the creation of research units in private higher education establishments and in public and private enterprises.

5.2. Towards the establishment of innovation centers

Facing increased competition for decades, the textile industry is developing a real strategy based on innovation. Tunisia, particularly affected by the decline in its ranking among the EU's suppliers of

textile and clothing products over the past decade, but also endowed with remarkable potential, has embarked on this path.

The main objective of the textile innovation centers will be to stimulate and support the development of the textiles of tomorrow. These centers will form a link between university research and business.

The WINTEX project aims to fill the lack of specialized services in the Tunisian textile sector with the creation of three textile innovation centers located in the participating universities in Tunisia: University of Sfax, University of Monastir and the Higher Institute of Technological Studies of Ksar-Hellal (ISET).

These three centers will be equipped with high-tech equipment to promote innovation in close collaboration with textile companies within the framework of university-industry collaboration and the strengthening of technology transfer. This equipment is funded by the European Union to the tune of 300,000 Euros.

Table 27. Preliminary list of equipment for textile innovation centers to be created as part of the Wintex project

ISET Ksar-Hellal Center	IS2M Center	ISAMS Center
Electrospinning unit	Scanning electron microscope	3d Body scanner Cabine
Extrusion and meltblown die assembly	Fourier Transform Spectrometer (FTIR)	Transfer printing machine
Web forming, edge-cutting & winding unit	Air permeability tester	Digital printing machine
Vacuum furnace and ultrasonic bath		Automatic lab Knitting flat machine
Labcalendering machine		3D print+ design software+ 3D scanner
Manual hot press		Head Laser Engraving Cutting Machine
Handtufting equipment		Digital embroidery machine with software
Warping machine		3D Simulation textile design software

5.3. Needs for setting up innovation centers and academia council

The equipment that will be supplied to the centers will meet certain needs and create synergies between these centers, thus optimizing the installed capacities. The main objective of the innovation centers is to support companies in the textile industry with advanced and specialized services. Staff from universities participating in the project will be trained in an international environment and will have access to the expertise of the European textile centers involved in the project.

The innovation centers will support companies in the textile industry, entrepreneurs who develop new solutions using cutting-edge textiles, students involved in start-ups as well as researchers seeking to enhance their results of research. The centers' business models will ensure their sustainability, regardless of the duration of the project.

The centers will offer the opportunity to provide new services to textile companies such as the prototyping of innovative textiles and the optimization of their performance, advanced quality controls, certification, specific trainings, workshops and seminars, support for projects, organization of events to encourage innovation, support for participation in exhibitions, promotion of entrepreneurship and the integration of innovative ideas in the textile industry.

Completely new services will be developed, such as quality testing, product certification, training, information seminars on fashion trends, new ways of organizing production, etc.

The three centers will be equipped with additional equipment covering various technical textile specialties but always in a dynamic of smart and circular economy:

- Pilot lines for the development of nonwovens by dry process and by meltblown spinning intended for medical, industrial, automotive applications, etc.;
- Pilot lines for the development of composite textiles
- Machines to develop eco-designed products with high added value
- Computer-aided simulation and creation tools and software
- Design and fashion 4.0 equipment
- Advanced metrology and analysis devices

The three textile innovation centers will aim to respond to societal challenges related to Sustainable Development to transform the entire sector and:

- Make smart technologies accessible.
- Integrate digital transformation into business lines.
- Minimize its environmental footprint.

- Develop value ecosystems.
- Deploy new business models (functional economy, circular economy).

To achieve this, these centers should have:

- Adequate financial and technical support during all phases of implementation
- Effective governance, according to an adapted public-private model, guaranteeing financial autonomy, sustainability and the future development of these centers
- Qualified human resources working for the centers (by employment contracts to be defined later) and benefiting from a specific program of continuous training and skills building
- Close cooperation with the industrial fabric and all stakeholders in the Tunisian textile sector on development work and prototyping of innovative products and processes, technology transfer projects and prospecting for new niches in the textile of the future.

These innovation centers will be overseen by an academic textile council whose objectives will be:

- Become a pole of R&D competences and a leading technological platform in Tunisia in the field of technical textiles and innovative textiles
- Lead a network of 3 textile innovation centers in ecosystems very active in the field of training textile manufacturers, with recognized expertise and full of great potential for innovation
- Involve large Tunisian partner companies in governance
- Host an on-site workforce of around one hundred people divided between:
 - R&D activity and technology transfer
 - Academic research
 - Valuation ecosystem
- Generate startups on innovative textiles and incubation companies
- Prospect funding and attract international partners for cooperation projects on themes related to innovative textiles
- Federate a network of growing regional textile-clothing SMEs thanks to innovation
- Encourage the creation of direct jobs in the field of innovative textiles.

During the implementation of the Wintex project, a collaborative platform could be set up online, a virtual space aimed at promoting collaboration between:

- The textile innovation centers established at ISET, ISAMS and IS2M;
- Centers and companies belonging to the European and Mediterranean region;
- Centers and other stakeholders, such as legislators, BIOs and research centers;
- Centers and initiative groups which intend to create other textile centers and / or universities which wish to establish textile centers.
- The upcoming platform will provide a space to learn about activities, events, projects, funding opportunities and to access different types of useful links.

6. SYNERGY WITH SIMILAR NATIONAL AND INTERNATIONAL PROJECTS

The detection of synergies with other national and international project ideas in the field of textile innovation structures and innovative textile materials is very important for the elaboration of WINTEX project. The identification of EU best practices and success stories could be transferred to Tunisia, including other financed projects which are in relation to the capacities reinforcement in the textile sector.

6.1. Projects with tunisian involvement

▪ **TEX MED ALLIANCE: Textile Mediterranean Alliances for Business Development, Internationalization and Innovation (2019-2022)**

Like many others, the textile sector has changed dramatically during the last decades. Advanced countries have brought in high performance and high added-value technologies while emerging countries, mainly from Asia, have sharply reduced the costs putting insane pressure on Mediterranean traditional clothing SMEs. In contrast, the Mediterranean textile sector has traditionally been a weak innovation performer. TEX-MED ALLIANCES aims at reducing that persistent innovation gap. To do that, the project proposes an innovative approach based on the development of two types of initiatives: cross-border initiatives identified and promoted by the project partners and cross-border project ideas/proposals arising directly from MSMEs. Together, these actions will put innovation at the core of the sector. Eventually, TEX-MED ALLIANCES will help textile and clothing MSMEs expand internationally inside/outside the Mediterranean area, fostering job creation and technological upgrading.

Thanks to the project, concerned MSMEs from the Mediterranean textile/clothing industry will acquire updated knowledge and technical skills in the modest fashion segment, smart textiles and digital printing, enhancing innovation, competitiveness and capacities to reach new markets. Solutions to foster more sustainability in the textile sector, based on a circular economy perspective, will be investigated and implemented. The ultimate ambition of the project is to turn the Mediterranean textile sector into an Industry 4.0, contributing to the re-orientation of the sector towards innovative productions and new business models.

Textile and clothing MSMEs and manufacturers

- Suppliers such as those of raw materials, machinery, software, specialized services (R&D centres, logistics) Professionals (designers, stylists, technicians, etc.) Wholesalers, distribution chains, retailers

- 31 support initiatives for the internationalization, innovation and technology upgrading and circular economy in the textile/clothing industry
- 34 MSMEs participating in key business events and internationalization/innovations fairs
- 1 open forum on circular economy to share best practices in the textile/clothing industry
- 4 business to business events gathering at least 123 MSMEs
- 22 MSMEs participating in new Euro-Mediterranean business alliances and partnerships

▪ GtexMenatex

The Global Textiles and Clothing Programme (GTEX) and its related work in the Middle East and North Africa (MENATEX) promote Textile and Clothing (T&C) exports from countries in Central Asia, the Middle East and North Africa. The aim is to stimulate employment and income generation along the value chain.

In its initial phase, the project targets Egypt, Jordan, Morocco, Tunisia, Kyrgyzstan and Tajikistan. The GTEX programme is funded by the Government of Switzerland. The MENATEX is funded by the Government of Sweden for the MENA region. ITC, in close collaboration with the Swiss State Secretariat of Economics Affairs (SECO) and the Swedish International Development Cooperation Agency (Sida), will implement the programme. The programmes will run until December 2021.

The envisaged impact of the programme is to increase employment and income along the T&C value chain in the six selected priority countries. To achieve this long-term objective, the programme intends to accomplish two major outcomes until the end of the programme. One is related to the institutional infrastructure around the sector in the priority countries, including policy aspects when required, and is formulated as “Improved business environment and Trade and Investment Support Institutions (TISI) performance in the T&C sector”. The second outcome targets the enterprise level and is formulated as “Improved competitiveness of Small and Medium sized Enterprises (SMEs) in the T&C sector”. GTEX MENATEX ultimate beneficiaries are employees and managers of SMEs that will benefit from job security and possible increased earnings through an improved competitiveness of their companies and the sector.

The intermediate beneficiaries are TISIs in the textiles and clothing sector that benefit from improved management and operations, as well as an enhanced service offering to their enterprise members. An inclusive approach will address sustainability issues such as gender, youth and the environment.

▪ COM TEXHA

The overall purpose is to support the Tunisian textile and clothing (T&C) sector, overcome existing challenges, move up the value chain and diversify export markets. The project will work at enterprise

level and at institutional level to boost export competitiveness by increasing value addition, particularly in the area of product development and product design.

The project will focus its interventions on two main levels:

- **Companies:** The project targets three types of companies in the textile and clothing sector. The first target is exporting companies based in Tunis / Sahel and the coastal region, other having export potential but are not currently exporting Companies specializing in a "niche" market. Another target is suppliers of technical textile products for specialized markets. The interventions will be adapted according to the needs and specificities for each of the market segments. These will mainly be interventions aimed at improving export competitiveness integration of young people in SMEs in the textile and clothing sector, identification of new markets and export support mentoring contracts between "advanced" and "less advanced" SMEs.
- **Institutions:** "CETTEX" textile technical, "CEPEX" Export Promotion Center National, Federation of Textiles and Clothing "FENATEX", Monastir - El Fejja competitiveness, Eight regional chambers of commerce and industry, Confederation of Tunisian Citizen Enterprises "CONNECT"

The expected results are the Capacity building of companies in the T/C sector in the production and export of value-added products by integrating new skills into economic circuits to strengthen business and partnership relations between companies in inland regions and companies in coastal regions of the T/C sector to facilitate local integration. It shall result in the production of products with greater added value in order to better meet the needs of new markets.

Implementation approach: Building on its significant experience and successes in designing and implementing trade and export promotion related programs and projects, including in Tunisia and the Arab world, ITC will opt for a business-based approach.

6.2. EU Projects

- **CLEVERTEX (Development of a strategic Master Plan for the transformation of the traditional textile and clothing into a knowledge driven industrial sector by 2015)**

The aim of the project was to contribute to the economic and social progress in the European Union by transforming the industry into a dynamic, innovative, knowledge-driven, competitive and sustainable sector by 2015.

The objectives of this project were to:

- Map the possible future technological developments in the intelligent textile sector from a socio-economic (non-technological) and technological perspectives.

- Prioritise these possible developments in the actual socio-economic environment (technology foresight).
- Identify needs, breakthroughs and bottlenecks in order to answer to these developments.
- Help the transformation of the European Textile and Clothing industry.

The application area of those materials is very large ranging from medical and health, construction and buildings, clothing and home, improved human performance.

In CLEVERTEX the Delphi study was used as a strategic analysis method for identification of:

- R&D horizon (year/level).
- Impact (eco/employment).
- Obstacles.

It was also a method to achieve involvement of all key-actors in Europe in the design of scenarios for the future and a communication instrument for building systematic interactions and feedback relation between the players.

The results that were obtained from the study were the following:

- Conductive materials were expected to penetrate in all suggested application fields according to a majority of experts - especially in Interior Textiles.
- Electronic components, sensors and actuators were expected in all textiles, - except in textiles for building - and especially in Interior Textiles and Textiles for Health Sector. - Materials allowing Encapsulation and grafting of advanced properties as well as Advanced polymers were expected to find more surely their application in Clothing sector.
- A majority of experts could not identify clearly applications in textiles for building industries (except for textiles generating energy and power supply).

The Gap Analysis was linked with the other parts of the project. This study analysed the deriving gaps in research and development by comparing the priorities identified by the Delphi study and the on-going research.

The Gap Analysis was performed in order to design the methodology to identify and describe the technological gaps between the priorities (needs or expectations of the market) and the state-of-the-art on going research.

The gaps could be considered based on different criteria, or more precisely according to different sets of characteristics: materials, technologies, functionalities, applications, production processes, and technical obstacles.

Using the state-of-the-art report, the Delphi, feasibility and socio-economic studies, the University of Gent performed the Roadmap describing the strategic analysis of the needs and future developments.

Based on the statistical data of the Delphy study, several scenarios were prepared. Those scenarios translated trends and technologies identified by experts into a less technical language illustrated with examples of use.

- 1) This project was followed by two other projects: CA SYSTEX (ICT) which aimed at developing a framework for current and future actions in research, education and technology transfer in the field of e-textiles and wearable micro systems / electronics in Europe to support the textile industry in the most efficient and effective way to transform it into a dynamic, innovative, knowledge-driven competitive and sustainable sector.
- 2) EC MICROFLEX which would exploit micro fabrication to produce active functions cost efficiently by using custom printing processes.

▪ FOSTEX (Foster Textile innovation)

Fostex project aims to fill the gap in the area of specialised services for the textile sector by upgrading one textile centre in Morocco and by establishing three fully operational advanced textile innovation centres, one in Morocco and two in Jordan.

The project also aims to reinforce the link between university research efforts and the textile industry to foster innovation and the manufacturing of high added value products.

The textile sector in Morocco and Jordan consists of companies that have limited access to services like testing, training, research, studies, technology and financial funding instruments. The involved universities in the two countries aim to develop focal points that bring together enterprises, universities and research centres in advanced textile production.

By focusing on knowledge sharing, entrepreneurial skills, socio-cultural factors and innovation potentials, Fostex contributes to fulfil the universities' third mission, that is strengthening the 'knowledge triangle' by linking education with research and innovation, stimulating the social and economic development.

Fostex initiatives has the ambitious and challenging purpose to upgrade the textile centre existing at ESITH – Ecole Supérieure des Industries du Textile et de l'Habillement and to establish a new centre at UH2C – Université Hassan II de Casablanca, both Moroccan Universities, transforming them into textile innovation centres, providing advanced and specialised services to companies in the first place. In parallel, the involved Jordanian universities, JUST – Jordan University of Science and Technology and BAU – Al-Balqa Applied University, will set up new innovation centres to overcome the lack of

specialised support from Higher Education Institutions in the country. This will offer new possibilities to the companies of the sector to invest in quality, innovation and to design added value products. Fostex project complies with the national Jordan industrial policy for the years 2017 – 2021 that aims to develop competitiveness in the area of production cost, quality, certification, export and innovation, encouraging applied research and technology transfer from universities to industry.

FOSTEX combines different background, experience and expertise of the partners in a highly competent consortium, covering the skills, expertise and competences required to carry out all aspects of the work plan.

The partnership comprises 13 institutions from 6 countries representing different parts of Europe and the mediterranean area.

The consortium is characterised by a mixture of institutions with different profiles, capacities and complementary competences: higher education institutions, companies and non-profit institutions, research and training centres as well as business associations.

▪ CREATIVE WEAR (9/2016-2/2019)

CreativeWear revitalizes the crisis-ridden Textile & Clothing (T&C) sector through a new attention to creativity, personalised design, as well as artisan and small-scale production for territorially specific value chains in customer-driven business models.

CreativeWear extends the on-going H2020 TCBL project (which complements techno-industrial with social innovation to return 5% of capacity to Europe and attain a 20% reduction in environmental impact by 2025) to creative clusters in the MED space, integrating them into the broader TCBL ecosystem.

CreativeWear aim to recover and valorise the design heritage and tacit “making” knowledge of T&C in Mediterranean cultures (MED-Texmedin) and to bring new energy to creative T&C clusters by reinforcing their creativity-based innovation capacity and integrating their activity into emergent transnational value chains

CreativeWear tests adaptation of the TCBL network model (which couples Design, Making, and Place Labs with Business Pilots in innovative value chain scenarios) to existing creative clusters such as museums, creative hubs, fashion schools, design centres, volunteer organisations, etc. Testing in CreativeWear unfolds across months 15-42 of the 48-month H2020-TCBL project, perfectly aligning the development of the complementary approaches. The transferrable CreativeWear model thus allows for greater coherence with ERDF and ESF policy frameworks in different national and regional contexts.

DESTEX - INDUSTRIAL AND CREATIVE DESIGN IN ADVANCED TEXTILE MANUFACTURING (2019-2022)

The textiles' manufacturing sector in Europe is facing several major challenges like competition from emerging markets or the environmental demands among others. In order to tackle the current and future needs, Europe requires reassessing its position on critical factors affecting its competitiveness like uniqueness of its products, skills of its workforce and innovation as a means of competitive advantage. Advanced textile materials sector is an emerging sector within the textile industry driven by transdisciplinary innovation in several end-market focusing on the technical aspects and contribution of textile materials rather than on the aesthetics. However, in order to foster the innovation growth within those companies, higher education systems need to bring in the creativity culture found in industrial design and creative design to textile higher education programs as a way to unlock the innovation potential of advanced textile manufacturing in a transdisciplinary industry.

In this context, the DESTEX project will develop the tools necessary for skills enhancement targeted to higher education in relation to innovation in order to reach its objectives:

- To support higher education students to acquire skills in transdisciplinary innovation based on creative and industrial design applied to the textile sector.
- To foster student cooperation in a multidisciplinary approach in work-based projects to provide knowledge, skills and competences using virtual collaboration tools
- To promote the application of good practices for the enhancement of innovative skills;

The DESTEX partnership comprises 8 institutions from 5 European countries (Sweden, Greece, Italy, Spain and Denmark) presenting a balanced geographic coverage. There is a mixture of institutions with different profiles, capacities and complementary competences that are appropriate for the development of the work plan (higher education institutions, training centers, SME's companies, non-profit institutions, and business associations).

A set of implementation activities will materialize the project objectives, supported by preparation, management, quality and dissemination activities that will ensure the outreach of its results even after the project has ended. All of the project results are the outcomes of four (4) Intellectual Outputs and one intensive training:

- Designing and developing of a virtual training program with open education resources for training higher education students with industrial and creative design applied for advanced textiles' manufacturing.

- Creating a book of lectures “Creative and industrial design for innovation thriving in advanced textiles’ materials”, aiming to serve as the training material to be used during the C1 learning activity. Once tested (during C1 activity).
- Development of a virtual hackathon platform for on open innovation and project-based training of students using real case studies and challenges from the advanced textiles’ manufacturing industry.
- Developing a “Project handbook of good practices & open challenges: training tools and methodologies to foster creative and industrial design in advanced textiles’ manufacturing sector”, a document containing all relevant information related to the project and its achievements as well as open challenges to be tackled.
- An Intensive training summer course will be held in Milan with participation from students selected from the 4 universities participating in DESTEX project using a blended methodology that will integrate the different results from DESTEX.

These projects are presented for illustrative purposes to illustrate initiatives and projects similar to WINTEX. A database of projects and good practices in the EU will be developed by the European project partners. Discussion around those suitable for the Tunisian context will be postponed (Recommendations report). These best practices will make it possible to prepare the establishment of innovation centers as well as their business model.

7. SYNTHESIS AND CONCLUSIONS

This report synthesises the study of the Tunisian textile sector carried out within the Wintex project, as part of the sector's development and innovation approach via the strengthening of the university/industry linkage. It provides a wide vision of this sector in its strategic dimensions and in its national and international context. The objective is to identify its strengths and weaknesses as well as the opportunities to be seized and the threats to be confronted in order to foster development and accelerate the sector's performance through innovation.

The aim is therefore to reinvent the sector to make it more competitive. This study revealed the need both for textile and clothing sector stakeholders (industrial and academic) and policy makers to bet on research and innovation as the main driver of both economic and social development. It also reported the innovation needs expressed by industrialists and academics as well as the innovation strategies implemented and future orientations to foster an ecosystem more conducive to innovation.

The macroeconomic data on the textile sector clearly show the positioning of the textile and clothing sector as a pillar of the Tunisian economy. It represents, in fact, 30% of the industrial fabric and 31% of industrial employment in the country. The export value in textiles and clothing represents 20% of industrial exports, thus favouring a clearly positive trade balance⁵⁸. This industrial fabric is mainly characterised by a clear dominance of the clothing activity (warp and weft and knitwear) with low added value and engendering a preponderance of sub-contracting companies in the sector.

In the international context, textiles and fashion are oriented to eco-responsible fashion (ethic consumer), offer customization and fast-fashion. It is within this international context that the sector must fit in. The sector must answer to these new international orientations and improve its performances to remain competitive on traditional markets particularly the European market. On the basis of the acquired experience, the geographical proximity to European contractors, the availability of high-level technical skills and the commitment of the State to this high priority sector, the textile industry must activate the innovation lever to control its value chain, increase its added value and compete on the international market. Industry 4.0 and digitalisation are also development niches of this sector to be exploited.

The study also reveals the potential of the technical textile industry. Indeed, the technical textile industry is a rapidly growing sector worldwide and especially on the European market, which presents an opportunity to be seized. The integration of this high added value area and the establishment of

the technical textile manufacturer's image is one of the most promising avenues with a high potential for innovation.

Moreover, this study also focused on the national research and innovation system set up in Tunisia. This system is based on diverse scientific research infrastructure (a large number of institutions and research structures) and a range of programmes and funds set up to promote innovation and orient research according to the industrial needs. Interface structures have also been implemented to encourage collaboration between researchers and manufacturers to develop the textile sector. These efforts are considered insufficient to democratize the innovation culture in the country.

The field research carried out among both researchers and industrialists to diagnose innovation environment in the textile sector has helped to determine the main needs of these actors to improve the research and innovation conditions. Indeed, questionnaires and focus groups conducted as part of the Delphi field approach revealed that research in the textile field is more akin to an applied research. Activities with a high innovation potential are, in order of importance, technical textiles, finishing and clothing. Especially, the sustainability, the mass customisation, design, fast-fashion and integration of augmented reality are considered in many projects. On another note, fields with a high innovation potential in the textile and clothing industry are innovation processes, innovation management, innovation in products and new technologies integration.

Furthermore, in order to be able to innovate, the study revealed that industrialists call for the availability of specific research equipment and the availability of innovation skills, not to mention non-technological and transversal skills. For their part, academics have expressed their needs to increase the performance of their research and contribute to the sector's development. The lack of advanced equipment or its poor governance and exploitation seems to be the first obstacle for researchers. The unacquired skills in management and the set-up of research projects and programme exploitation were also cited by researchers as an obstacle to the development of research and innovation.

Finally, despite the initiatives and structures put in place within the framework of a national research and innovation system, the study emphasised the insufficient cooperation between universities and industry and the complexity of the incentive programmes for collaborative research. This insufficiency was pointed out on both sides by academics and industrialists.

In fact, the participants indicated that there is a need to enhance the university-industry collaboration in the textile sector by establishing innovation centers to train them to the use of textile-testing

machines, and the design of textile products. At the national level, they stressed on the government to assess the different programs to have more efficient encouraging the young entrepreneur. They also mentioned the need of rigorous and objective evaluations of the created mechanisms and program of encouragement to the innovation, the effectiveness of these mechanisms and to select the most effective ones.

The focus group participants also emphasized on the importance of collaboration between Tunisian universities and the industry. It stressed the importance of establishing educational and effective training programs related to textile processing and manufacturing in Tunisian universities and be able to innovate, to communicate and create marketing content.

Those centers must be linked to the research part, to overcome the TRL 4 (lab approval level) to semi-industrial and further levels. In these centers, we need to develop samples and prototypes, to bring (R&D) skills, in innovation procedures.

This university-industry collaboration can be institutionalised by setting up a collaboration platform bringing together academics and industrialists with the mission of implementing an effective cooperation and research and innovation strategy. The creation of a textile academia council within the WINTEX project falls within this framework.

8. ANNEXES

8.1. Survey for researchers and academics in the textile-clothing sector (1st Round)

Dear Colleague,

To carry out the activities and the research axes of the WINTEX center and in order to better define the main needs in the textile field in Tunisia, we thank you for agreeing to give us a few minutes to fill out this sheet.

It will allow us to put in place a new strategy to reinvent the textile sector in Tunisia, taking into account your comments and suggestions.

Who we are?

Name & surname:

Research unit/laboratory:

Situation: ☐ Ph Student ☐ unemployed doctor ☐ Assistant ☐ Associate professor ☐ Professor

Specialty (diploma): ☐ textile engineer ☐ other:

Address:

Email:

Phone number:

Introduction contexte		Researchers and teachers on textile fields
Specification of sub-	1 st sub-objective: General informations	Q1: You are fields research <input type="radio"/> Raw Material <input type="radio"/> Spinning <input type="radio"/> Weaving <input type="radio"/> Knitting <input type="radio"/> Finishing <input type="radio"/> Clothing <input type="radio"/> Metrology <input type="radio"/> Management <input type="radio"/> Other:
		Q2: If you are an university teacher, what subjects do you teach <input type="radio"/> Raw Material <input type="radio"/> Spinning <input type="radio"/> Weaving <input type="radio"/> Knitting

	<p> <input type="radio"/> Finishing <input type="radio"/> Clothing <input type="radio"/> Metrology <input type="radio"/> Management <input type="radio"/> Other: </p> <p>Q3: The Research project idea was proposed by</p> <p> <input type="radio"/> An industrialist <input type="radio"/> Your university supervisor <input type="radio"/> Your own idea </p> <p>Q4: Are you receiving funding for your research project?</p> <p> <input type="radio"/> Yes <input type="radio"/> No </p> <p>If yes, what is the type of funding that you have obtained?</p> <p> <input type="radio"/> VRR <input type="radio"/> PNRI <input type="radio"/> PIRD <input type="radio"/> MOBIDOC </p> <p>Others:</p> <p>Q5: Did you do an internship abroad during your thesis years</p> <p> <input type="radio"/> No <input type="radio"/> Yes </p> <p>If yes, - The name of the host laboratory</p> <p> - The country - Duration of the traineeship <input type="radio"/> self financing <input type="radio"/> Tunisian scholarship <input type="radio"/> International scholarship </p> <p>Q6: What type of research project are you doing?</p> <p> <input type="radio"/> Fundamental research <input type="radio"/> Applied research (solve an industrial general subject) <input type="radio"/> Applied research for Tunisian companies Name of company: </p>
--	--

Q7. Your research results are/will be used for

- ☐ New product/design
 ☐ Improve an existing state
 ☐ Solve a problem

☐ Other:

Q8: You tried to apply an idea and / or research results obtained which directly affect industrial innovation

- ☐ Yes

☐ No

If yes, we invite you to fill in the table below

Proposed project Idea/ Research	
<input type="radio"/> New added value <input type="radio"/> New product <input type="radio"/> Process optimization <input type="radio"/> waste recycling <input type="radio"/> Product reuse <input type="radio"/> Management solution <input type="radio"/> Technological solution <input type="radio"/> Other:	Industrial opinion <input type="radio"/> Very satisfied <input type="radio"/> Satisfied <input type="radio"/> unsatisfied Results of the project <input type="radio"/> Goal achieved <input type="radio"/> Not as accepted <input type="radio"/> Failure

If no, what are the constraints that you have encountered?

- ☐ You think that your idea has no added value

☐ You think that companies will not be interested in the idea

☐ You have not found the contacts or how to present the project

☐ You did not find companies encouraged by the idea

☐ Other:

	<p>Q9: Have you carried out expert assessments with industrialists to solve an innovation problem or to develop and implement a new process?</p> <table border="1"> <thead> <tr> <th>OYES</th> <th>ONO</th> </tr> </thead> <tbody> <tr> <td> <p>If Yes,</p> <p>The initiative is launched by</p> <p><input type="radio"/> You</p> <p><input type="radio"/> The company</p> <p><input type="radio"/> Intermediate</p> <p>describe your experience</p> <p><input type="radio"/> Very satisfied</p> <p><input type="radio"/> Satisfied</p> <p><input type="radio"/> unsatisfied</p> </td> <td> <p>If No,</p> <p><input type="radio"/> No real benefits this type of action</p> <p><input type="radio"/> I have other occupations</p> <p><input type="radio"/> I not had opportunities</p> </td> </tr> </tbody> </table> <p>Q10: Did you encounter any difficulties during your research work?</p> <p><input type="checkbox"/> Financial problem</p> <p><input type="checkbox"/> Unavailability of raw material or product</p> <p><input type="checkbox"/> Know-how type</p> <p><input type="checkbox"/> Available technology</p> <p><input type="checkbox"/> Legislative problem</p> <p><input type="checkbox"/> Personal occupations</p> <p><input type="checkbox"/> Professional occupations</p> <p><input type="checkbox"/> Others:</p>	OYES	ONO	<p>If Yes,</p> <p>The initiative is launched by</p> <p><input type="radio"/> You</p> <p><input type="radio"/> The company</p> <p><input type="radio"/> Intermediate</p> <p>describe your experience</p> <p><input type="radio"/> Very satisfied</p> <p><input type="radio"/> Satisfied</p> <p><input type="radio"/> unsatisfied</p>	<p>If No,</p> <p><input type="radio"/> No real benefits this type of action</p> <p><input type="radio"/> I have other occupations</p> <p><input type="radio"/> I not had opportunities</p>
	OYES	ONO			
<p>If Yes,</p> <p>The initiative is launched by</p> <p><input type="radio"/> You</p> <p><input type="radio"/> The company</p> <p><input type="radio"/> Intermediate</p> <p>describe your experience</p> <p><input type="radio"/> Very satisfied</p> <p><input type="radio"/> Satisfied</p> <p><input type="radio"/> unsatisfied</p>	<p>If No,</p> <p><input type="radio"/> No real benefits this type of action</p> <p><input type="radio"/> I have other occupations</p> <p><input type="radio"/> I not had opportunities</p>				
<p>2nd sub-objective:</p> <p>Q11: You consider that textile research is applied research</p> <p><input type="radio"/> Totally agree</p>					

The state of scientific research	<p> <input type="radio"/> Partially agree <input type="radio"/> No <input checked="" type="checkbox"/> Is fundamental research than applied research <input checked="" type="checkbox"/> Could not go to the industrialization stage </p> <p> Q12: Research topics for the past 10 years <input type="radio"/> More and more applied research <input type="radio"/> No progress <input type="radio"/> No ideas <input type="radio"/> Other: </p> <p> Q13 : Equipment in your research laboratories <input type="radio"/> There are advanced equipments (New technologies) <input type="radio"/> Basic equipment for classical research <input type="radio"/> No tools for innovative research </p> <p> Q14 : Equipment in your institute / university <input type="radio"/> There are advanced equipments (New technologies) <input type="radio"/> Existing but restricted for some researchers <input type="radio"/> Not exceptional equipment <input type="radio"/> Other: </p> <p> Q15: Do you know the national programs for funding research projects (PNRI, PIRD, VRR, PostDoc, MOBIDOC, etc.) <input type="radio"/> No idea <input type="radio"/> Yes, but I'm not benefit from these programs <input type="radio"/> I benefited from some program (for example:) </p>
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3rdsub-objective: Needs to innovate	Q16 : Research topic: List 3 research topic that you think are innovative - - -
	Q17 : List 3 technology needed to innovate - - -
	Q18: Name 3 textile or paratextile industries of the future - - -
	Q19: Training courses: propose training subjects to succeed in innovative textile projects - - -
	Q20: Please specify your recommendations and your proposals below

8.2. Survey for industrials in the textile-clothing sector (1st Round)

Dear Manufacturers

As part of the WINTEX project, we are asking for your expertise to shed light on the current state of the textile-clothing sector, the main challenges to be met for its modernization and its future prospects.

We would like to thank you in advance for your interest in this survey.

Who we are?

Name & surname :

Enterprise :

type of products worked (specialty).....

Position :

Address :

Email:

Phone number:

Introduction
context

/ Textile-Clothing Industry Manufacturers

Specification of sub-

1st sub-
objective:
General
information

Q1: You are a textile company

☐ Confection ☐ technical textiles ☐ usual textile (Weaving, Knitting, Spinning...etc)
☐ Other:

Q2: Type of company

☐ Subcontractor ☐ co-contracting ☐ you have your own brand
☐ Other:

Q3: Do you have a Research and Development department within your company?

☐ Yes

☐ No

Q4: Have you encountered difficulties during your work within your company?

☐ Material type

☐ Raw material type

☐ Know-how type

☐ Others

Q5: have you carried out applied research in your company?

☐ Yes

☐ No

If yes, it is the researcher who makes the relationship or you?

☐ The researcher

☐ The company

Q6: Have you hear by these structures

☐ VRR

☐ PNRI

☐ PIRD

☐ MOBIDOC

☐ PRF

☐ NO

Q7: Did you do an internship abroad during your work years
☐ No

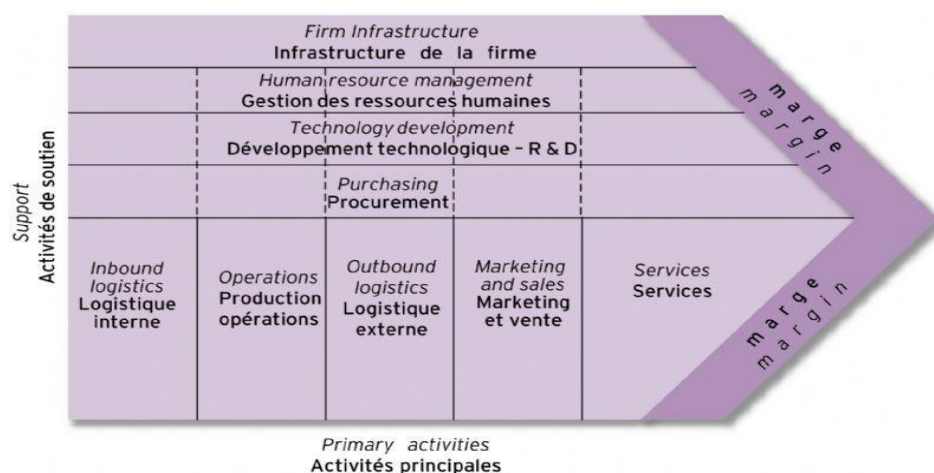
☐ Yes

If yes, - The name of the host laboratory

- The country

- Duration of the traineeship

☐ self financing ☐ Tunisian scholarship ☐ International scholarship

Q8: Where are you in the value chain, you can use percentages in main activities and support activities?

☐ Logistics

☐ Operations

☐ Marketing

	<input type="radio"/> Purchasing <input type="radio"/> Technology development <input type="radio"/> Human resource management <input type="radio"/> NO
2nd sub-objective: The state of innovation	<p>Q9 : You consider that textile research is applied research</p> <input type="checkbox"/> Totally agree <input type="checkbox"/> Partially agree <input type="checkbox"/> No <input type="checkbox"/> Is fundamental research than applied research <input type="checkbox"/> Could not go to the industrialization stage <p>Q10 : Do you make innovation in your company?</p> <input type="radio"/> No <input type="radio"/> Yes <p>If yes, - The name of the innovation part</p> <input type="radio"/> Material type <input type="radio"/> Raw material type <input type="radio"/> Process <input type="radio"/> Management <input type="radio"/> Others..... <p>Q11 : What do you need to innovate</p> <input type="checkbox"/> the knowledge <input type="checkbox"/> the knowledge <input type="checkbox"/> Tools

	<p><input type="checkbox"/> Others.....</p> <p>Q12 : Equipment in your Company</p> <p><input type="checkbox"/> There are advanced equipment (New technologies)</p> <p><input type="checkbox"/> Existing but restricted for some innovation works</p> <p><input type="checkbox"/> Not exceptional equipment</p> <p><input type="checkbox"/> Other:</p>
<p>3rd sub-objective:</p> <p>Opinion</p>	<p>Q13 In your opinion, what are the main needs facing the sector?</p> <p><input type="radio"/> Human resources</p> <p><input type="radio"/> Human competence</p> <p><input type="radio"/> Financial resources</p> <p><input type="radio"/> Technical equipment</p> <p><input type="radio"/> Others</p> <p>Q14 How do you envisage the future of the sector in view of the health crisis (Covid-19) plaguing the world?</p> <p>.....</p> <p>.....</p> <p>Q15 What are the opportunities available to Tunisian textile-clothing industry?</p> <p>.....</p> <p>.....</p> <p>Q16 Do you think that Tunisian government gives enough support to help companies to achieve their transition to circular economy?</p> <p><input type="radio"/> Yes</p> <p><input type="radio"/> No</p>

	<p>If yes, what types of support are available?</p> <p><input type="radio"/> Technical</p> <p><input type="radio"/> Financial</p> <p><input type="radio"/> Legal</p> <p><input type="radio"/> Others</p> <p>Q17 If no, what other types of supports do you suggest?</p> <p>.....</p> <p>.....</p> <p>Q18 In your opinion, is tunisian textile-clothing industry innovative?</p> <p><input type="radio"/> Yes</p> <p><input type="radio"/> No</p> <p>If yes, explain how?</p> <p>.....</p> <p>.....</p> <p>If no, what are the actions to be taken to promote innovation within it?</p> <p>.....</p> <p>.....</p>
	<p>Company data sheet</p> <p>Field of activity:</p> <p>Size of the company (turnover, balance sheet, employees, etc.):</p>

We would like to thank you for your collaboration.

8.3. Survey for industrials and researchers in the textile-clothing sector (2ndRound)

The second questionnaire presents a summary of the main results of the first questionnaire (of the first round). The objective is to have the opinions of the various participants of the first round on the results obtained. In this new questionnaire, we have grouped the results of the first questionnaires asked to industrialists with those asked to researchers.

"Dear Colleague,

To carry out the activities and the research axes of the WINTEX center and in order to better define the main needs in the textile field in Tunisia, we thank you for agreeing to give us a few minutes to fill out this sheet.

It will allow us to put in place a new strategy to reinvent the textile sector in Tunisia, taking into account your comments and suggestions."

Who we are?

General information		Name & surname: Email : Situation: <input type="checkbox"/> Researcher <input type="checkbox"/> Industrial <input type="checkbox"/> Teacher
Specification of sub-objectives	1 st sub-objective: Equipments	<p>Q1: 85% of researchers say that research equipment is either basic (54%) (Equipment does not allow innovative research) or existing but difficult to use (26%) (Restricted, poorly maintained, etc.).</p> <p> <input type="radio"/> Totally agree <input type="radio"/> Partially agree <input type="radio"/> This is an exaggeration, we have state-of-the-art equipment but in different research centers and laboratories <input type="radio"/> Other idea: </p> <p>Q2: To ensure the proper use of research equipment, we must:</p> <p> <input type="radio"/> Keep them in research laboratories but with authorization for joint use, <input type="radio"/> Each laboratory has the right to keep its own resources for its researchers, <input type="radio"/> Group the equipment in research centers and charge researchers to manage these centers. </p>

2nd sub-objective: Innovation	<p>Q3: The most rewarding areas of innovation for manufacturers are process innovation (91.7%) and management innovation (62.5%).</p> <p><input type="radio"/> Totally agree</p> <p><input type="radio"/> You share the same opinion but there is another equally important area</p> <p><input type="radio"/> Other:</p> <p>Q4. To innovate, manufacturers have declared that it is linked to the availability of tools (76%) and know-how (68). The rest of the resources are needed, but not with the importance of these two conditions.</p> <p><input type="radio"/> Totally agree</p> <p><input type="radio"/> Other idea:</p> <p>Q5. Following a question on the need for innovation, most manufacturers insist on improving skills (knowledge and know-how), while researchers insist on the availability of equipment (especially tools for identifying surface modifications). In your opinion:</p> <p><input type="radio"/> To innovate, you need to have both: advanced technologies and know-how</p> <p><input type="radio"/> We have the knowledge, but we lack the technology to validate innovative results.</p> <p><input type="radio"/> The lack of technology is not an obstacle, but mastery of information is important (training in techniques and innovation technology)</p> <p><input type="radio"/> Other idea:</p> <p>Q6: More than 70% of researchers propose technical textiles (mainly medical and paramedical, in second place in the field of composites and the automotive industry) as sectors of innovation. On the other hand, 72% of the manufacturers questioned believe that the textile-clothing industry is not an innovative industry.</p> <p><input type="radio"/> Totally agree</p> <p><input type="radio"/> Partially agree</p> <p><input type="radio"/> Other idea:</p>
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	3rd sub-objective: funding mechanisms	<p>Q7: 63% of industrialists and 54% of researchers said they had benefited from the MOBIDOC program. The PNRI program ranks second in funding for industrial research subjects (27% of researchers and 47% of industrialists). You think that this result is due to the fact that:</p> <p><input type="checkbox"/> These are the two most efficient mechanisms</p> <p><input type="checkbox"/> These are the mechanisms that suit mostly the expectations of researchers and manufacturers</p> <p><input type="checkbox"/> These are the simplest to set</p> <p><input type="checkbox"/> These are the simplest management mode</p> <p><input type="checkbox"/> The execution times in these two mechanisms are the most suitable.</p> <p><input type="checkbox"/> Other idea:</p>
	4th sub-objective: Applied research	<p>Q8: 56% of manufacturers say that they have proposed research topics, an opinion in agreement with the statements of more than 50% of researchers who confirm that companies propose the ideas of research subjects. What do you think?</p> <p><input type="radio"/> Approach to keep (manufacturers and researchers each propose topics)</p> <p><input type="radio"/> To strengthen the initiative of manufacturers to offer even more subjects according to their needs</p> <p><input type="radio"/> To strengthen the initiative of research structures and researchers to propose subjects on new themes</p> <p><input type="radio"/> Other idea:</p> <p>Q9: 50% of manufacturers and 50% of researchers consider textile research to be applied research. 8% consider it as non-applied research. The rest consider it partially implemented.</p> <p><input type="radio"/> You are convinced of this result, and it is a normal result (Balance between applied research and basic research)</p>

	<input type="radio"/> You are convinced of this result, but we must work to increase the share of applied research compared to basic research <input type="radio"/> You are not convinced of this result, normally it is more theoretical / fundamental research <input type="radio"/> You are not convinced of this result; normally it is rather applied research. <input type="radio"/> Other idea:
Free comment	Other recommendations?

We would like to thank you for your collaboration.

8.4. Focus group

8.4.1. FOCUS GROUP QUESTIONS

The focus group focuses on group interaction and allows for data to be generated collectively. The first organized focus group was performed particularly well in focused on fourth thematic which are below:

- First Theme: The status and the future of the textile industry in the country
- Second Theme: The needed steps and regulations from the government to help the textile industry in the country
- Third Theme: The collaboration with the universities
- Fourth Theme: Strengths, weakness, opportunities and threats

In the first thematic, we will ask about the status and the future of the textile industry in the country.

- Q1. How you see the status of the textile industry in the country.
- Q2. How you see the future of the textile industry in the country.
- Q3. How do you see the competition of the local products vs the imported ones?
- Q4: What are the obstacles that face exporting high quality textile products?
- Q5: What kind of human resources are available in the industry now?

Q6: What kind of human resources are needed in the future?

In the second thematic, we will ask about the needed steps and regulations from the government to help the textile industry in the country.

Q7. Do you think that the government is promoting and helping the textile industry in the country?

Q8. How do you think the government can help the textile industry in the country?

Q9. How do you think the Commerce of Industry or other associations can help the textile industry in the country?

In the fourth thematic, we will ask about the collaboration with the universities

Q10. Do you think that collaboration with universities can help the textile industry in the country?

Q11. What services do you need from universities?

Q12: What types of devices are needed to perform the needed tests?

In the last thematic, we will ask about the Strengths, weakness, opportunities and threats.

Q13: What are the Strengths of the textile industry in Tunisia?

Q14: What are the weaknesses of the textile industry in Tunisia?

Q15: What are the opportunities for improving the textile industry in Tunisia?

Q16: What are the threats that face the textile industry in Tunisia?

The second Focus group discussion was focused on validating the results obtained from the questionnaires and to tune affine some idea and in more identifying the following topics (among many others):

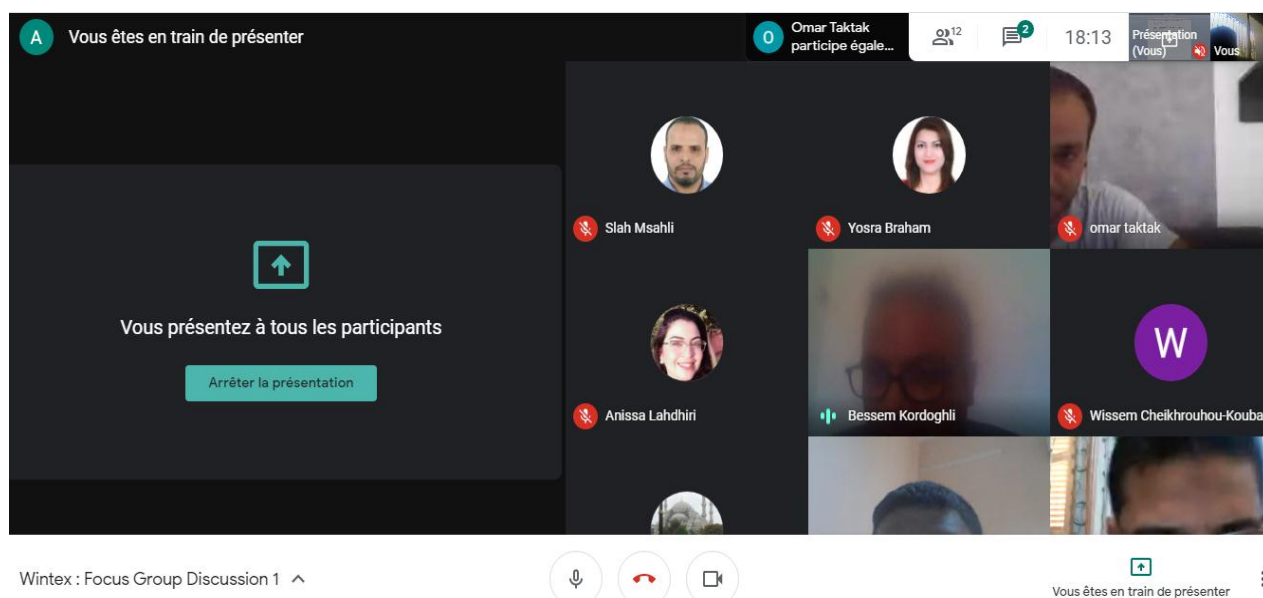
- o How do you name, understand, experience and textile sector in Tunisia, its weakness and causes, strength, causes?
- o How do you perceive and understand the link between opportunities and risks in textile sector in Tunisia?
- o How do you act on it?
- o How do you distinguish your role in the textile sector?

	Nesrine Bousaada	SET KH
	Slah Msahli	LGTex
	Ali Moussa	ENIM
	Ramzi Zammali	MFCPôle
	Mahdi Sahnoun	ATCTEx
	Jalel Bel HAdj Khelifa	MFC Pole
	Lassad Ghali	SET KH
	Yosra Brahem	MFCPôle
Focus Group 2		
Date of Focus Group	October 13, 2020	
Location of Focus Group	Sfax, Online	
Number of Participants	6	
Moderator Name	Amine HAJ TAIEB	Lecturer, USF
Note Taker Name	Omar Taktak	Associate professor USF
Participants	Bassem Khordogli	ATCTEx
	Wisssem Cheikhrouhou	CRNS
	Helmi Khelif	SET KH
	Lassad Ghali	SET KH

	Yosra Brahem	MFCPôle
	Ramzi Zammali	MFCPôle

8.4.3. Focus group photos

First Focus Group



Second Focus Group

