As Ekoten, as a result of our research on the digitalization of our quality control processes, we have decided that the best solution in terms of efficiency is to detect the error in the knitting stage, which is the first production process of the fabric. With artificial intelligence-based image processing technology, we are able to detect fabric defects that are difficult to detect visually and cannot be detected before dyeing. Thus, by preventing the error at the source, we prevent the loss of raw materials, energy, work force and time.

We contributed to Smartex Portugal, a start-up company, in developing the first integrated automatic quality control system in the industry for Circular Knitting machines. The system can detect errors by comparing the photos taken during production with high-speed cameras and multi spectral lighting at certain locations in the machine with the clean fabric photos in its library by using image processing and computer vision technologies. When the system detects an error, it immediately stops the knitting machine and prevents faulty production.

Hardware and software were developed in twelve months in 2020 in cooperation with Smartex, a demo process was started on two machines in 2020 at Ekoten and the application was expanded with eleven machines in the last quarter of 2021. System was applied in eleven machines in the pilot study and it was seen that it reduced the error rate in these machines by approximately 50%. Thus, 376 hours of defective manufacturing has been prevented since its implementation in November 2021 and we have saved 30040 € by preventing 6008 kg of defective fabric production. In addition, we prevented the environmental impact of 420560 liters of water consumption, 15020 kWh electricity consumption and 2704 kg of CO_2e emissions. Thus, we contributed to our targeted SDGs SDG7, SDG12, SDG13 and SDG15. We carried out the green transformation together with the digital transformation in line with the European Green Deal roadmap and EU Strategy for Sustainable and Circular Textiles. Thus, we also contributed to SDG9 by supporting the development of this efficient technology with a short return on investment of four-six months. 28 knitting operators received theoretical and field training for 14 days on the use of the system, its improvement and artificial intelligence. The operators, who developed their competencies in these fields as a result of trainings and studies and intervened directly at the source of the problem at the time of error, made on-site quality control practices and gained a new career development opportunity by increasing their qualifications. With this achievement, they meet the pre requirements to become a production team leader and also they earned monetary and non-monetary rewards. Their commitment to their duties and the company was strengthened with celebration ceremonies, shared appreciation and gifts. All these practices contributed to SDG8 by increasing the qualified workforce and offering new career development opportunities. This valuable cooperation with Smartex once again proved the importance of SDG17.

Together with Smartex, we have carried out improvement and development studies on the systems that we have been using effectively on our 11 machines since November 2021, determining the actions to be taken in different cases encountered in the production processes. We supported these studies with business process management techniques such as the process flow chart of the system and use case diagrams and provided the documentation of the interaction between the two companies. For instance, when the Smartex system was first installed, it only had three types of error grouping as vertical, horizontal and point. We created different subgroups under each group by adding the oil error definition, which is an error we encountered in Ekoten production processes, thus expanding the error pool and improving the ability of artificial intelligence to react to different errors. In this way, while the adaptation of the product to Ekoten was increased, version developments were also made and it was transformed into systems that better meet the sector's needs. As new system versions were developed and features were increased, it was necessary to increase the qualifications of the person working on these features. As a result of this need, while the competencies of Ekoten personnel were developed through trainings, Smartex provided new employment for new positions of expertise. In this way, Smartex company has transformed from a technology provider to a solution provider for the textile industry.

As a result of the preliminary analysis, we carried out the studies for the development of the quality control system under six process subjects. The first subject was defined as the recognition of fabrics with different patterns and structures produced by Ekoten and teaching the clean fabric images and stopping the system in case of a real error. During the fabric recognition process at the early stage of the project, learning was provided by physically defecting the fabric and tagging them in the artificial intelligence library. As a result of early stage collaboration consultations in our cooperation, it was decided that using an artificial intelligence system that can learn dynamically is more efficient in terms of different fabrics within Ekoten fabric library. In the learning model developed by Smartex, fabrics with different patterns are dynamically learned during production, enabling rapid adaptation to program changes, and production continues with 100% quality control without stopping.

The second subject, 28 knitting operators received theoretical and field training for 14 days on the use of the system, its improvement and artificial intelligence. The operators, who developed their competencies in these fields as a result of trainings and studies and intervened directly at the source of the problem at the time of error, made on-site quality control practices and gained a new career development opportunity by increasing their qualifications. With this achievement, they meet the pre requirements to become a production team leader and also they earned monetary and non-monetary rewards. Their commitment to their duties and the company was strengthened with celebration ceremonies, shared appreciation and gifts. All these practices contributed to SDG8 by increasing the qualified workforce and offering new career development opportunities.

Under the third subject, hardware management is carried out and it is aimed to integrate the hardware developed by Smartex into Ekoten processes and to use it in a sustainable way. The use of electronic parts continues in cooperation and a problem encountered is solved jointly by the authorized persons of the two companies.

As a fourth and critical subject, the development of rule tables is discussed. Rule tables are divided into two classes by Ekoten as error threshold determination and machine stopping criteria. Error threshold values and machine stop criteria were defined according to the quality specifications determined by the Ekoten knitting team, and optimum rules were determined for different quality fabrics in line with the data analysis of the Smartex team.

Under the fifth subject of developing the user interface, improvements were made on the Smartex website in line with the needs, allowing the Ekoten team to monitor every moment of production dynamically, while the development of the daily, monthly and periodically received performance and sustainability reports from the Smartex team in line with the needs were examined under the sixth subject Analysis-Reporting. Thanks to the reports, benchmarking was done, and Ekoten's comparison with other companies in the sector and its performance compared to the previous months could be followed. According to the results of this report, the fabric types with the most downtime were determined and the quality control department was provided with more efficient sampling. It has made a positive contribution to the Ekoten brand by increasing customer satisfaction by ensuring quality control without damage in the quality control roles of sensitive fabrics produced using costly yarns and the Smartex system not only preventing faulty production but also playing a role in increasing the quality of clean fabrics.

As the investment share of the sector shifts to knitting machines that can produce more fabric in a unit of time, the high-speed circular knitting machines that Ekoten has invested can produce high quantities. Therefore, using Smartex automatic quality control systems in these devices, the error will be caught instantly and while parameters such as production amount, production and resource efficiency will increase, production costs will be reduced. Expected results at micro, meso and macro scales are shared in a one-page summary document. In collaboration with Ekoten and Smartex Company, a second international cooperation project application has been made to the Eurostars Sustainability Call 2022 program in order to improvement of the Smartex system.