Promoting Innovation Within the Fashion-tech Sector. The Role of Pan-European Projects

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Abstract

Purpose: Fashion-tech is an emerging, pervasive, cross-sectoral, and transdisciplinary sector whose innovation potential can be activated by collaborative innovation practices. The paper aims to assess drivers and challenges of the European Fashion-tech entrepreneurial ecosystem and to advance the understanding of the role of pan-European projects in boosting European competitiveness and innovation potential, through the lenses of the EU project "DeFINE – Developing a Fashion-tech Network for Europe".

Methodology: The research adopts a participatory process to capture the data through surveys (21x), polls (14x), semi-structured interviews (30x), snapshot interviews, observation and case studies (10x). Data are captured from the participants and stakeholders on the relevance of the mentoring activities delivered by DeFINE, and to identify best practice in support models and any unmet needs and barriers to obtaining or accessing support for Fashion-technology start-ups. All data are analysed through a multi-stage coding process and integrated in the broader themes emerging from the other set of data collection tools mentioned above.

Findings: The research investigates the perceived impact of the mentoring programme on the start-ups and SMEs' evolution and recommendations to improve the support. The perceived impact has been on dual-level – both soft and hard skills. One-to-one mentoring support is considered a key value, as well as the involvement of cross-sectoral players from the European public and private sector. The findings revealed insights towards how these networks and ecosystems encouraging cross-fertilization and collaboration can be improved in the future so as to more efficiently support Fashion-tech start-ups and SMEs.

Keywords: fashion-tech, entrepreneurship, pan-European project, support innovation network, collaboration, knowledge exchange

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1. The transdisciplinary and pervasive nature of Fashion-tech

In respect to other industries, the Textile and Apparel industry (from now broadly defined as "Fashion industry") has been slowly evolving integrating emerging technologies along the value chain. The case of fashion e-commerce is an example of such statement. The first online fashion retail platforms, born at the beginning of 2000s, were:

> visually unappealing, technically incompetent, functionally frustrating, and lacking aesthetic pull or interactive capability failed to seduce. They were, at best, little more than additional distribution channels: computerised catalogues that neither enticed nor excited consumers. Compounded by media dot-bust theories which suggest that some sectors (notably fashion) simply are not suited to the web, on-line fashion, it seemed, faced an uphill struggle. (Crewe, 2013: 764)

It took several years for fashion brands to understand the potentials of the World Wide Web. Nevertheless, with the advent of Web 2.0, the interaction between companies and users started witnessing profound changes driven by bottom-up dynamics. Thanks to the democratization of personal computers and the rise of blogs, forums, and social networks, consumers were being enabled by digital technologies to generate knowledge, producing and sharing content within online communities. In other words, digital developments have given voice, knowledge and power to broader and more diverse groups of consumers (Crewe, 2013). In this "Knowledge Economy" (Brand & Rocchi, 2013) fashion brands progressively needed to equip themselves to capture the intrinsic value of user-generated knowledge, co-creating value through interactions and dialectical relationships with increasingly active and aware consumers (Prahald & Ramaswamy, 2004). Almost twenty years after, this co-creation process is marking its peak thanks to the spread of mobile-based social networks powered by Artificial Intelligence (AI), Big Data, Augmented Reality (AR) features, enabling fashion brands to develop market intelligence strategies.

AI, Big Data, and AR are some of the "radical technologies" (Greenfield, 2017) promising to profoundly change all disciplines, economies, and industries, as well as the way people live, produce and consume. The list further includes Internet of Things (IoT), Cloud Computing, Radio Frequency Identification (RFID) & Near Field Communication (NFC) technologies, 3D Scanning and 3D Modelling, Wearable Technologies, Digital and Bio Fabrication, Robotics, Augmented, Virtual, and Mixed Reality, Blockchain, and Cryptocurrencies. Klaus Schwab (2015), Executive Chairman of the World Economic Forum, defines this paradigm shift "Forth Industrial Revolution", as the upgrade of the Third Industrial Revolution based on electronics and Internet Communication Technologies (ICTs), where the blending and combination of emerging technologies generate cyber-physical systems where physical, digital, and biological boundaries fade (Schwab, 2016).

The fashion system, as a socio-cultural, and industrial global phenomenon, is being inevitably impacted by the introduction of these disruptive technologies along the whole value chain. Many scholars and industry experts are

investigating short-term opportunities and long-term effects deriving from their integration within the fashion industry. While few scientific studies and industry reports provide a broad overview of digital transformation developments in the textile and apparel industry (Bertola & Teunissen, 2018; CB Insights, 2018; Noris et al., 2021; Nobile, 2021), several studies assume a technology-specific approach, providing in-depth insights on technologies applications, advantages, limits, and implementation hurdles. Scholarly contributions illustrate and discuss the applications of AI methods in design and manufacturing processes, marketing and communication, and distributions (Giri et al., 2017; Luce, 2018); the potentials and impacts of e-textiles, smart wearables and IoT-based garments on business models (Fernández-Caramés & Fraga-Lamas, 2018); motives, employment and implementation of AR and VR technologies in physical/online retailing (Bonetti et al, 2018); opportunities and difficulties of integrating RFID technologies in fashion and apparel retail management solutions, from logistics to customer-brand relationships (Nayak,et al., 2015, Rizzi et al., 2016) and advantages, implementation hurdles and impact of IoT, blockchain technology and smart contracts for transparency, traceability and IP management (Yanisky-Ravid & Monroy, 2020).

Albeit the above list is far from being exhaustive, it demonstrates the willingness of academic community to deeply comprehend and anticipate, when possible, how these emerging technologies will affect fashion industry's practices before they reach mainstream applications. Similarly, the industry report "The Future of Fashion. From Design to Merchandising, How Tech is Reshaping the Industry" (2018) curated by the tech market intelligence platform CB Insights envisions future trends and identify the sector frontrunners, leveraging several descriptive cases of pilot and running projects from Fashion-tech early adopters. AI-powered fashion designers and brands, algorithms predicting style trends, sustainability-driven material innovation, on-demand and personalised apparel making systems, automated warehouses, blockchain-enabled end-to-end digital histories of inventories, VR mirrors in dressing rooms, digital stylists, virtual fashion, and an array of other innovations are presented to prove how technology can automate, personalise, and speed up the fashion industry.

Finally, Bertola & Teunissen's (2018), referring to it as "fashion 4.0", offer one of the seminal works framing a systemic architecture of Fashion-tech. The scholars propose an extended concept of Industry 4.0 applied to the textile and apparel industry and develop a multi-layered tripartite model where "smart products", "smart factories", and "smart networks" are intimately intertwined with the diverse stages of the traditional fashion value chain and disruptive technologies, enabling the actualisation of I4.0 design principles: decentralization, modularity, interoperability, real-time capabilities, virtualization, and service orientation. Bertola & Teunissen (2018) conceive their architectural model as a guide to perform a deeper analysis of emerging practices innovating the field and as a support for the detection of adoption criticalities and slowness.

This scenario offers a glimpse at the complexity and fragmentation of the Fashion-tech sector. Even though its unanimous definition is still missing, due to its breadth, the awareness of its pervasiveness is widely shared. Residing

at the crossroad of computer science, engineering, social and behavioural sciences, entrepreneurship, user experience, design, and arts, its boundaries are constantly redefined as experiences are shared and explored. The fashion industry has only just begun to unleash the potential of Fashion-tech concepts, as Bertola and Teunissen (2018: 12) state:

> These are only few cases of the ongoing transformation dynamics but they well represent a growing phenomenon which should be taken into account while drafting the future of fashion system. [...] the enabling ecosystem is in place and young designers and entrepreneurs are moving enough quickly to support the idea that the real radical transformation towards more sustainable, consistent, and efficient models, will not necessarily come from the already established "fashion colossi".

Indeed, bridging the well-known Fashion Industry and Technology Industry, Fashion-tech is giving rise to transdisciplinary, cross-sectoral, and collaborative experimental and entrepreneurial paths. In the next lines, the interplay of "fashion and tech colossi" with the ecosystem of young, agile, and resilient players will further reveal the collaborative and cross-sectoral nature of Fashion-tech, where partnerships, networks, and knowledge exchange enable to tackle current and future challenges of the sector.

1.1 Knowledge Exchange at the basis of Dynamic Innovation Systems

In the context of a dynamic innovation system, knowledge is created through the exchange between the institutional components of each stakeholder (R&D, policymaking), from mutually beneficial relationships and from sharing their functional expertise in social, cultural, technical and entrepreneurial domains (Mitra and Edmondson 2015). In the technology sector particularly, the dynamic nature and collective approach is beneficial to exchange knowledge of concepts, methods, techniques, research outputs and practitioner findings. In the world of new technology, being able to gather and promote a constant shuttling of ideas, resources and talents from and between different types of organisations is key. This largely impacts the creation of value in the fashion industry, with technology driving new communication channels, processes, and ways of working, enabling better use of resources and economic growth.

As such, knowledge exchange can be defined as "*a set of activities, processes and skills that enable close collaboration between universities and non-academic partners to deliver commercial, environmental, cultural and societal benefits, opportunities for students and economic growth*" (Macmillan et, cited in Lavinas KE report).

Undoubtedly, knowledge exchange projects are increasing being used as an important vehicle to support the growth of emerging multi-disciplinary business sectors, such as fashion and technology, where product and process innovation is endemic. It appears as opportunities to develop diverse sources of innovation, derived from the cross-boundary exchange of knowledge. However, there is a lack of understanding of how this unfolds in practice and

few useful models for researchers to capture how knowledge exchange works in a community or a business sector (Ward, Smith et al. 2012). Hence why knowledge exchange is not only a complex process, but also largely dependent on the context (Bierly, Kessler et al. 2000, Nonaka, Toyama et al. 2000). The EU offers a solid explanation of the learning process in knowledge exchange projects and programmes as well as its purpose and benefits for the wider community. It encompasses the emerging Fashion-technology network in Europe as well as the related fashion and design industries.

> *'Evaluation is an intensive-learning exercise in so far as lessons learned from experience can be capitalised on, and knowledge acquired can be transferred and reused by actors who have no direct link with the evaluated intervention. In this context the identification of good practices and transferable lessons is a key step'. (DeFINE, 2021)*

As such, it is important that the impact assessment of the EU Project DEFINE provides constructive, informative, and practical knowledge that is useful and transferrable for different members of the Fashion-technology community to leverage the adoption and fostering of dynamic innovation.

1.2 Collaborative innovation boosting the Fashion-tech sector

In a rapidly changing and competitive environment, companies must achieve high performance level, develop innovative solutions, be reactive to the market demand. To innovate and meet these requirements and developing new solutions for existing and future challenges, companies need to join forces with established and emerging actors owning complementary skills and competences, high level of agility and resilience (Ivascu et al., 2016; Camarinha-Matos, 2009). This collaborative effort is partially due to the necessity of leveraging knowledge exchange to fill the in-house skills gap, for competitiveness and reputation reasons (Ivascu et al., 2016), as well as to address technology integration hurdles and explore inedited opportunities. Research across the latest partnerships in the sector proves collaborative innovation (Esposito, 2015) to be a fast-developing area and key organizational paradigm (Camarinha-Matos, 2009) in the Fashion-tech field. In this paragraph, descriptive cases guide the analysis of collaboration typologies currently experimented by players willing to claim a role in the Fashion-tech industry. The interplay among fashion and tech colossi, start-ups, academic institutions, business support organisations and policymakers is analysed and labelled in order to visualize collaborative models and connected opportunities.

Technology colossus affirming itself as Fashion-tech pioneer

FASHION COLOSSUS — TECH COLOSSUS —— *i.e. Google's Project Jacquard, Fitbit acquisition, Project Muze*

One of the exemplar pioneers of the Fashion-tech industry is Google. The tech giant is step by step entering the fashion realm with frontrunning projects covering user-driven AI fashion design systems, wearable technologies for wellness and lifestyle, retail tech, and trend forecasting, building numerous collaborations with relevant players of the sector. Since 2015, Google's Advanced Technology and Products (ATAP) group has partnered with Levi Strauss & Co. to develop Levi's Trucker Jacket empowered with Google's Jacquard technology allowing users to control their smartphone through simple hand gestures on the jacket cuff, thanks to a touch-sensitive fabric and a Jacquard Tag: a rechargeable mini device, equipped with Bluetooth and LED. This collaboration led Google to partner with other fashion brands (Samsonite, Adidas, and Saint Laurent) *"to integrate connectivity and digital experiences directly into their products" (Google, NA)*. While the success of these devices isn't clear yet, Google's smartwatch operating system "Wear OS" found its place on smart watches branded by Michael Kors, Tag Heuer, Montblanc, and Diesel. In addition to this, in January 2021, the company announced the completion of acquisition procedures to acquire the successful wearable-tech firm Fitbit in Google's portfolio. From the retail point of view, the tech colossus developed the experiment "Project Muse" in collaboration with Zalando (2016/2017), an AI-driven fashion design process. The project trained a neural network to understand colours, textures, style preferences, and other aesthetic parameters, derived from Google's Fashion Trends Report and Zalando's sales data, and used an algorithm to create styles based on users' interests and aligned with the style preferences recognized by the network. While the pilot project demonstrated current limits of this technology, it proves once again the tech company's desire to affirm its relevance as interlocutor of excellence for fashion high-end brands and retail firms.

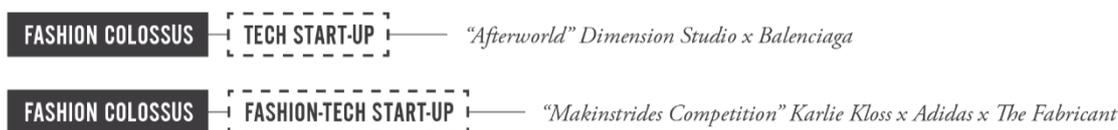### *Exploring Fashion-tech potentials through academia-industry partnerships*

While academia-industry partnership between fashion firms and fashion design schools is a well-known and long-lasting partnership model, recent experiences are showing growing interests from tech giants, as Microsoft and IBM, in replicating this solution.

For example, in 2019, the tech colossus Microsoft teamed up with Fashion Innovation Agency and Digital Learning Lab at the London College of Fashion launching "Accelerating Future of Fashion". The project aimed at inspiring young designers to respond to modern-day issues, designing new solutions for fashion design, advertising, and retail, experimenting with Microsoft's up-to-date Mixed Reality, Artificial Intelligence, and Internet of Things technologies. The resulting projects ranged from the adoption of Machine Learning to reduce waste generated during pattern-cutting; smart fitting rooms personalizing the consumer journey; mixed reality collaborative design platform; to activewear as a tool for athlete recovery and rehabilitation. Similarly, the tech giant IBM joint forces with the American fashion brand Tommy Hilfiger, part of the PVH group, and DTech Lab at the Fashion Institute of

Technology - New York to explore opportunities for tech-informed inspiration in the project "Reimagine Retail". By combining IBM research AI tools and Hilfiger's runway and product pictures, students experimented with AI systems to decode real-time industry trends and customer's emotional bond with the fashion company's products. The knowledge captured from the AI tool informed back the decision-making process of the designers, reframing the emerging findings into patterns, silhouettes, colours, and styles as inspiration to design the collection. Due to the success of "Reimagine Retail", FIT and IBM are taking the cooperation further exploring opportunities such as the integration of IBM's AI within the DTech Lab's tools to foster novel collaboration with fashion companies, as well as within the didactic offer to enhance students' curricula, and to develop joint research programmes. Academia-Industry partnerships involving fashion design and business universities, tech and fashion industry experts are providing safe space for experimentation and prototyping of Fashion-tech innovations and inedited solutions without necessarily stepping into market pressure mechanism.

Forward fashion with industry-start-up collaborations

FASHION COLOSSUS → TECH START-UP ——— *"Afterworld" Dimension Studio x Balenciaga*

FASHION COLOSSUS → FASHION-TECH START-UP ——— *"Makinstrides Competition" Karlie Kloss x Adidas x The Fabricant*

To face newcomers and industry disruptors, collaborating with start-ups is increasingly conceived a source of innovation for several large corporations (Kohler, 2016). These small and agile players are often considered more innovative than established companies (Criscuolo, Nicolaou & Salter, 2012) as they launch new products and services and experiment with novel business models disrupting established markets (Roessler & Velamuri, 2015). An emblematic example of industry-start-up collaboration is the project "Afterworld: The Age of Tomorrow", developed by the luxury brand Balenciaga in partnership with the tech start-up Dimension Studio. The project is a multi-platform immersive game disclosing Balenciaga's Fall 2021 collection, fusing volumetric capture and video gaming, completely rethinking the catwalk show system. The players discover the collection thanks to fifty virtual characters part of an interactive journey across mythological pasts and projected futures of Balenciaga's world. Despite the case Balenciaga-Dimension Studio reproduces a company-supplier dynamic, it shows how gamification can innovate fashion industry traditional practices, like catwalk shows, both from a technological and brand-customer relationship perspectives. In fact, players are invited to actively participate in the multi-platform game, being a constitutive part of the creation of value. Another interesting case is the "Makinstrides competition", an open innovation challenge launched by the sportwear company Adidas, the supermodel Karlie Kloss and the Fashion-tech start-up The Fabricant. In 2020, the three players worked together to digitize the Wind.RDY Parka Jacket from the Adidas x Karlie Kloss collection and publicly released its 3D model to the community to let users design their own version. The twenty best designs were selected and auctioned via blockchain technology, with 50% reward to the creator and 50% donated to Karlie Kloss's non-profit foundation. The collaboration and the

crowdsourcing strategy brought diverse benefits to the project's stakeholders from higher reputation to the discovery of new talents and innovation potentials of virtual fashion in the design and communication spheres.

In-corporating fashion-tech innovation

| ACCELERATOR | FASHION COLOSSUS | TECH & FASHION-TECH START-UPS | — *"La Maison des Startups" LVMH program* |
| ACCELERATOR | FASHION-TECH COLOSSUS | TECH & FASHION-TECH START-UPS | — *"Dream Assembly" Farfetch program* |

Corporate accelerators are considered as tool for innovation management (Weiblen & Chesbrough, 2015) built on collaborative innovation and on the entrepreneurial and innovative nature of start-ups. So far, only a few fashion industry corporates have started to establish their own corporate acceleration programmes. The LVMH group and the technology platform for luxury retail Farfetch exemplify this practice. Since 2017, each year, LVMH acceleration programme "La Maison des Startups", located in Paris at the co-working hub Station F, offers 50 international start-ups dedicated support to co-create product, service, and market innovation. The most promising solutions gain privileged access to the group's ecosystem made of 70 brands and subsidiaries. The selection of entrepreneurs is driven by a multi-sectoral approach, in consideration of the various luxury segments of the holding's portfolio. Similarly, the global platform Farfetch – here defined a "Fashion-tech colossus" – in 2018 launched its corporate acceleration programme "Dream Assembly", with a narrower focus on fashion and retail, a shorter duration, and a smaller gathering in respect to the previous example. The seven-week acceleration programme, today at its fourth cohort of participants, provides networking opportunities and visibility with industry players, technological and business tailored support, leveraging its wide network of industry experts, luxury brands, and Venture Capitals.

Specialist approaches seeding Fashion-tech innovation

| INCUBATOR | ACADEMIC INSTITUTION | FASHION-TECH START-UPS | — *"Foundry" incubator powered by IFA Paris* |
| ACCELERATOR | TECH & FASHION-TECH START-UPS | — *Fashion Technology Accelerator program* |

In the last five years, few fashion-tech dedicated support programmes are emerging in fertile and hybrid contexts in which the institutional and private sector interlace. This is the case of academic-powered incubators like Foundry, founded by the French Fashion School of Design and Luxury Business IFA. This fashion innovation hub within its pre-seed incubation programme provides entrepreneurs with a twelve-month access to tailored support in addition to access to co-working spaces, a makerspace, digital manufacturing technologies, and events facilities. On the acceleration side, Fashion Tech Accelerator (FTA) is worth to be mentioned. FTA is an investment company and international hub based in Milan and London aiming to advance the fashion, luxury and retail industries by offering 6-month support to start-ups and enterprises to develop their innovative digital-based business models and

connecting them with a network of experts from diverse fields. FTA's partners include academic institutions, investor networks, and industry players. On the other hand, also generalist accelerators, such as Plug&Play, are increasingly understanding the potentials of Fashion-tech businesses as industry disruptors. In the case of Plug&Play, their dual-strategy resides in setting up cross-sectoral and transversal acceleration programmes, for example focusing on specific tracks such as "New Materials", "Supply Chain", "Brand & Retail", and "Media and Ad", and partnering with global luxury groups for more focused editions, such as Plug&Play x Kering's "Kering Generation Sustainable Innovation Award in China". While the multi-sectoral approach seems to be adopted by most incubators and accelerators, only a few business support organisations are fully dedicated to offering guidance and consulting services to Fashion-tech emerging businesses.

City-driven, multi-institutional, cross-sectoral fashion-tech-sensitive clusters

The Fashion District is a city-driven cluster of Fashion-tech innovative businesses, academic institutions and investors in East London, set-up in conjunction with London's policymakers. It aims to speed up investment in skills, workspace, businesses, and R&D. Located in East London, within one of the main historical manufacturing textile and fashion districts, the project was developed over four years. It is part of a wider collaboration between fashion colleges and collectives, the British Fashion Council, the Mayor of London, the planning authority London Legacy Development Corporation, a large real estate corporation, housing associations and East-London neighborhoods. Fashion District example proves the opportunity of how proximity, policy-driven initiatives and multi-institutional collaboration can be drivers of fashion-tech innovation. When more actors enter the fashion-tech ecosystem, a delicate balance between stakeholders' specific goals and communion of purposes is key for the initiative success.

While this rundown illustrates the trend of establishing more and more collaborative projects to unleash the very potentials of Fashion-tech, further research is needed to compare and assess the impact of each partnership typology on innovation dynamics in the fashion industry. Within this context, through the lenses of the EU project (DeFINE), the paper aims to assess drivers and challenges of the European Fashion-tech entrepreneurial ecosystem and to advance the understanding of the role of pan-European projects in boosting European competitiveness and innovation potential.

2. The Pan European Project DeFINE

Scaling up the example of Fashion District's cluster system, it is interesting to consider European Commissions' strategic

partnerships in EU-wide distributed networks to boost the old continent's innovation and economic competitiveness. The European Commission's "Action Plan for Fashion and High-end Industries" (2014) presents a roadmap towards cross-sectoral and transdisciplinary cooperation and strategic partnerships between industry, governmental and educational institutions as key levers to anticipate skills needs, support innovation, enhance creativity, and improve access to finance. The "Call for Funding" and grant opportunities following the action plan greatly reflected its directions. As a matter of fact, EU Programmes supporting research, innovation, and entrepreneurship in Europe like the Horizon 2020 (2014-2020), COSME programme (2014-2020), and Erasmus+ (2014-2020) laid the ground for transdisciplinary and multi-institutional alliances to identify key challenges and promising solutions to enhance innovation and competitiveness. The crucial enabler common to all these initiatives is the purpose of building productive distributed networks leveraging their hybrid consortia, whose nature enables to reduce the information asymmetry among the project partners and the addressed cross-sectoral community since the very beginning of the collaboration. The communication gap is tackled through coordinated actions aimed at understanding the stakeholders' requirements and needs, clarifying common and individual goals, codifying shared languages, connecting and matching key players, and iteratively feeding these relationships (Di Lodovico & Colombi, 2021). Among the pan-European project promoting cooperation in the Fashion-tech domain, DeFINE - Developing a Fashion-tech Innovation Network for Europe represents a case of success. It is committed to building an EU-wide ecosystem of start-ups, SMEs, academic institutions, and business support organizations and to stimulating product, process, and business model innovation in the Fashion-tech field.

DeFINE is an EU-wide collaborative project aiming at empowering to the competitiveness of Fashion-tech start-ups and SMEs. The project addresses four main barriers the Fashion-tech sector is experiencing in Europe:

1.   The lack of networks and ecosystems encouraging cross-fertilization and collaboration across fashion and tech sectors reduces the identification of fruitful partners and alliances.

2.   The scarcity of specific Fashion-tech knowledge in tech-driven and fashion-driven incubators and accelerators limits their capacity to support Fashion-tech businesses,

3.   The gap of understanding of Fashion-tech start-ups and SMEs on how and when to present themselves to access funding leads to randomised, inefficient, and time-consuming trails to access support mechanisms.

4.   The absence of financier networks focused on Fashion-tech limits the understanding of the value of investing in these businesses.

The Consortium structure emerged to be key to tackle these challenges. The players addressed by the project were fully represented by the consortium members. As a matter of fact, fashion design, business and Fashion-tech academic institutions collaborated with incubators and accelerators, pan-European network of financiers, textile & apparel associations, and business support organisations, together with an advisory board made of industry experts.

Given these premises, the project committed to encouraging the growth of an ecosystem to support the development of innovative European fashion start-ups and Small Medium Enterprises (SMEs). For this purpose, coordinated activities were planned and performed. The Fashion-tech sensitive ecosystem actors were mapped to build pan-European communities of sectoral and cross-sectoral interest. Fashion-tech start-ups and SMEs, incubators and accelerators, financiers and investors were engaged in knowledge sharing initiatives, dedicated networking events, training, and mentoring sessions. Finally, best practices and lessons learned emerging from the project findings were disseminated to benefit the Fashion-tech community.

Key players of this ecosystem were involved in an 8-month mentoring programme where a selected number of Fashion-tech start-ups and SMEs had the opportunity to further improve and implement their innovative ideas and projects and develop unedited product/service solutions. The companies, selected in two rounds, covered fields ranging from implemented products and processes for textile innovation; e-textiles and wearable technologies for health, lifestyle and wellness; to solutions aimed at speeding up fashion industry digitalization processes, from sourcing to retail; AI-powered systems for personalization and forecasting; 3D and AR services for brands, stores, and consumers; and solutions to support consumers in sustainable practices, from clothing storage to rental platforms. The development stage of the businesses varied significantly from case to case. Before entering the programme, almost half of the businesses (40%) were already commercializing their solutions, 20% were in the Research & Development stage, and 10% and 30% respectively in the early prototype and proof of concept phases. The distribution of hours delivered was adapted according to the needs of each project supported. The mentoring provided one-to-one lead supervisions, technical, business and IP management, and investment readiness guidance and operational support to progress corporate goals towards an improved awareness of the entrepreneurial journey of Fashion-tech start-ups. The companies were gaining skills, know how, and knowledge on how to achieve product-market-fit, how to present their innovative and technological product/service solutions and business models. In addition to this, several mentees were supported with introductions to industry players, guidance on bid-writing and innovation grants, as well as executive coaching.

When the COVID-19 pandemic began, the DeFINE project was midway. The travel restrictions affected the project in various ways, among all the mentoring activities. Most supported businesses in the first round could not access labs, facilities and physical training sessions. Nevertheless, the mentoring teams conveyed the support towards business management, communication, and marketing strategy. Interestingly, the second-round selection process welcomed a higher number of applicants promoting digital/virtual-based projects, proving that COVID-19 pandemic accelerated the development of digital transformation solutions for the fashion industry.

The purpose of the mentoring activities was two-fold. On one side, it aimed at giving 27 project holders access to relevant support activities to progress their innovative projects and identify gaps, needs, and the following needed steps to undertake their own entrepreneurial path. On the other hand, it enabled the consortium to collect, analyse,

and triangulate findings deriving from each experience to frame best practices and recommendations for future similar support programmes.

3. Methodology

The methodology involved an inductive approach based on a participatory research strategy. The aim of a participatory strategy is to provide opportunities for stakeholders to take an active role in setting relevant questions, planning the evaluation design, selecting specific measures, data collection methods, analysing the data and reaching an agreement on the findings (Evely, Lambert et al. 2012). According to Saunders et al. (2012), by following an inductive approach, researchers aspire to comprehend the individual and culturally created suggestions communicated by the interviewees (ibid, 2012) regarding the topic examined. The purpose of this approach was to conceive and generate descriptions and explanations. It was informed by the theoretical concepts presented in the literature review and state of the art, specifically directing the design of the protocols of data collection methods. The research instruments were selected and used to capture data from the participants and stakeholders on the impact of the activities delivered by DeFINE, and to identify best practice in support models and any unmet needs and barriers to obtaining or accessing support for Fashion-technology start-ups. These were: surveys (21x), polls (14x), semi-structured interviews (30x), snapshot interviews, observation, and case studies (10x).

In terms of sampling strategy, this paper followed purposeful sampling, a technique is based on "the identification and selection of information-rich cases related to the phenomenon" (Palinkas et al., 2013). This appeared as the most suitable strategy for the findings we were trying to achieve. Interviews were held with key players of the DeFINE project – from mentees, to mentors, to business support organizations and project managers. These constitute a one-to-one data collection method valuable to gather specific expertise and knowledge in a particular research field (Saunders et al., 2012) and allow for greater depth. Experts are powerful agents that influence the meaning and represent the ecosystem studied (Smircich and Morgan, 1982). The success of using interviews depends on the quality of contributors so as to reconstruct social circumstances (Glaeser and Laudel, 2004). The interviews were held across a variety of stakeholders from the DeFINE project so as to represent the totality of aspects involved and provide more meaningful insights to emerge.

The evaluation questions were used to guide the data analysis process. Data was triangulated from the different sources of information and abstracted to identify the impact of the DeFINE interventions on: start-up's engagement with the DeFINE network; entrepreneur's actions, contacts, connections (behavioural change); entrepreneur's awareness of support organisations; start-ups and project partners operations, strategy or leadership; financial support or financial awareness; surpassing challenges and barriers; leveraging innovation drivers and supporting a Fashion-tech ecosystem.

Thematic analysis was the procedure followed to analyse the data collected from the tools mentioned above. The thematic analysis provided a methodical yet adaptable procedure to investigate the data gathered (Saunders et al., 2019) and allowed for all data to be analysed through a multi-stage coding process and integrated in the broader themes emerging from the other set of data collection tools.

4. Results

This research aims to assess the impact of a pan-European project (DeFINE) in supporting the development of Fashion-tech product, service, and process innovation, leveraging community growth and financial interest or backing for start-ups, MSEs and SMEs. The analysis of the data conducted allowed us to better understand the perceived impact of the mentoring programme on the company's evolution as well as use the data to provide recommendations to improve the support of the Fashion-tech entrepreneurial ecosystem and its role in boosting European competitiveness and innovation potential.

(A) Perceived impact of the mentoring programme on the company's evolution

The mentoring programme offered bespoke support to 27 selected businesses to further develop and improve their innovative Fashion-tech projects or inedited product/service solutions. These were placed in 2 separate rounds:

- Round 1, started in October 2019 welcomed 11 start-ups and SMEs;

- Round 2, started in September 2020 accepted 16 start-ups and SMEs.

Overall, the mentoring programme was highly valued by participants in both Round 1 and Round 2 as most businesses rated their participation in the DeFINE project highly with majority of responses classifying it as excellent in the survey conducted. Individual Mentoring was referred to as the most useful and effective typology of support, with close to 90%, followed by connection to experts in the field with 52.38%. Investment readiness (45%), business sessions (35%) and executive coaching (30%) were also referred by participants as key learnings with potential to show impact on the development of their businesses. Additionally, we can also distinguish between soft and hard skills as companies' perceived improvements. These are classified below:

Soft Skills

On the soft-skill side, aspects such as engagement, trust-building and team building, reputation and networking were the most valued ones. The engagement with the mentoring programme (90%), DeFINE community (40%), information sharing (25%), networking (25%) – were the key highlighted factors in terms of impact related to soft skills. In terms of trust-building and confidence, these were some of the aspects that mentees referred to the most and were pleased about their involvement. 55% stated that the programme made them feel more positive, 23%

more optimist and 28% more confident. They also report high levels of progress in terms of team building and reputation.

Individual mentoring contributed to an increased confidence as well as better preparation for the support process. Most of the start-ups and SMEs felt that business training became more effective when key performance indicators (KPIs) were prepared in advance and presented to mentors for feedback. This highlighted the need for clarification of expectations, processes and business training methods so as to make the most out of intense and fast-paced training sessions with the mentors. This also appears intimately connected to building the start-up's business skills and culture, where awareness and presentation of KPIs increase confidence and validation of business credentials.

Hard Skills

In terms of hard skills, we can mention tech information, knowledge of the fashion domain and entrepreneurial skills (project management, marketing, business strategy, IP and financial strategy).

Close to 70% of the businesses in the programme have made long-term strategic changes as a result of their interaction with DeFINE and these concentrated mostly around 2 key areas: business model and product related aspects. Business awareness, improved methodologies, improved processes and solutions are amongst the field's businesses agree they have developed the most with the highlights of the support being on Business Model and Business Plan improvement; Lean Model Canvas development; Brand identity and communication strategy; Acknowledgment and road map on data privacy, security, trademark and IP protection; Identification of target customer and market segment and Increase of company visibility to relevant stakeholders.

Information about funding was a key aspect highlighted with mentees stating that knowledge of how to gain access to funding in Europe and at what stage is a crucial skill for the Fashion-tech start-ups and SMEs, as mentees highlighted the difficulty to access this information and to understand the requirements necessary to raise funding at its various stages of growth.

B) Recommendations to improve the support of the Fashion-tech entrepreneurial ecosystem

The DeFINE project emerged to tackle the main barriers the Fashion-tech sector is experiencing in Europe as mentioned above in this paper. Our findings from the mentoring programme revealed insights towards how these networks and ecosystems encouraging cross-fertilization and collaboration can be improved in the future so as to more efficiently support Fashion-tech start-ups and SMEs.

The recommendations fall within 5 categories:

- Networking events
- Involvement with stakeholders
- Mentoring sessions

- Peer-to-peer learning activities
- Matchmaking with industry players

Networking Events

Accessible industry-wide events to facilitate connections with manufacturers, retailers and start-ups and SMEs in fashion and tech is an unmet need. There are few opportunities for start-ups and SMEs and established fashion businesses to mingle or get to know each other, outside of formal introductions. This is critical to enhance social capital, build trust and breakdown the barriers in the sector. One of the main findings of the project is the lack of organized support systems and networks that could facilitate introductions and build industry support, prompting collaborations and partnerships. Hence why access to networking events and encourage knowledge sharing with industry experts can be seen as source of added value.

Involvement with stakeholders (industry experts, workshops and labs in academia)

The first aspect is involvement with stakeholder and consequent engagement to build commitment and a purposeful-driven ecosystem of Fashion-tech. The stakeholders involved are entrepreneurs, public sector, financiers, academics, and private sector. Collaborations and involvement with all these players are pivotal to innovation. Europe has huge upside potential if it succeeds in building active tech communities in cities where there are large tech talent clusters. This is because there is a very high correlation between the strength of tech community engagement within cities, as defined by the number of tech-related Meetups, and the rate of companies' formation (The European Tech Report, 2018). These should be leveraged and access to industry players, support businesses, universities, research labs should be made available. This ongoing engagement appears highly beneficial for the start-up/SME to generate contacts, awareness of sectoral innovation and manage personal and business growth. Engagement includes attending recurring events and leveraging opportunities to informally meet the individuals in the national and wider European Fashion-tech via face to face or online events. Introductions and meetings increase shared social capital and trust within the community, provides access to cross-border networks and bolsters the confidence of new business owners. SME engagement increases access to specialised technical knowledge and networks (textiles, garment construction, retailers, manufacturers, technology) and provides the glue to create and accelerate opportunities for longer term innovation.

Mentoring sessions

The findings revealed that 1-1 mentoring support was crucial, involving various stakeholders from business support organisations, financiers, academic & research institutions, policymakers, and research centres. Focus informative and tailored actions in form of one-to-one mentoring on specific topics like fashion- and technical-related knowledge, corporate business strategy, branding and marketing strategy, IP Protection, and financial strategy were seen as highly relevant and as a best practice to replicate.

In terms of managing the mentoring process, close attention should be paid to allocating the right amount of resources: classify the mentee's needs and accordingly define a preliminary plan (duration and milestones), resources allocation and different percentages of support.

Crucial for this would be the development of a mentors' database/ pool of experts and profile them according to expertise, support availability, organisation, and country. This can become a very useful resource to be iteratively nurtured and shared with the mentored businesses to help them identify and select where they could get help from.

As seen above, mentees highlighted the need for continuous support in terms of business aspects, as they go through different stages of scale and growth. Ongoing mentoring can be especially useful when the mentor understands and is familiar with the challenges and innovation opportunities in the sector.

This highlights the need for tailored/ expert-based support. *Because a lot of the start-ups operate in emerging and non-traditional business models and sectors, there is a need to provide* mentoring support to allow for strategic thinking to emerge as well as Trans-European mentoring networks, specialised in Fashion-tech start-ups and SMEs to facilitate European expansion.

We could see above how Fashion-tech is giving rise to transdisciplinary, cross-sectoral, and collaborative experimental and entrepreneurial paths. This justifies the need for specialised networks and knowledge exchange to tackle current and future challenges of the sector. This specialization could be anchored around some of the typologies mentioned in the literature review that display the current Fashion-tech landscape.

A support programme should also consider planning for companies at different stages in their development, and hence will need tailored support. A higher investment in the screening of applications and placing companies within different stages of development could lead to *"more personalized or customized support with more impact in terms of the outcomes".* Design tailored support according to the Technology Readiness Level and Business Readiness Level of the Fashion-tech product/service solution and set-up mentoring goals considering the skills and competences owned by the team members together with their availability and commitment in the programme activities is crucial. This pre-classification of needs and corresponding allocation of resources more in-depth can prove to be more beneficial in the future for the start-ups and SMEs joining a mentoring programme.

Peer-to-peer learning activities

Peer-to-peer appears as a successful collaborative learning technique with the potential to bring out the strengths of each individual while strengthening the work of all through teamwork, cooperation and combined effort and resources. The programme should have the ability to encourage knowledge sharing and cross fertilisation meetings between participants through ad hoc thematic and networking events, support and sharing expertise sessions, collective workshops on challenges encountered by all as well as success opportunities display.

In terms of platform, this could be done though leveraging community building, developing a social media and branding strategy to continue building and engaging the DeFINE community. Support ongoing connections and communication between the start-up members of the community through a WhatsApp group could be an important tool.

Matchmaking with industry players

By fostering larger scale partnerships with key industry players and conglomerates, businesses can combine a strategic innovation process with mechanisms to power innovation developments and scale-up. These partnerships can provide advantages of working with a bigger company, leverage resourced and synergies and shielding start-ups from the unnecessary bureaucracy of a conventional accelerator or incubator. Fashion-tech can benefit from larger scale regarding customers, distribution, brand and negotiating leverage yet provide bigger businesses with agile ways of working and organizing and the right talent. The need for increased partnerships in this sector was highlighted in the interviews conducted with industry experts on Fashion-tech. Partnerships in the true sense of the word, setting win-win situations and allowing innovation strategy to be streamlined across the company. Benefits can include the ability to test ideas on a small scale before allowing it to scale, being mindful of the time and investment needed to succeed.

Managing these collaborations is crucial to the successful delivery of outcomes and to facilitate the power of collaborative thinking. In order to achieve superior innovation performance, each party needs to develop specific skills including the ability to collaborate and communicate effectively with partners. Proactively engage with larger pan-European fashion and/or fashion tech businesses for sponsorship, business or mentoring support can lead to expansion when executed in a structured manner. This means that the involvement of these players needs to be at a consortium structure level, so that their involvement becomes as holistic as possible and therefore with increased impact in sustaining innovation created on a long-term.

5. Conclusion

We are witnessing many players from inside and outside the traditional fashion ecosystem fostering the adoption of emerging and disruptive technologies within different stages of the supply and value chain. Tech companies are entering the wearable-tech market and partnering with fashion brands for improved product and market solutions. Fashion groups are embracing open innovation paradigms launching contests, corporate incubation, acceleration programmes and educational partnerships. Academia-powered and independent incubators and accelerators are promoting entrepreneurial innovation. Fashion, tech and Fashion-tech start-ups are driving the change with B2B, B2C, B2B2C and C2C innovative solutions, accessing diverse partnership solutions to hit the market.

This highly disruptive market can benefit largely from Pan-European projects through its unique ability to leverage on all the factors and contribute directly to the support of Fashion-tech across European member states.

Additionally, by leveraging on resources provided and gathered by the network, new products, processes, technologies and business models were developed that will strengthen Europe's role as a conductor in Fashion-tech innovation.

Through its European network-based support, DeFINE has allowed participants to break existing barriers and challenges and equip them with tools to enhance their market positioning and innovation potential. A key factor was the fact that participants could access this programme for free, contrary to a lot of business support organisations existing in the ecosystem. For companies that deal with limited available financial and human resources this becomes a crucial Unique Selling Proposition of the programme.

Within our results and impact assessment, there was a common agreement that extending the evaluation period would be beneficial to make sure real impact is captured. To properly study the impact and consequences of the programme, there is a need to follow the businesses throughout the project but more importantly, to assess their evolution and growth past the end of the project. Impact can be measured by looking at where they started and where they are in the future and discovering to what extent the tools provided by the project were essential.

In conclusion, empowering collaboration is one of the most effective ways to drive innovation. When combined with institutional and cross-stakeholders support and commitment it generates an environment that stimulates innovation and aims to build an ecosystem that is hard to replicate.

References

Bertola P., Teunissen, J. (2018), "Fashion 4.0: Innovating fashion industry through digital transformation", Research Journal of Textile and Apparel, Vol. 22 No. 4, pp. 353-369.

Bierly, P., E. Kessler and E. Christensen (2000). "Organizational learning, knowledge and wisdom." Journal of Organizational Change Management, Vol. 13 No. 6, pp. 595-618.

Bonetti F., Warnaby G., Quinn L. (2018) "Augmented Reality and Virtual Reality in Physical and Online Retailing: A Review, Synthesis and Research Agenda", in Jung T., tom Dieck M. (eds), Augmented Reality and Virtual Reality. Progress in IS, Springer, Cham, Switzerland, pp. 119-132.

Brand, R., & Rocchi, S. (2011). "Rethinking value in a changing landscape. A model for strategic reflection and business transformation", A Philips design paper, Philips Design, Eindhoven, The Netherlands.

Camarinha-Matos, L. M. (2009). "Collaborative networks contribution to sustainable development", in IFAC Proceedings Volumes, Vol. 42 No. 25, pp. 92-97.

CB Insights (2018) "The future of fashion: from design to merchandising, how tech is reshaping the industry." Available at: https://www.cbinsights.com/research/fashion-tech-future-trends/

Crewe, L. (2013). "When virtual and material worlds collide: democratic fashion in the digital age", Environment and Planning A, Vol. 45 No. 4, pp. 760-780.

DeFINE – Developing a Fashion-tech Innovation Network for Europe (n.d.), available at: https://www.define-network.eu/

DeFINE (2021) D8.1 - Best Practice Guidelines and recommendations to the Industry. EU COSME co-funded programme GA n.806912

Di Lodovico, C., and Colombi, C. (2021). "The Emerging Fashion-Tech Paradigm in the Contemporary European Landscape". In Cumulus Roma 2020 Conference "Design culture(s)" Proceedings, DC(s)_MAKING, pp. 1811-1824

Esposito, M. (2015). "Collaborative Innovation: Transforming Business, Driving Growth", World Economic Forum, August 2015, pp. 7-8.

European Commission (2014). "Action Plan for Fashion and High-end Industries", available at: http://ec.europa.eu/DocsRoom/documents/4154/attachments/1/translations

Evely, A., E. Lambert, M. Reed and I. Fazey (2012). Evaluating Knowledge Exchange: a review, University of St. Andrews, School of Geography and Geosciences, Scotland

Fernández-Caramés, T. M., & Fraga-Lamas, P. (2018). "Towards the Internet of smart clothing: A review on IoT wearables and garments for creating intelligent connected e-textiles", *Electronics*, Vol. *7* No. 405, pp. 1-36.

Giri, C., Jain, S., Zeng, X., & Bruniaux, P. (2019). "A detailed review of artificial intelligence applied in the fashion and apparel industry", *IEEE Access*, Vol. *7*, 95376-95396.

Glaeser, J., Laudel, G. (2004). "Life with and Without Coding: Two Methods for Early-Stage Data Analysis in Qualitative Research Aiming at Causal Explanations", Qualitative Social Research, Vol. 14 No.2

Google (2021) Google completes Fitbit acquisition, available at: https://blog.google/products/devices-services/fitbit-acquisition/

Greenfield, A. (2017), Radical technologies: The design of everyday life, Verso Books, Brooklyn New York, US

Ivascu, L., Cirjaliu, B., & Draghici, A. (2016). "Business model for the university-industry collaboration in open innovation", Procedia Economics and Finance, Vol. *39*, pp. 674-678.

Luce, L. (2018). Artificial intelligence for fashion: How AI is revolutionizing the fashion industry, Apress, New York, US

Mitra, J. and J. Edmondson, Eds. (2015). Entrepreneurship and Knowledge Exchange, Taylor & Francis Group, New York and Abingdon, Oxon, Routledge

Nayak, R., Singh, A., Padhye, R., and Wang, L. (2015), "RFID in textile and clothing manufacturing: technology and challenges", *Fashion and Textiles*, Vol. 2 No.9, pp. 1-16.

Nonaka, I., R. Toyama and N. Konno (2000). "SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation." Long Range Planning, Vol. 33 No.1, pp. 5-34.

Nobile, T. H., Noris, A., Kalbaska, N., & Cantoni, L. (2021). "A review of digital fashion research: before and beyond communication and marketing.", International Journal of Fashion Design, Technology and Education, pp. 1-9.

Noris, A., Nobile, T. H., Kalbaska, N., & Cantoni, L. (2021). "Digital fashion: A systematic literature review. A perspective on marketing and communication.", Journal of Global Fashion Marketing, Vol. 12 No. 1, pp. 32-46.

Palinkas, L., Horwitz, S., Green, C., Wisdom, J., Duan, N. and Hoagwood, K. (2013). "Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research", Administration and Policy in Mental Health and Mental Health Services Research, Vol. 42 No.5, pp. 533-544.

Prahalad, C. K., and Ramaswamy, V. (2004), "Co-creating Unique Value With Customers", Strategy & Leadership, Vol. 32 No.3, pp. 4-9

Rizzi, A., Romagnoli, G., & Thiesse, F. (2016). "A new framework for RFID use cases in fashion and apparel retailing.", International Journal of RF Technologies, Vol. 7 No. 2, pp. 105-129.

Sarac, A., Absi, N., & Dauzère-Pérès, S. (2010). "A literature review on the impact of RFID technologies on supply chain management.", International Journal of Production Economics, Vol. 128 No. 1, pp. 77-95.

Saunders, M., Lewis, P. & Thornhill, A. (2012). Research methods for business students, Pearson Education Limited (6th Ed.), Harlow, UK

Saunders, M, Lewis, P, & Thornhill, A. (2019). Research Methods for Business Students, Pearson Education, Limited, Harlow, UK

Schwab, K. (2016). The Fourth Industrial Revolution: what it means, how to respond, World Economic Forum, available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Smircich, L., Morgan, G. (1982). "Leadership: The management of meaning.", Journal of Applied Behavioral Science, Vol. 18 No. 3, pp. 257–273

The European Tech Report (2018), available at: https://2018.stateofeuropeantech.com/chapter/state-european-tech-2018/

Ward, V., S. Smith, A. House and S. Hamer (2012). "Exploring knowledge exchange: A useful framework for practice and policy." Social Science & Medicine, Vol. 74 No. 3, pp. 297-304.

Yanisky-Ravid, S., & Monroy, G. (2020). "When Blockchain Meets Fashion Design: Can Smart Contracts Cure Intellectual Property Protection Deficiency?.", Columbia Journal of Law & the Arts, Vol. 44.