Innovation and Foresight in SMEs: Lessons from the case of UK Digital Health Companies

Abstract **-** Technological innovation represents a significant opportunity for those organizations that are able to identify new technologies early and anticipate their future evolution and impact. At the same time, technological change is a key challenge, particularly for organizations that have limited resources for monitoring and developing emerging technologies and/or for transferring technologies from other industries/sectors. This is the case, in particular, for SMEs. The main objective of this paper is to propose a new methodological approach to foresight that contributes to the literature on innovation management. This approach is tailored to SMEs and addresses the specific barriers they face in relation to foresight and innovation, e.g., lack of time and financial resources, limited access to information about new technologies, and limited familiarity with advanced managerial practices. We illustrate our novel approach to foresight and innovation in SMEs and its application to a cluster of 16 SMEs of the London Digital Health Hub, and we discuss the main benefits and disadvantages of this approach. We contribute to the foresight and innovation literature by developing a methodological framework that is specifically designed for SMEs, rather than the adaptation or transfer of the dominant frameworks that have been previously designed for and applied in large organisations, corporate firms and public institutions.

Managerial relevance statement **-** The core novelty of our approach to foresight and innovation in SMEs is the revision and combination of different techniques that have been applied in large corporate firms, including technology scanning (analysis of literature sources, bibliometric and patent analysis, expert pools and case studies), Delphi and future oriented workshops. The Delphi technique, in particular, has been rarely used in SMEs because of the high costs, its resource consuming nature, its duration and complexity. In order to apply this technique to the SMEs of the London Digital Health Hub, we carefully revised it in order to reduce the overall cost and duration, the managerial competences required to SMEs, and the access and availability to information about emerging technologies. The feedback from the managers of the SMEs involved in our project showed that the flexible foresight methodology we designed and experimented worked well in terms of both process and outcomes. SME managers were able to implement our methodological framework successfully and smoothly. At the end of the project, many of them decided to invest in the technologies identified as priorities for future growth from the new foresight methodology.

Index Terms - Innovation; Technological change; Foresight; SME clusters; Networking.

I. INTRODUCTION

Technological innovation is a key challenge yet represents a huge opportunity for enhancing the long term performance or corporate organizations. Firms that are able to early identify new technologies can achieve significant “first mover advantages” and thereby higher profits and market shares [1]. In this regard, ‘foresight’ is being receiving increasing attention from practitioners and scholars [2].

Foresight encompasses a wide range of practices and activities that decision makers might use to enhance their ability to detect new events and trends promptly, as well as to explore their future evolution and effects and identify the likely response options [3], [4]. In particular, there is a growing stream of literature that underlines the role of foresight in technology and innovation management [5], with a special emphasis on the early, ambiguous stages (i.e., opportunity identification and idea generation) of the new product development process [6].

The benefits of foresight encompass the enhancement of the organisational capacity to perceive technological change, interpret and deal with it, and create new connections and networks among evolving innovation ecosystems [7]. In this way, it is argued that foresight helps firms cope with uncertainty and optimise investments through the early rejection of weak new product ideas and the selection of the most promising ones [8]. Adegbile et al. [9] conducted a comprehensive analysis of strategic foresight, highlighting its impact on innovation. They argue that foresight plays a pivotal role in shaping novel management tools and processes, leading to an accumulative enhancement in innovation performance.

Where many studies have focused on the link between foresight and innovation in large companies, research on foresight in small and medium sized enterprises (SMEs) has remained rather low and limited [10]. Still, SMEs represent the largest share of all businesses and employment worldwide [11]. They not only play a major role in most economies, but

also in the development and adaptation of innovation ecosystems [12].

This article aims to bridge this gap in the extant literature by exploring how SME managers can use foresight for enhancing technological innovation. The main novelty of this research is the design and implementation of a bespoke methodological framework for foresight, tailored to the specific needs of SMEs operating in business clusters. The methodological framework presented in this article differs from mainstream approaches to foresight in SMEs, which are usually based on the adaptation or transfer of the techniques applied in large corporate organizations or public institutions [13].

The contribution of this paper is twofold. First, we add to the research stream exploring the relationship between foresight and the early identification and seize of innovation opportunities [14], [15]. Second, we add to the efforts of previous scholars who investigated the benefits and dynamics of networked foresight [16], [17]. Overall, we enhance our knowledge of foresight practices in small and medium sized enterprises, by contributing to answering the question whether the principles and benefits of foresight can be extended to the SME context.

This article is structured as follows. First, we illustrate recent findings in literature on foresight and innovation in SMEs. Then we describe our research methodology, i.e., action research, and the new approach to foresight we developed and applied as a result of this action research project which involved a cluster of London based digital health SMEs. We illustrate the main outputs and outcomes of this innovative approach to foresight, including a list of critical technologies that the SMEs that participated in our project could implement in order to improve their productivity and a list of actions that the same companies could implement for fostering their networking and cooperation with external partners. Finally, we discuss the contribution of this work to the extant literature on foresight and innovation in SMEs and the lessons learnt, and we propose avenues for future research.

II. FORESIGHT AND INNOVATION IN SMES

A. Technological change and innovation in SMEs

Technological change and innovation represent significant opportunities for those organizations that are able to identify and develop new technologies early[1] [18]. Scholars define as "first mover advantages" the main benefits that a firm might gain by anticipating – and thus by pioneering – new technologies and, conversely, the disadvantages encountered by late mover firms [1]. The main sources of first mover advantages are superior technological capabilities, customers' switching costs, and pre-emption of scarce inputs or assets.

On the other hand, technological change is a major source of uncertainty, particularly for those organizations that have limited resources for monitoring emerging technologies or transferring them from other industries/sectors, [19]. Specifically, new technologies create three layers of uncertainty [20]. The first kind of uncertainty concerns the evolution of a new technology (i.e., 'state' uncertainty): managers experience such kind of uncertainty when they do not feel able to understand the future pattern of evolution of this technology. The second kind relates to managers' inability to predict the impact of a new technology on the organization (i.e., 'effect' uncertainty) with regard, for instance, to new markets and customer needs and the rise of new product or service features. The third kind of uncertainty relates to the difficulty of understanding what response options are available to the organization (i.e., 'response' uncertainty).

In order to cope with the uncertainty surrounding new technologies, previous research has emphasized the key role of innovation capability, which is the ability to continuously create and absorb knowledge about new technologies [21]. The sequential learning process

[1] In the remainder of this paper, we use the term "new technologies" to refer to both emerging technologies and existing technologies that might be transferred from other industries/sectors.

for this ability starts with the exploration and identification of valuable sources of new knowledge. Then, the knowledge gained from these sources is assimilated and transformed and eventually exploited to produce new commercial outputs or new processes that are going to improve existing offerings [22]. Cohen and Levinthal [23] defined absorptive capacity as exactly "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends".

The acquisition and assimilation of knowledge about new technologies is a key challenge for large corporations but more so for SMEs because of the idiosyncratic limitations of these companies [24], [25]. Cost has been cited as one of the most significant barriers to innovation in SMEs: the need to make relatively huge investments usually collides with the risk aversion of the managers and owners of SMEs, given also their limited financial resources [26]. SMEs also lack the human resources often needed for innovation. Several studies point to the reduced external contacts of SMEs managers (who are often also the owners of SMEs), their tendency to exert a high control, the lack of awareness of environmental changes and appropriate education/training [27]. Furthermore, the framing of strategic decisions within the constraints of the owning managers, rather than the overall goals of the firm, might encourage the rejection of the organizational changes and investments required for technology innovation. Similarly, several studies have emphasized the resistance of employee to innovation in SMEs, due to such limitations as poor communication, weak human resources practices and corporate culture, and lack of commitment of top management [28], [29]. Equally important, a barrier to innovation in SMEs is the difficulty to retrieve and process information about a firm's external environment, in relation to technological change, emerging customer needs and product features, competitors' moves and market opportunities, and government policy [26], [30]. Hence, costs, lack of human resources and managerial skills, risk aversion, resistance to

change and difficulty to retrieve and process information about new technologies all contribute to increasing the difficulty of SMEs to innovate.

One of the most effective and widespread solution to coping and mitigating these barriers, is the development of innovation networks and cluster of SMEs [31]. A cluster of SMEs is a geographically proximate group of interconnected companies and interrelated institutions in a particular industry or business area [32]. The geographic proximity as well as the linkages among peers provide SMEs with cost advantages, access to economies of scale and shared infrastructures, technological externalities, and knowledge they can access and assimilate more easily [33].

B. Foresight and innovation management

Faced with the growing uncertainty of their business environment, a growing number of corporate organizations rely today on strategic foresight as a helpful approach which emphasizes anticipation and the proactive management of external changes [34]. This term is now commonly used to encompass a broad range of techniques aimed at supporting decision makers identify external changes, anticipate their likely evolution and impact, and the most suitable response options [2], [3]. Some of the most common foresight techniques include Delphi, scenarios, strategic options, and product and technology roadmaps [4], [35].

In particular, the link between foresight and innovation is now attracting growing attention [9]. Innovation studies have traditionally focused on the impact on the long-term performance of incumbent firms (and newcomers) of the emergence of new dominant designs, disruptive innovation, and technological discontinuities, among others, with a strong emphasis on organizational learning and change [6]. Foresight can be used exactly for the early assessment of new customer needs and product ideas, technical progress and technological feasibility in the midst of such major environmental changes and as such can

play a relevant role in increasing the efficiency and effectiveness of innovation efforts [15]. Von der Gracht et al. [8] suggested that foresight supports innovation managers first by leveraging their understanding of environmental changes to inspire new product ideas and, second, by helping assess the commercial and technological viability of new product concepts. According to Rohbreck [36], foresight helps innovation managers consider the needs of not only present but also potential future users. In this way, customer latent needs and aspirations for future products and services can be anticipated and incorporated into innovation concepts [37]. Mühlroth and Grottke [38] explored the use of different foresight techniques and data sources for supporting innovation efforts at different stages of the product and technology development, while Gordon et al. [39] established a framework integrating the stages of product development and those of strategic foresight into one integrated five-step model.

In the extant literature, two research streams seem particularly promising for further exploring the relationship between foresight and innovation: these are the “open innovation” and “network ecosystem” streams, which both emphasize the use of external sources for accessing, absorbing, and elaborating new knowledge about future products and services. As defined by Kappor [40], an ecosystem consists of a set of actors that contribute to enhancing the value proposition of the offer to the focal users. Similarly, the literature on open innovation addresses problem-solving tasks that entail generating and remixing knowledge about new technologies sourced from entities outside the firm, encompassing customers, suppliers, rivals, and universities. Research in these streams overlap with the terrain of foresight in relation to the early anticipation of technological change and the investigation of how firms can gain superior performance by jointly orchestrating the development of the broader ecosystem in which they participate [41]. Mirroring the word “open” innovation, many scholars now use the words “networked”, “open” or “collaborative” foresight to

explicitly refer to joint interorganizational forms of foresight and knowledge exchange among different companies and institutions [42]. Networked foresight is similar to traditional foresight practices but is conducted in inter-organizational innovation networks with contributions from many partners for their benefit and the benefit of the network itself [43]. Networked foresight thus emphasizes the absorption and elaboration of knowledge, ideas, and trends from a wide range of external sources, by highlighting a systematic strong (active or passive) collaboration [44]. For instance, Van der Duin et al. [16] explore networked foresight in the context of the EIT ICT Labs network of large corporations, small-and-medium sized companies, and academic and research institutes. Li et al. [17] investigate how Chinese pharmaceutical companies manage their partner ecosystems to acquire insights for innovation and translate them into actionable strategies. Similarly, Laurell and Sandstrom [45] explores open foresight in the case of Tesla with a focus on their use of social media.

Despite the interest of scholars in foresight and innovation and the growing number of publications in this field, however, we still know relatively little on the long-term impact of foresight on innovation outcomes. While there is general agreement that foresight can assist innovation efforts, further research is needed in relation to the link between foresight activities and the specific innovation decisions that are made based on these activities [14], [6] . Scholars might refine, in particular, our understanding of the design and use of ad hoc foresight practices and techniques for supporting long-term investments in new product and services [3]. Similarly, while extant research on open (networked) foresight primarily addresses how foresight may stimulate radical and disruptive innovations in innovation clusters, the same research has focussed less on extending our understanding of the dynamic interactions between participating firms [16]. The complexities of such interactions call for the further investigation of the mapping of the tasks of different participants, their connections, architectures, and transaction costs [15], [46].

C. Foresight and innovation in SMEs

Most research on foresight and innovation in organizations has focused so far on large firms. As a result, we know relatively little on the use of foresight for innovation in SMEs.

On the one hand, SMEs might benefit particularly from the adoption of foresight, to overcome their specific barriers to technology management, by pooling their knowledge about external changes and thus set priorities and joint efforts, in a systematic way, for the optimal allocation of their human and financial resources [47], [25]. On the other hand, there are only a few empirical studies that have explored the utility of foresight in SMEs, or provide evidence of the benefits that would accrue, as argued in principle by scholars. These empirical studies have emphasized that the adoption of foresight in SMEs is quite limited, especially compared with large corporations, and this limited adoption is largely associated with the barriers themselves to innovation that foresight is meant (at least in principle) to overcome. These barriers include the focus of SMEs owners and managers on day-by-day operations, their short-term horizon in strategic decision making, reactive approaches to environmental changes, and – most important – a lack of the methodological skills and competences related to foresight [16], [25], [48].

As a result, so far foresight in SMEs has basically consisted of the transfer of the findings of national and regional foresight exercises, or the transfer of the methodologies that have being applied in large firms. However, both these approaches have relevant limitations and drawbacks. In relation to the transfer of the findings of national and regional foresight studies, SME managers are required to draw from existing, external sources and adapt this knowledge to their own company and cluster. The processing and utilization of external knowledge represent a key bottleneck for foresight and innovation in SMEs because of the lack of absorptive capacity [49]. Similarly, in relation to the adoption of the typical foresight methodologies and processes of large corporations, scholars emphasized that these

methodologies and processes cannot actually be easily transferred as such to SMEs as the latter ones have idiosyncratic needs in terms of costs, duration and time horizon, resources, access and elaboration of knowledge, managerial skills [50], [51].

This gap in the extant literature includes also the case of networked (i.e., open or collaborative) foresight. On the one hand, in principle such kind of approaches might be extremely useful for supporting foresight and innovation in SMEs, especially those operating in business clusters [52]. On the other hand, beyond the extant theoretical works and argumentations, we still know very little about networked foresight in SMEs, especially in relation to the methodological approaches (and inherent interactions) that are most appropriate for SMEs and specifically designed for addressing the barriers to foresight and innovation in these companies. The few empirical studies that are available in the extant literature are limited to techniques like roadmapping [53], [54] or future-oriented workshops [46], [48], [52], as they were revised and transferred from the case of large corporations. There is scarce evidence also regarding the impact of networked and collaborative foresight on the investment decisions of SMEs and their long-term performance.

This gap in the literature reveals a timely opportunity to develop a more complete and theoretically rich understanding of the relationship between foresight and innovation in SMEs. In this paper, we seek to seize this opportunity. We extend current theory and create new insights by exploring *how SMEs managers can design and use foresight for enhancing technological innovation and networking in a business cluster.*

III. Research Context and Method

This article is based on the action research project we carried out (with the financial support of Innovate UK) with a group of 16 SMEs based in the London Digital Health Hub [55], [56]. Action research was adopted for two main reasons: the first is related to the need

for an in-depth understanding of networked foresight and new product/service development in the context of SMEs; and the second is the possible contribution to existing theories concerning innovation management processes [57], [58].

The sector and cluster context were chosen on the criteria of their impact on the UK economy, their impact on the fundamental services of the national health service (NHS), and the perceived need for enhancing levels of productivity. The London Digital Health Hub is an accelerator which works over a 12-month period with up to 20 London based digital health SMEs, giving support and advice, and brokering connections between innovators and the UK NHS. Support focuses on areas specific to individual companies' needs and may include helping to refine products to meet NHS requirements, showcasing innovations in health facilities and market access and navigation, turning ideas related to digital innovation into tangible improvements for staff and patients. Up to the end of 2020, the Digital Health Hub collaborated with 105 SMEs.

Working with the London Digital Health Hub, the authors (hereafter called the foresight team) identified 16 small and medium-sized enterprises among those connected with the hub and involved them in a project which aimed to develop and test a bespoke method for foresight and innovation that could help these SMEs to (i) quickly identify relevant technologies, (ii) assess their potential risks and opportunities and (iii) set out priorities for their adoption in a quick and effective way.

To carry out our action research project, we followed the cyclical action research process outlined by Susman and Evered [59]. This process encompasses five primary steps: diagnosing, action planning, action taking, evaluating, and specifying learning. In the initial step ("diagnosing"), we identified design principles for shaping foresight strategies for innovation in SMEs, as well as essential challenges and prerequisites for helping SMEs to comprehend and adopt foresight practices, all derived from the extant literature. These

findings were subsequently deliberated within the project team, taking into account the objectives of the foresight method intended for promoting innovation in SMEs. In the second step ("action planning"), we sketched a preliminary methodology for applying foresight in SMEs. This methodology drew insights from the review of existing approaches suitable for our purpose, as well as extensive discussions within the project team and consultations with external experts in technology and entrepreneurship, and SME managers participating in the project. In the subsequent step ("action taking"), we implemented the designed methodology. The fourth step ("evaluating") involved ongoing and post-implementation assessments of the actions taken during the application of the methodology. In the final step ("specifying learning"), we analyzed the results of our methodology for foresight and innovation in SMEs to elucidate its primary strengths and limitations (and the measures to mitigate the latter ones).

As typical of action research, the data collection and analysis processes adopted throughout this project were conducted through various complementary sources and methods aimed at enhancing its overall validity, i.e., the accuracy and trustworthiness of the research findings and conclusions [60]. In particular, we heavily relied on triangulation of data (different case studies on foresight and innovation, different technology experts, entrepreneurs, and different patent databases of digital technologies), extant theory (different theoretical perspectives on foresight, entrepreneurship, innovation management), and methods (semi-structured interviews, participant observation, workshops and group discussion, patent analysis). The data collection and data analysis process also involved the foresight team throughout the different phases of the research project, which made it possible to collect different points of view and ultimately increase the richness and reliability of the findings [61].

IV. Results: A New Methodological Framework for Foresight and Innovation in SMEs

In this section we describe the design and application of our methodological framework for foresight and innovation in SMEs, consistent with the action research framework illustrated in the previous section [59].

A. Diagnosing

The goal of the diagnostic phase was to identify the fundamental principles for formulating foresight and innovation practices tailored to SMEs, in addition to recognizing the primary obstacles and prerequisites for assisting SMEs in the implementation of these practices. This phase, spanning a duration of three months from October 2018 to December 2018, commenced with an extensive examination of the existing literature on foresight and innovation in SMEs. It also encompassed an in-depth analysis of prior foresight projects carried out in SMEs, along with the valuable insights gained from these projects.

Contextually, based on both Google Scholar and IEEE Explore search engines, the foresight team selected almost 600 scientific publications covering the adoption of ICTs in the healthcare domain. An analysis of these publications allowed the development of an up-to-date review of the scientific literature, with the identification of the main ICTs-based healthcare paradigms developed in the last few years. At the same time, we carried out desk research (internet sources, business and media press) covering recent foresight exercises in the healthcare sector, at an international level, and future oriented publications depicting futures scenarios for digital health applications and technologies. Our desk research also covered the white papers of national governments in the EU, USA and Asia regarding the evolution of healthcare. This also included the UK Government's White Paper on "The future of healthcare: our vision for digital, data and technology in health and care (published in

October 2018). Finally, we monitored recent trends in related sectors including Home Automation, Digital Media, Digital Game and Self-Driving Cars, searching for new digital innovations that could be transferred to the Digital Health sector.

The result of this research was a preliminary list of technologies that could affect the future evolution of the digital health sector and have an impact upon the future growth (or even the survival) of digital health companies. These technologies were then further examined on the basis of their popularity in the extant literature (e.g., number of citations) and were ultimately reduced to a list of 26 technologies which were grouped in 4 main categories: 1. Communication; 2. Hardware; 3. Software; 4 Transversal technologies (technologies that involve 2 or more of the above domains or could be transferred from other industries). These 26 technologies are listed in Table 1.

INSERT TABLE 1 ABOUT HERE

B. Action planning

The action planning phase, which lasted one month, aimed to design a first draft of the methodology for foresight and innovation in SMEs. This phase was informed by a systematic review of the foresight practices that had been carried out in other SME clusters and regions [46], [52], [53]. The foresight team also interviewed the managers of the London Digital Health Hub as well as other selected foresight experts, in order to design a methodological approach that could match the requirements of the SMEs in the hub, in terms of process (e.g., time, costs) and expected outcomes (identification of some clear priorities for future investments in the highly dynamic digital health industry).

Contextually, working with the managers of the Digital Health London Accelerator (DHLA), the foresight team partnered with 16 businesses of the hub that volunteered to take

part in the project. The senior managers of each business were interviewed by a member of the foresight team in order to share the objectives of the project and collect their views regarding the potential benefits and limitations of the use of foresight of innovation in SMEs. After the interviews, two managers withdrew due to unforeseen, new commitments. Altogether, 14 businesses eventually took part in the research project. Furthermore, the foresight team identified six technology experts: three belonged to DHLA and three were academics. The experts were identified on the basis of their reputation and activities in the digital health sector.

Overall, the designed methodology for foresight and innovation in SMEs consisted of two main stages. The first one was of a 3-round Delphi process; the second stage consisted of two workshops.

The first stage, i.e., the Delphi process, was aimed to enable the evaluation of the technologies and the selection of the most relevant ones for the target cluster of SMEs. This involved of all the 14 SMEs managers and 6 technology experts. The technology assessment was based on a set of ad-hoc criteria of attractiveness and feasibility which were carefully defined: they were meant to be limited in number in order to make the evaluation process simple and flexible, consistent with the requirements (time, access to data on emerging technologies) of the SMEs managers. At the same time, the criteria were meant to help the entrepreneurs to cope with the common barriers to innovation in small and medium companies, by addressing exactly the state, effect, and response uncertainty of new technologies that is exacerbated in SMEs by these barriers. The assessment of the technologies focused on their impacts on the digital health SMEs based in the London area, specifically the SMEs of the Digital Health London Accelerator.

Precisely, the attractiveness criteria focused on the capability of the technologies to improve products (or services) and product features and foster the competitiveness (and

ultimately the sales and profits) of digital health companies. These criteria are illustrated in Table 2.

INSERT TABLE 2 ABOUT HERE

The feasibility criteria (Table 3) instead linked a given technology with the concrete capability of the SMEs of the London Digital Health Hub to develop or adopt the technology.

INSERT TABLE 3 ABOUT HERE

After the Delphi, the second stage of the designed methodology for foresight and innovation in SMEs consisted of two of workshops through which all the entrepreneurs and technology experts could meet in person and discuss the results of the Delphi, by assessing together the evolution, impact (e.g., new products and process), and response options available for adopting/developing the critical technologies identified in the Delphi. In particular, the two workshops were meant to explore the joint actions enabling the SMEs to overcome the limitations - e.g., expertise, financial – of each individual firm.

C. Action taking

The preliminary methodology for foresight and innovation in SMEs was then put into practice and tested during the action implementation phase, which spanned a period of three months. The 3-round Delphi took place between the end of January 2019 and mid-April 2019 and involved all the technology experts and SME entrepreneurs. In the first round of the Delphi, each participant was given 8 points: these had to be distributed among the 26 technologies (e.g., 1 point each allocated to 8 technologies, or 2 points each allocated to 4

technologies, etc. A participant could even give all the 8 points to just one technology). The same process was repeated for each one of the three attractiveness criteria illustrated in Table 2 and, after that, for the overall attractiveness of the technologies.

For the feasibility assessment, each participant was asked to select the four technologies that they considered to be the most feasible. These four technologies could not be those that the same participant had considered to be the most attractive. The same process was repeated for each one of the three feasibility criteria illustrated in Table 3 and, after that, for the evaluation of the overall feasibility of the technologies. At the end of the first Delphi round, the points allocated by all the participants for each technology were added up, in relation to each criterion and to the overall attractiveness and feasibility, and the results were shared among all the participants.

The second round of the Delphi process then started. The SMEs managers and the technology experts were asked to comment on the overall scores that had resulted from the previous round. Specifically, if a given technology achieved a very high score and the participants agreed with it, they could write down their comments and add information and thus explain the reasons why they agreed with such high score. Alternatively, if they did not agree with the overall evaluation received by a given technology (e.g., a technology that resulted particularly attractive or feasible while they did not think so or, vice versa, a technology that resulted to be not particularly attractive or feasible while they thought it was) they were requested to share their opinions about this technology, so explaining the reasons why they disagreed with the score it received in the first Delphi round. It is worth noting that the SMEs managers and technology experts were not asked to consider all the 26 technologies in Table 1: they could just focus instead on a few technologies, i.e., those 3-4 technologies for which they particularly agreed or disagreed with the scores received in the first Delphi round.

Finally, in the third Delphi round, participants were asked to repeat their attractiveness and feasibility evaluation of each technology (as in the first round of the Delphi) in the light of the feedback received from the previous (second) round of the Delphi exercise. The criteria and procedure were exactly the same as in the first round of the Delphi. The SME managers and technology experts had the option to either change or confirm their evaluations in the first round. However, they were asked to repeat the process only in relation to the specific criteria of 'overall attractiveness' and 'overall feasibility'. At the end of the third Delphi round, the participants highlighted the technologies that were the most critical for the SMEs operating in the London Digital Health Hub, i.e., the technologies that resulted to be, at the same time, the most attractive and feasible. These technologies, therefore, represented the main priorities for future investments of the SMEs of the Digital Health London Accelerator.

Precisely, four key technologies emerged from the Delphi. These were: a) Artificial Intelligence; b) Big Data Analytics; c) Internet of Things: d) Smart Devices. These technologies already emerged at the end of the first round; afterwards, the results of the second and third rounds confirmed the results of the first round, by actually increasing the overall attractiveness and feasibility scores and relative prominence of these four technologies (highlighted in red in Table 4). In Table 4, the scores of each technology have been normalised, i.e., expressed as the relative weight – percentage – of the score of the technology that received the highest evaluation.

INSERT TABLE 4 ABOUT HERE

The second stage of the action taking consisted in two workshops during which the SME managers and experts hold interactive discussions to: a) further analyze the key

technologies that resulted from the Delphi; b) generate a list of actions to enable SMEs to adopt these technologies. The workshops were held at the end of April 2019.

In the first workshop the participants explored further the evolution of the critical technologies for Digital Health SMEs identified in the Delphi and their impact on future products and services and, more generally, the future growth of Digital Health SMEs. The foresight team also presented the aggregated results of the preliminary interviews that were conducted with all the company managers at the beginning of the research project, in relation to the main barriers and enablers of technology innovation in Digital Health SMEs.

In the second workshop the participants focused on the options available for adopting/developing the new technologies (especially joint actions enabling the SMEs to overcome the limitations - e.g., expertise, financial – of each individual firm. These actions are summarised in Table 5).

INSERT TABLE 5 ABOUT HERE

The first priority regarded the data access to NHS records. This was considered to be an essential enabler of new Artificial Intelligence based products and services, by helping SMEs to understand patients' needs and problems and the role of new digital technologies in addressing these problems. Digital Healthcare start-ups often experience difficulties in accessing data due to their limited resources and networking. The way information is retrieved and collected from patients should include (and actually emphasize) intuition, from both patients and GPs, and their tacit knowledge. This would bring about a big opportunity to develop health records that combine health data and social care.

The second action regarded collaboration with hospitals and medical centres. SME managers emphasized that their companies should team up with hospitals and clinical

research team to enhance knowledge sharing, data access, funding, and the development of a common vision for the future of digital healthcare. Such collaboration could involve as well universities, research centres, and stakeholders providing early feedback and accelerating knowledge transfer and information exchange.

The third action regarded customer education since early stages (e.g., primary school) as an essential condition for fostering the development of a favourable environment, enhancing mutual understanding and nurturing a wide range of capabilities in both service providers and final users, such as problem-solving, idea generation, analytical skills, networking and relational skills. These capabilities in turn could be beneficial to increase the adoption of digital technologies and services.

The fourth action regarded the definition of lead projects and products. SMEs managers highlighted that their companies needed to focus on few selected priorities in terms of products and services. Conventional NHS procurement practices often favour large corporations, by promoting large-scale projects (and procedures) that are too large for SMEs to bid for. By focusing on a few projects and products, SMEs could develop 'state-of the art' skills that could ultimately enable them to partner with leading, large corporations. Contextually, standard public procurement procedures could be revised in order to make easier the understanding and access of SMEs.

Finally, the fifth priority for action regarded the definition of new funding instruments. Innovative approaches to fundraising were discussed during the workshop, including crowdfunding, private venture capital and private equity, and Initial Coin Offerings (ICOs).

D. Evaluating

The methodology for foresight and innovation we applied in this project was assessed on the basis of the data we gathered throughout and following the development and

implementation of the methodology itself. Data collection included observations, formal and informal feedback sessions with various stakeholders, and reflective discussions within the research team. In particular, there were two key assessment activities: the first one, regarding the results of the Delphi; the second activity, regarding the overall outcomes (benefits and limitations) of the proposed methodology for foresight and innovation in SMEs.

Regarding the Delphi, soon after they were collated at the end of the third round, the results were compared with an analysis of citations of the 26 technologies in the Web of Science database (i.e., the number of scientific articles mentioning the technologies in the title, abstract, or keywords).[2] This comparison revealed that the four key technologies stemming from the Delphi were not those receiving the highest levels of the attention in the scientific literature (see Figure 1). This most probably derives from the different foci of our Delphi evaluation and the Web of Science citation analysis: while the Delphi focused on the digital health SMEs of the London hub, the Web of Science citation analysis covered any kind of institution and organization, at a global level. This comparison highlights the originality and distinctiveness of the results of the methodological framework for foresight and innovation in SMEs we implemented in this action research project, as these results were set within the particular context of the London Digital Health Hub.

INSERT FIGURE 1 ABOUT HERE

Later on, six months after the completion of the workshops, we asked the SMEs managers to provide their direct feedback as we monitored their efforts to adopt at least one of the critical technologies they contributed to identifying. An online survey was carried out

[2] The Web of Science is an online subscription-based scientific citation indexing service providing a comprehensive citation search. It gives access to multiple databases that reference cross-disciplinary research, which allows for in-depth exploration of specialized sub-fields within an academic or scientific discipline.

to systematically collect the experiences and opinions of the SMEs managers regarding the clarity of the Delphi exercise (Attractiveness and Feasibility criteria, overall foresight methodology and process); the actual use of the results of the project for informing technology investment decisions; and the overall benefits of participating in the project.

The results showed that out of the 11 managers that completed the survey, six had already invested in at least one of the four technologies (Artificial Intelligence, Dig Data Analytics, Smart devices, Internet of Things) that were highlighted in the Delphi and eight managers were considering to invest (or invest further) in any of these technologies in the next three years. The reported benefits of the managers gained by participating in the foresight project included: a) increasing their capability to assess new technologies; b) deepening their understanding of critical technologies for future growth and productivity; c) identifying barriers to the adoption of new technologies; d) identifying actions for accelerating productivity; e) enhancing networking; and f) a better understanding of business foresight processes.

Overall, eight SME managers found that their participation in the foresight project added value to their companies. Out of the three managers that found their participation unhelpful, two pointed out that the lack of a face-to-face meeting at the beginning of the project was a key issue. (The foresight team had difficulty in scheduling a face-to-face meeting with these two managers because of the tight scheduling of the project and so a Skype meeting or a phone call was arranged instead). The strict schedule was probably the aspect of the project that was most critical, as this affected the participation of the managers and their understanding of the project itself – as we point out hereafter in the learning section where we illustrate the main benefits and limitations of our novel methodological framework for foresight and innovation in SMEs.

E. Specifying learning

From the evidence presented so far, a three-stage methodology for foresight and innovation in SMEs emerges (as shown in Figure 2).

INSERT FIGURE 2 ABOUT HERE

The first stage focuses on the identification of the SMEs to involve in the project, the identification of the technology experts, the raising of awareness among the entrepreneurs and experts, the gathering of background information, and the identification of a preliminary list of technologies that are potentially relevant.

The second stage consists of a 3-round Delphi process. This enables the evaluation of a preliminary list of technologies selected in the first stage and the identification of the most relevant technologies for the target cluster of SMEs.

The third stage consists of two workshops involving all the entrepreneurs and technology experts meeting and assessing the evolution, impact (e.g., new products and process), and response options available for adopting/developing the critical technologies identified in the Delphi.

The novelty of this foresight methodology is related to the involvement of different entrepreneurs of different SMEs (i.e., cooperative foresight process) rather than a team of managers from the same organization, as it is usually the case of foresight in large corporations; and the careful rethinking of a set of techniques that, despite being originally developed in large corporations, were deeply revised and tailored to the specific needs of SMEs. Such rethinking took into account the specific barriers to foresight and innovation in

SMEs in terms of process (e.g., time and costs) and skills (e.g., confidence with advanced managerial practices, access to information about new technologies).

As it emerged in the evaluation stage of our action research project, the feedback from the managers of the SMEs showed that the foresight methodology we designed and experimented worked well in terms of both process and outcomes. First of all, the SMEs managers could implement our methodological framework successfully and smoothly. These SMEs managers fully understood the methodology in relation to both the process (Delphi rounds) and criteria (attractiveness and feasibility criteria). They were capable to share, process and collect further information about the technologies. SMEs managers were also willing to share their insights and opinions regarding the evolution and impact of the technologies, by interacting with both other managers and technology experts. Based on this interaction and information, managers and experts could change and refine their scores across the different Delphi rounds and ultimately create a shared vision about future technological challenges and opportunities. The Delphi and the final workshops provided a virtual and actual environment where the SMEs managers and technology experts could meet and prepare the ground for future cooperation.

Second, our methodological framework for foresight and innovation in SMEs led to outputs that were clear, tangible, and ready to use. At the end of the third Delphi round, four technologies clearly stood out as the most attractive and feasible and therefore, as the priorities for future investments. This result was recorded as the consensus between SMEs owner-managers and technology experts. These technologies were Artificial Intelligence, Big Data Analytics, Internet of Things, and Smart Devices: all of them, however, were not those receiving the highest levels of the attention in the scientific literature, according the Web of Science database. The results are both original and bespoke to digital health SMEs in the London area, bringing unique and innovative insights which were not available in public

sources. These results reflected the collective wisdom and knowledge of 14 SMEs managers and 6 technology experts, by instilling more confidence in these managers in their selection and adoption of new technologies for future growth.

Despite the positive feedback received by the SMEs managers that took part in our action research project, some relevant limitations have also emerged.

First of all, we noticed a drop in feedback across the three different rounds of the Delphi: while 14 managers sent their scores by the end of the first round, 9 managers sent their comments by the end of the second round and 4 managers changed their scores by the end of the third round (all the other managers confirmed the initial scores they had given in the first round). These figures showed that, although all the 14 managers kept participating in the three rounds of the Delphi, in the second and the third rounds the number of managers that decided to add to (or change) their initial scores was relatively limited. Such drop is not uncommon in Delphi studies [62]. We believe, however, that the time schedule of our action research project (6 months altogether) was particularly tight and had a major role in the above figures. The rounds of the Delphi took place consecutively and required somewhat the SMEs managers too much effort in such a short period (the Delphi was completed in 2 months). Allocating more time for the Delphi might improve the participation of SMEs, while still being compatible with their need for a short duration of the overall foresight process and the timely availability of concrete outputs.

Second, the sample of firms involved in the research project with the London Digital Health Hub was quite heterogeneous, typically ranging from micro companies with 2-5 employees to small companies with up to 30 employees. Overall, we noticed that the firms that were relatively bigger were generally more prepared to take part in the foresight project and take advantage of the foresight approach itself, in terms of both outputs and outcomes (understanding of the different phases of the Delphi and capability/willingness to contribute

to each phase; capability/willingness to invest in the most relevant technologies that are highlighted at the end of the project). This suggests our methodological framework for foresight and innovation might be more suitable to small and medium companies, rather than micro firms.

Third, while the limited number of attractiveness and feasibility criteria used in the Delphi reduced the complexity of the foresight methodology and enhanced the capability (and willingness) of SMEs managers to understand and apply it, some participants pointed out the opportunity to add a few indicators. This could be the case, in particular, of some extra criteria related to the kind of innovative products and services related to the new technologies and the use of public procurement for stimulating the design and provision of such innovative products and services (i.e., public measures which attempt to pull through innovations and the diffusion of innovations).

Finally, at the end of the project, the bulk of businesses that participated pointed out that they would not embed autonomously and systematically foresight in their innovation process. This confirms that the design and implementation of technology foresight is quite demanding in terms of both methodological and organizational resources [53]. This is particularly true in the case of Delphi exercises. When applying technology foresight, SMEs need external organizations to act as facilitators, by providing them with methodological guidance and support in relation to the selection of the participants and the design and coordination of all the phases of foresight.

V. Discussion

This article contributes to our understanding of the role of foresight in supporting innovation, by presenting a novel methodological approach that is specifically designed for SMEs [6], [63]. This approach takes into account the advantages and limitations of SMEs, rather than transferring established methods from public, governmental bodies or large

corporate organizations. Precisely, our approach aims at pooling the resources (first of all, the knowledge and understanding of emerging technologies) of different SMEs managers, so that they can process a wider range of information than if they would have to work separately [16], [48]. We thus add to the efforts of previous scholars who explored the dynamics of networked foresight and the relationship between foresight and the early identification and seize of innovation opportunities [14], [15], [17].

We applied our framework to the SMEs of the London Digital Health Hub to help them inform their investment decisions, by coping with the uncertainty of emerging technologies, the fast pace of change in regulation and customer needs, and the continuous rise of new products, services, and markets. The proposed framework to foresight and innovation led to three main outputs: first was a list of critical technologies for future growth; second was a list of key actions enabling SMEs to concretely develop/adopt the critical technologies; and the third was the decisions of several SMEs that were involved in the project to concretely invest in the technologies that were identified as priorities for future growth. Furthermore, one of the most valuable outcomes was the creation of a shared vision about future technological challenges, which enabled effective communication partnerships between SMEs and other cluster stakeholders (e.g., university research centres, funding institutions) and fostered their networking and cooperation to accelerate future growth.

Figure 3 illustrates the relationship among our framework for networked foresight in SMEs, the barriers to innovation in these companies this framework is meant to address, and the management of the uncertainty of technological change.

INSERT FIGURE 3 ABOUT HERE

A. Theoretical and practical implications

The effectiveness of our novel framework for foresight and innovation in SMEs has been tested first of all through the analysis of its benefits as perceived by the SMEs managers that applied it, as we have outlined in the previous "specifying learning" sub-section of this article. Furthermore, the theoretical contribution of our action research has been tested through a comparison with foresight and innovation practices in other organizations.

First, a systematic literature review was carried out to identify the foresight practices adopted in public institutions and corporate organizations (including SMEs and SME clusters) since the early 2000s in addition to theoretical work in the field. Although the previous work of scholars covered a large number of application domains, such as foresight for innovation (including networked foresight) in governmental bodies and large corporations, we found a gap regarding the design and implementation of innovative methodological frameworks for foresight and innovation in SMEs. Previous scholars also highlighted this gap in the extant literature [13], [25].

In particular, despite theoretical papers praising the role of foresight for innovation management in SMEs and the opportunities inherent in networked foresight (e.g., [48], [52]), we found little empirical evidence regarding how traditional foresight methods might be rethought in order to overcome the specific barriers to foresight and innovation in SMEs and foster their collaboration. These barriers regard both the process features (e.g., time and costs) and skill requirements (e.g., confidence with advanced managerial practices, access to information about new technologies) of the foresight methods that have been historically used by public institutions and large corporations: process features and skill requirements that prevent the direct use of such methods in SMEs [50], [51]. Hence, the results in this article help to fill this gap [49], [53] [54].

The core novelty of our approach to networked foresight and innovation in SMEs is the revision and combination of different techniques that have been applied in large firms,

including technology scanning (analysis of literature sources, bibliometric and patent analysis, expert pools and case studies), Delphi and future oriented workshops. The Delphi technique, in particular, has been rarely used in SMEs because of the high costs, its resource consuming nature, its duration and complexity. While previous work of scholars illustrated the adaptation and transfer from large corporations to SMEs of other foresight techniques like technology roadmapping, in the extant literature there is no empirical evidence of the use of Delphi in SMEs. In order to apply this technique to the SMEs of the London Digital Health Hub, we carefully revised it in order to reduce the overall cost and duration, the managerial competences required to SMEs, and the access and availability to information about emerging technologies. We carefully selected a limited number of criteria against which these technologies had to be assessed. Such criteria (attractiveness: economic impacts; competition; uncertainty of evolution; overall attractiveness; and feasibility: capabilities; congruence with the London Digital Health Hub, required investments, overall feasibility) took into account exactly the main opportunities inherent to the new technologies and the main barriers to their adoption in SMEs. The criteria of attractiveness and feasibility used in the Delphi helped SMEs managers retrieve and process information about new technologies and improved the understanding of their evolution (state uncertainty), impact on new product and markets (effect uncertainty) and the resources required for their development (response uncertainty). The Delphi thus mitigated the risk aversion and resistance to change of the SME managers, by contributing to the adaptation of their strategic beliefs about new technologies.

In particular, the feasibility indicators required SME managers to assess the technologies against the London Digital Health cluster, rather than any individual companies, by emphasizing the opportunities for networking and thus for economies of scale. The reduced number of indicators allowed to reduce in turn the overall duration (and costs) of the Delphi process: the application of the approach for foresight and innovation in SMEs we

describe in this paper required altogether less than 6 months for its completion. By allowing SMEs managers to have an active role in the assessment of the new technologies (and thereby in the collection, elaboration, and assimilation of related knowledge), our methodological approach also reduced the risks that new technologies were rejected, as in the case of the transfer of the findings of national and regional foresight studies (when the processing and utilization of external knowledge is hampered by the lack of absorptive capacity) [46], [50].

B. Limitations and future research

We recognize that this paper carries several limitations, which we hope will serve as starting points for future research.

Primarily, there are concerns related to the generalizability of our findings [61]. Our investigation draws upon the analysis of a singular case, specifically a sample of firms within the London Digital Health Hub. While a single case study approach is conducive to the development of new theories and the generation of fresh insights, a broader analysis of multiple cases would be necessary to support the generalizability (i.e., external validity) of our conclusions.We hope that future research efforts might further test the advantages and disadvantages of the approach to foresight and innovation we present in this paper by increasing the number of SME managers and technology experts involved. The number of firms that took part in the research is limited and not large enough to make a quantitative and counterfactual analysis of the impact of our foresight framework on the innovation efforts and outcomes of a cluster SMEs.

Moreover, our analysis is centred on an innovation contest within the Digital Health sector, a field of particular relevance for the London region. This focus mitigates concerns associated with factors that could potentially undermine the applicability of our research, such as participants and partners encountering an unfamiliar sector or the absence of

capabilities for assessing the results. Consequently, it is considered suitable for addressing our research question. However, to enhance the broader applicability of our findings, further investigations could address the implementation and testing of our methodology for foresight and innovation in clusters of SMEs operating in different industrial sectors. These investigations would enable us to uncover additional limitations of the methodology and explore potential solutions to mitigate them. In this regard, the approach to foresight and innovation we propose in this paper is likely to be beneficial especially to those SMEs operating in industries where technology and regulation are the main drivers of change. This is the case, for instance, of the digital game industry or the autonomous (self-driving) car sector. Future research might address also SME clusters of different but related industries, by testing the capability of the methodology we propose in this paper to point out opportunities for synergies.

Finally, our analysis is centred on an SME cluster situated in the United Kingdom. Consequently, the specificity of the national cultural context could have exerted an influence on the formulation and implementation of our approach to foresight and innovation. Future research endeavours may consider testing this approach in diverse cultural contexts, shedding light on both commonalities and distinctions, thereby potentially broadening the generalizability of the findings.

VI. CONCLUSIONS

Technological innovation in SMEs has received considerable attention in the literature [64], but there has been dearth on the benefits of foresight in this context despite its perceived attractiveness. This article aims to expand our understanding of the utility of foresight and its role in enhancing innovation and collaboration (networking) in SMEs. The core novelty of the methodological approach we developed is the rethinking and combination of different

foresight techniques. This involved the design of a simplified 3-round Delphi process enabling a cluster of SME managers to identify the most relevant technologies for their future growth and productivity. This process is based on four bespoke criteria of attractiveness and four criteria of feasibility. We applied this methodological framework to a cluster of firms facing the growing turbulence of their business environment. Our research setting, data collection and data analysis were designed to enhance the elaboration, implementation and testing of this methodological framework.

Overall, our research showed that foresight (especially the methodology for networked foresight we designed and implemented) can be handled effectively by SMEs managers and bring results that are tangible, significant and clear. The results of our research are relevant to policy makers as well, who might use them for setting priorities for future calls and foresight initiatives. However, it is critical to note that our work is based on a single case and this affects the validity and generalizability of our findings. We particularly hope that scholars and practitioners might build upon our work to expand the generalizability of our results and further improve the seamless embedding of foresight into the overall innovation process of SMEs and its impact on their long-term competitiveness. The digital health sector itself, given the ongoing massive challenges due to the pandemic that started in 2020, might represent a compelling case for future research [65]. Our findings, which pointed out the crucial role of artificial intelligence and big data analytics before the pandemic itself, might contribute to the growing literature exploring the impact of technological innovation (especially artificial intelligence) on the broad health and life science sector [66].

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Table 1 - Critical technologies for digital health SMEs

1. Machine to machine communication 2. Internet of things 3. Cloud computing 4. Fog computing and Mobile Edge computing 5. Wireless body area networks communication protocols 6. Wireless body area networks 7. Wireless sensors (wearables) 8. Smart devices 9. Robotics 10. Smart e-health systems 11. 3D printing 12. Health Data Formats 13. Big data analytics	14. Artificial Intelligence 15. Image analysis and facial recognition 16. Speech recognition and chatbots 17. Social media 18. Security and privacy (cryptography) 19. Augmented reality and virtual reality 20. Biometrics 21. Blockchain 22. Micropayments 23. Technologies from self-driving cars 24. Automated Transport Systems (drones, autonomous ambulance) 25. New touch interfaces and displays 26. Human augmentation

Table 2 - Attractiveness criteria

1a) Economic impacts	These regard the size (number of customers, potential sales) and dynamics (rate of growth) of the markets for the technology in the UK. The economic impacts regard as well the opportunity for exporting new services/products based on the technology into foreign markets, e.g., EU or the Commonwealth. The attractiveness of a technology increases when the economic impacts are high.
1b) Competition	Intensity of competition from foreign companies (other EU countries, US, Asia) that are developing as well the technology and new products/services that are based on the technology. The attractiveness of a technology decreases when the intensity of competition is high.
1c) Uncertainty	Uncertainty regarding the future development of the technology (i.e., capability of the technology to eventually provide the expected benefits). The attractiveness of a technology decreases when the uncertainty is high.
1d) Overall attractiveness	This an overall evaluation of the technologies based on the aggregated assessment of the 3 above criteria.

Table 3 - Feasibility criteria

2a) Capabilities	Technology capabilities (assets and knowledge available in the UK industrial and scientific system, companies – both large and SMEs – representing potential partners, suppliers, universities, public research

	centres), especially in the London area, for developing the technology. The feasibility of a technology increases when technology capabilities are high.
2b) Congruence	Congruence of the technology to the UK socio-economic system, in relation to the local demand (e.g., NHS, demographics of population), complementary technologies in related sector (e.g., game industry or automotive industry, local (regional and national) regulation. The feasibility of a technology increases when the congruence is high.
2c) Technological investments	i.e., the average amount of financial resources necessary for a company to gain the competences and assets needed to adopt the technology and provide competitive products/services based on the technology itself. The feasibility of a technology decreases when the technology investments are high.
2d) Overall feasibility	This an overall evaluation of the technologies based on the aggregated assessment of the 3 above criteria.

Table 4 - Comparison of attractiveness evaluation in the first and third round

TECHNOLOGY	OVERALL ATTRACTIVENESS - 1st round	OVERALL ATTRACTIVENESS - 3rd round	OVERALL FEASIBILITY - 1st round	OVERALL FEASIBILITY - 3rd round
Communication technologies				
1. Machine to machine communication	43%	42%	47%	32%
2. Internet of things	53%	61%	74%	64%
3. Cloud computing	17%	15%	63%	45%
4. Fog computing and Mobile Edge computing	3%	0%	0%	0%
5. Wireless body area networks communication	3%	0%	0%	0%
6. Wireless body area networks	0%	0%	0%	0%
7. Wireless sensors (wearables)	20%	24%	84%	64%
8. Smart devices	43%	45%	79%	68%
9. Robotics	7%	6%	5%	14%
10. Smart e-health systems	23%	18%	32%	18%
11. 3D printing	7%	6%	5%	5%
Software technologies				
12. Health Data Formats	30%	24%	63%	64%
13. Big data analytics	53%	52%	95%	100%
14. Artificial Intelligence	100%	100%	100%	95%
15. Image analysis and facial recognition	7%	3%	11%	9%
16. Speech recognition and chatbots	17%	18%	21%	36%
17. Social media	7%	6%	32%	27%
18. Security and privacy (cryptography)	40%	36%	47%	50%
19. Augmented reality and virtual reality	27%	24%	11%	9%
Transversal technologies				
20. Biometrics	0%	0%	0%	0%
21. Blockchain	17%	12%	21%	9%
22. Micropayments	3%	3%	0%	0%
23. Technologies from self-driving cars	7%	6%	0%	0%
24. Automated Transport Systems (drones, auto	10%	9%	0%	9%
25. New touch interfaces and displays	0%	0%	0%	0%
26. Human augmentation	23%	21%	11%	9%

Table 5 – Priorities for the joint development of key technologies

Action 1. Securing data access to NHS records
Action 2. Collaboration with selected hospitals and medical centres
Action 3. Customer education since early stages (e.g., primary school)
Action 4. Joint selection of lead (pilot) projects and products
Action 5. Joint selection of new funding instruments

Fig. 1 - Overall (all industrial sectors) technology citation and Health Sector technology citation (from January 2015 to April 2019) - Source: Web of Science

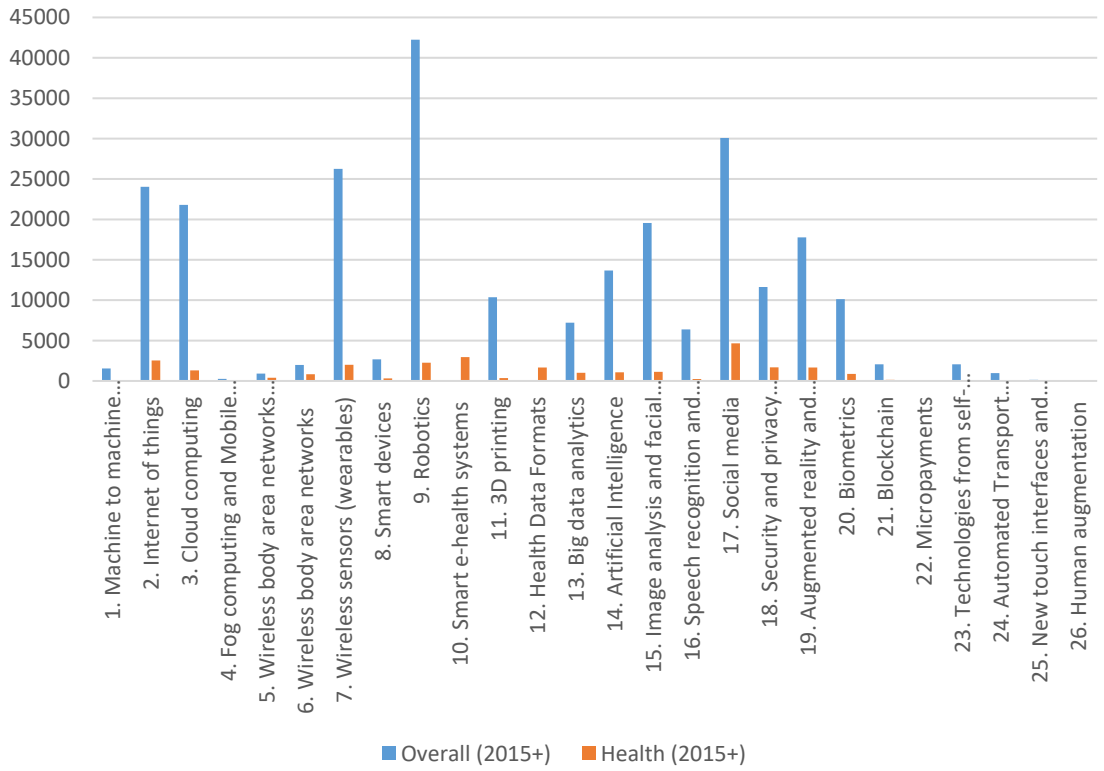

Fig.2 - Overview of the Methodological Framework

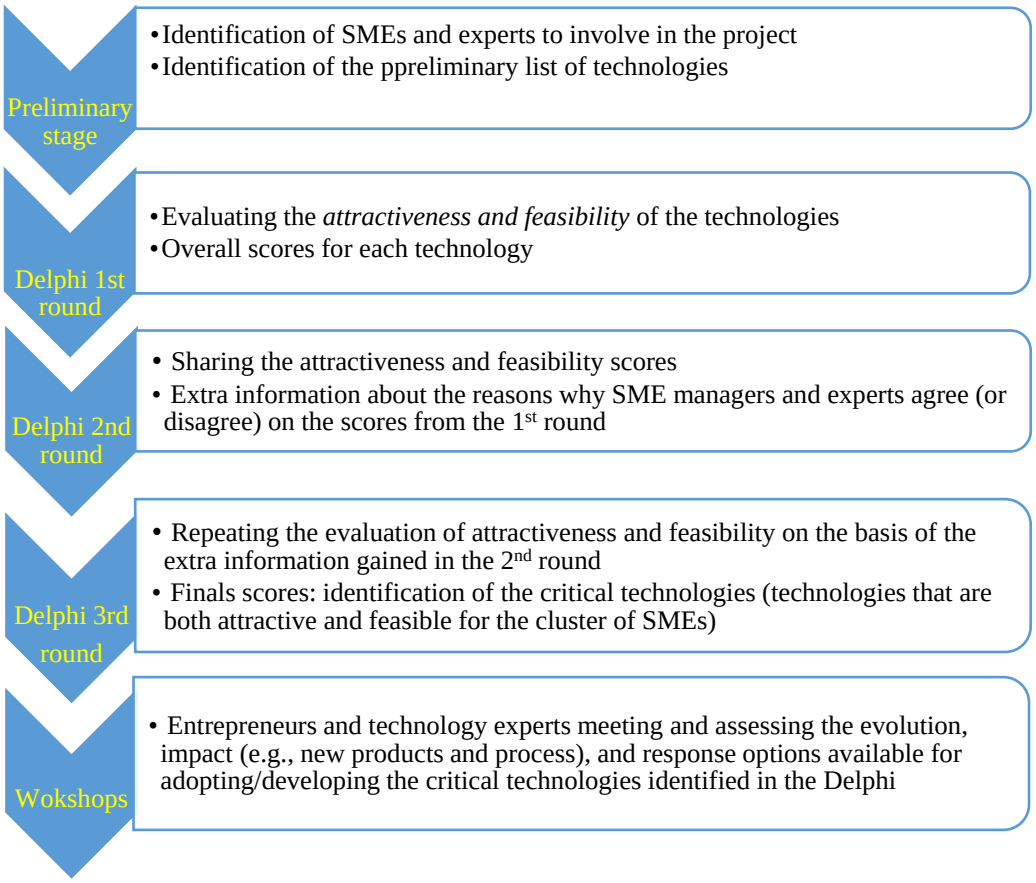

Fig. 3 - Conceptual framework of the relationship among foresight, barriers to innovation, and the management of technological uncertainty in SMEs