Scenario projection and envisioning techniques for SMEs and startups: Insights from the DC4DM project

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Abstract

This study explores future forecasting methodologies through a qualitative, exploratory lens, bridging theoretical constructs with applied strategies in entrepreneurial ecosystems. Anchored in literature review and selected case analyses, it draws on insights from the Design Competences for Digital Maturity (DC4DM) project to illustrate how trend analysis, business modelling, and envisioning techniques can be operationalized by SMEs and startups to cultivate strategic resilience and future-readiness. Emphasizing the integration of foresight tools into both academic curricula and entrepreneurial practice, the findings reveal the transformative potential of scenario-based thinking for innovation and adaptability. The paper identifies critical gaps in empirical validation and proposes pathways for future research to refine and scale such approaches in diverse organizational and cultural contexts.

Keywords: DC4DM; Future Forecasting; Scenario Projection; SMEs; Startups.

1. Introduction

In today's increasingly volatile, uncertain, complex, and ambiguous (VUCA) global environment, small and medium-sized enterprises (SMEs) and young ventures frequently find themselves frozen, off course, or even forced to fold. Although digital tools and data have never been more accessible, many of these organizations still lack a clear, systematic way to spot emerging shifts and build forward-looking strategies.

Scenario planning has long been touted as a potent approach for imagining multiple possible futures and getting ready for them (Schwartz, 1997; Schoemaker, 1995). Rather than just crunching numbers, scenarios spark the kinds of strategic dialogues that foster shared insights and strengthen an organization's ability to adapt (Van der Heijden, 1996; Fildes, 1998).

Yet, while foresight methods are well established in large corporations and government bodies, their hands-on use by entrepreneurs remains surprisingly rare and under-researched (Magistretti et al., 2019). This paper aims to fill that gap by examining how forecasting and visioning tools were put to work in the Design Competences for Digital Maturity (DC4DM) project. Rather than dwell on theory alone, we combine a critical literature review with a close look at real deliverables from DC4DM.

We show how techniques like trend spotting, business-model innovation, and creative envisioning can be embedded in both teaching programs and daily practice to boost strategic flexibility and drive innovation. By weaving these methods into the fabric of SME and startup operations, it becomes possible to nurture more resilient, sustainable visions of what lies ahead.

The article unfolds as follows. First, we survey the key literature; next, we outline our qualitative, conceptual approach; then, we analyse selected DC4DM outputs; and finally, we discuss our theoretical contributions, practical take-aways, study limitations, and avenues for future research.

Small and Medium-Sized Enterprises and Startups: Projecting the Future of Businesses

In the European Union SMEs make up over 99% of business. In recent years, the performance of SMEs has been impacted by several unprecedented external events, such as the COVID-19 pandemic, which has led to price increases and difficulties in human resources. More recently, in 2022, SMEs were affected by the Ukraine conflict leading to an increase in inflation, energy costs, raw materials (Bella et al., 2023).

The importance of future forecasting for SMEs and startups, and techniques for scenario projection, constitute an important aspect of business existence. According to recent research, business ideas do not survive the first few years in the market as small businesses, generally startups. The main reason for this failure is the lack of planning and forecasting of future scenarios.

In fact, paraphrasing Thiel (2014), co-founder of PayPal, companies that did not predict the future are trapped in a world that no longer exists. They are doomed to stay in the past and eventually disappear. Moreover, Thiel (2024) argues that no one can predict the future exactly, but it's going to be different, and it must be rooted in today's world.

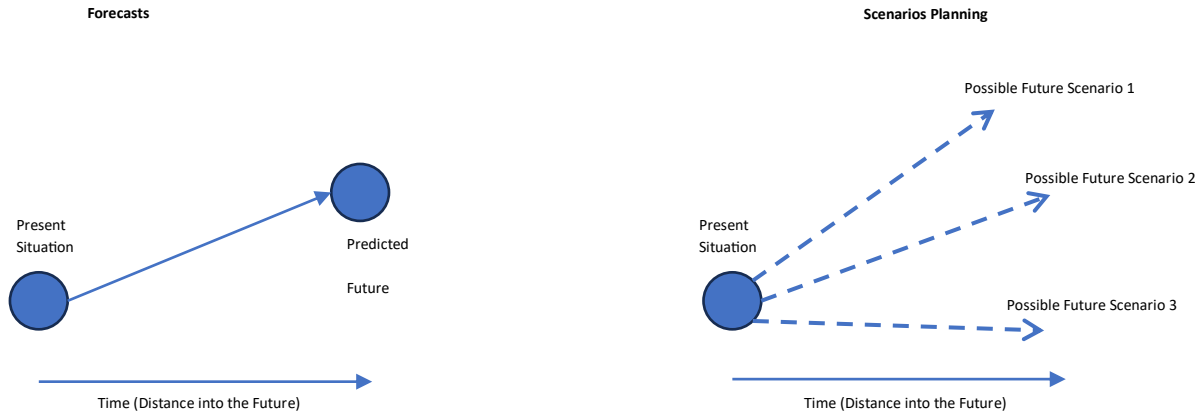
However, the future itself holds a lot of uncertainty, and the question arises: how to develop a mindset for prediction and benefit from the use of existing technologies and those that will be created soon? The 2020 Future of Jobs report tells us that to develop this mindset, it is necessary to be constantly informed about technological trends and innovations, as well as be open to experimentation and adaptation (World Economic Forum, 2020).

In the same vein, Diamandis (2012), founder of the XPRIZE Foundation, adds: "The future is created by those who see something that does not yet exist and make it real.". And according to Kotler (2016) accurately forecasting the future is a cornerstone of business success. Without this ability, companies risk falling behind, constantly struggling to keep up with the pace of change.

This all relates to entrepreneurship and a certain profile of professional open to risk, equipped with technical skills. Different available tools are referred to in the literature (Abdelkarim, et al., 2019). Among them is the trend analysis technique for projecting future business scenarios, which involves identifying patterns in past and current data to predict possible future outcomes.

Scenario planning is a strategic methodology that can be applied in predicting various future situations over a medium-term horizon. Unlike other strategic planning tools supported by extrapolating trends and patterns to make a forecast, the objective is to elaborate different possible images to support conscious decision-making. It should be noted that a scenario can be defined as a consistent and plausible description of a future reality (Dean, 2019) (Figure 1).

Figure 1: Comparison between single-point forecasts and scenarios planning.



Source: Dean (2019).

Another technique is business modelling, which allows for the creation of simulations to test possible future scenarios. Business modelling provides organizations with the necessary flexibility, so that executives can test their strategies under economic, regulatory and competitive uncertainties in a context of rapid change (Nwoke, 2025; Oluwafemi Oloruntoba, 2024).

3. Future Scenario Projection

Scenario planning presents itself as a technique that has been developed for more than 40 years (Lehr et al., 2017) and researched, taught and applied by management professionals (Ramírez & Wilkinson, 2016).

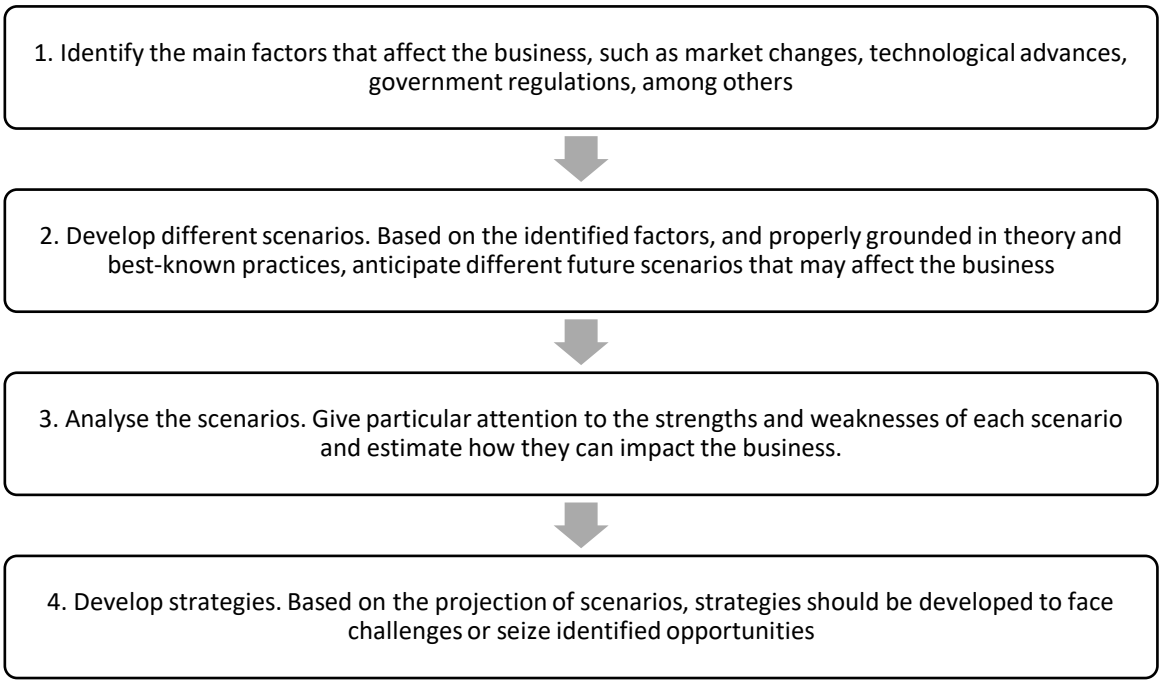
There are several definitions of scenario planning, such as that of Schwartz (1997) who states that the projection of future scenarios is not an attempt to predict the future, but rather a way to anticipate the possibilities of the future that may become a reality (Schwartz, 1997). According to Lindgren & Bandhold (2009), the aim of scenario projection is to construct plausible and convincing stories of the future that can be used to support informed and strategic decision-making. Or we can consider more recent views, such as that of MacKay and McKieman (2018), who define scenario thinking as a cognitive process concerned with imagining how the future can unfold in various ways through analysis and consideration of the effects of the actions and reactions of the modelling forces.

Thus, the technique of estimating future scenarios is a methodology that does not focus on a single prediction but instead integrates a diversity of possible scenarios that help managers make decisions and guide the company. Wright (2025) warns that scenario planning was developed based on the assumption of an uncertain future, which serves as a basis for learning about the importance of distinguishing between predictors and uncertainties. The former (predictors) being events that have already occurred (or will occur with a high degree of certainty), but the consequences have not yet developed, and the latter (uncertainties) should be considered from an additional perspective to gain a greater understanding of their importance for the future thinking.

In fact, the projection of future scenarios is an analytical methodology that allows companies to anticipate and prepare for the challenges of uncertainty. In practice, this technique involves creating different scenarios based on various factors, such as technological, political, economic, and social trends. The projection of future scenarios can be applied across various areas of the company, with particular interest in strategic planning and risk management. Through the projection of future scenarios, companies can identify potential opportunities and threats and develop expansion and contingency plans, respectively, in cases of immediate response to opportunities or setbacks.

Like most methodologies, the technique of projecting future scenarios as a support for decision-making in anticipation of the future requires a sequence of at least four stages as shown in Figure 2.

Figure 2: Stages of decision-making.



Source: Authors.

There are cases of successful use of the scenario projection methodology with several years of application. For example, Shell has adopted this technique since the 1970s to anticipate possible futures in the energy market, allowing them to develop adaptation strategies to changes in the sector, regarding the transition from the fossil fuel-based energy paradigm to sustainable energy. As Wright (2025) points out, what Shell´s organization presents on its website are not predictions or expectations of what will happen, or should happen, but explorations of how the world could evolve underpinned by different sets of assumptions.

4. The Communication of Future Scenarios and the Potential of Technology

Based on the previous sections, there is no doubt that projecting future scenarios is essential for the survival of companies and organizations, and technology is accelerating its adoption. Martino (2007) supports the first part of this statement, concluding that there is no doubt that technology has a considerable influence on the decision-making process in many areas, being considered a critical factor in building future scenarios. He adds that this is relevant for both the private and public sectors.

Regarding the potential of technology, Porter and Cunningham (2005) state that new technologies, such as text mining, network analysis, data modelling, and visualization, offer unprecedented potential for future scenario projection and strategic analysis, providing organizations with an extraordinary ability to anticipate emerging trends and gain competitive advantages.

Effective adoption of communication of this exploratory potential of the future, assisted by technology, must be well communicated. For this purpose, it should be included in strategic documents and clearly and accessible to all stakeholders, both in the vision, mission, and values of companies, so that strategic decisions are informed. Saunders (2009) states that this situation may be further aggravated by the fact that not all elements have the necessary skills to communicate effectively and therefore the scenarios are inherently biased in relation to the information provided element. It should be noted that scenarios are not predictions, but plausible stories that are constructed to challenge our perceptions and prejudices, allowing us to explore the implications of different possible futures (Ramírez and Selin, 2014).

Scenarios can be presented using various methodologies (Richter et al., 2021). For instance, they can be displayed through graphs, tables, narratives (Steenberg et al., 2019) and images (Löfström et al., 2020), among others approaches. It is crucial to communicate the message effectively to avoid misleading and creating false hopes. Therefore, communication follows some basic rules, such as:

- Use of simple and direct language to facilitate understanding. Despite the richness of technical management language, communication of future scenarios should be clear and objective while avoiding the use of jargon.
- Use of visual resources such as graphs, tables, and infographics, as they are more easily memorable images and more likely to better illustrate the expected results of future scenarios.
- Presentation of different perspectives on future scenarios so that those involved can have a holistic view of the implications.
- Use of technology for data visualization, such as virtual reality and other technologies that can provide an immersive experience.

Best practices have already revealed successful cases of communication of future scenarios. One of them is Unilever's "The Future I Want" campaign (Unilever, 2021). The company uses virtual reality to simulate life experiences in different future scenarios, showing the implications of each scenario, relating scenarios to options, and stimulating awareness of the impact of these options on the future of the planet and human life.

Another example of best practices is presented to us by Toyota (2021). Under the slogan "2030: Long Range Planning," the company uses data and technology to anticipate changes in the automotive market and develop more efficient and sustainable vehicles.

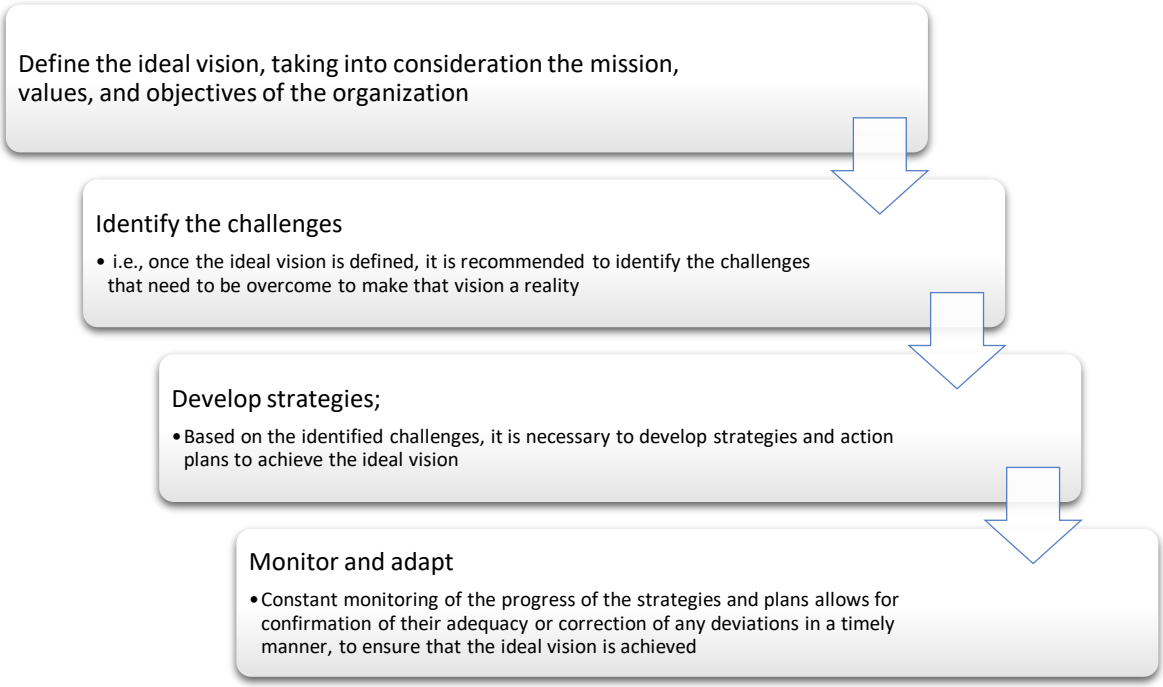
5. Envisioning

According to Slaughter (1996), the ability to visualize alternative futures is not an intellectual luxury, but a practical requirement for surviving in the complex and rapidly changing society we live in.

One of the main techniques for visualizing the future in the English-speaking world is called envisioning. According to Vizcaino & Sridharan (2013), the concept of envisioning does not mean predicting the future but rather creating it. Thus, envisioning is seen as a strategic planning technique that involves creating ideal visions or scenarios of the future for a company or organization. This technique is based on the idea that by creating visions, it is possible to have a clearer understanding of what needs to be done to achieve them and make more informed, knowledge-based strategic decisions (Capatina et al., 2024). This perspective aligns with recent contributions in educational foresight, which emphasize how envisioning methodologies can profoundly reshape curricula and pedagogical strategies by fostering anticipatory thinking and transformative learning processes (Milojević & Inayatullah, 2023). In heinous literacy, there is a combination of foresight (Rooyen et al., 2025), strategic design (Bühring & Liedtka, 2018) and digital tools (e.g. Nweke, 2025), to stimulate long-term visualizations, technological roadmaps and sustain strategic decision-making for SMEs.

In the practical application of envisioning, it is relevant to consider the following sequential steps shown in Figure 3.

Figure 3: Steps for practical application of envisioning.



Source: Authors.

Apple is a good example of the best envisioning practices, creating the ideal vision of being the leading company in innovation and design of consumer electronics. The company focused on developing innovative and appealing products that revolutionized the market, such as the iPhone and iPad. Through these devices, Apple created a culture of innovation that became the company's brand image (Podolny & Hansen, 2020).

6. Alternative Approaches

Beyond the technological forecasting techniques, there are other methods and techniques that can be considered to anticipate the future of technological evolution. Below are some additional approaches, as well as descriptions of some of the advantages and disadvantages of using these methods and techniques.

a) **Patent analysis**

Patent analysis presents itself as a tool for technology foresight and strategic innovation for both startups and SMEs (Vecchiato et al., 2024). The study of patents registered by areas is a technique used to identify technological trends, market opportunities, and anticipate future innovations, evaluate the competition and avoid risks of obsolescence, since the patents represent an indication of the investment in R&D of companies with a commercial focus (Hassanabadi, 2019; Lee et al., 2014; Salamzadeh et al., 2022). However, patent analysis has limitations, since many technological innovations are kept secret, without patent registration, precisely to avoid industrial espionage.

b) **Technology surveillance**

SMEs are increasingly turning to technology surveillance to increase their predictive capabilities (Halima et al., 2022). Technology surveillance is a process of constant alert and systematic collection of data, analysis, and dissemination of information about technologies relevant to a company or organization. This technique can be useful for identifying new technological trends, as well as threats and opportunities in the market. It allows startups and SMEs to be constantly updated on scientific advances, market trends and innovations, which leads to more agile and adjusted strategic decision-making. In the most recent publications, there is a focus on automatic methods using Big Data analysis, AI and tools such as roadmapping, biblical analysis and competitor

monitoring (Burroughs, 2020; Capatina et al., 2024; Oladele, 2025). Nevertheless, technology surveillance can be limited by the availability of information, which may vary depending on the sector and country in question.

c) **Prospective scenarios**

Despite limited resources, startups and SMEs building prospective scenarios has become essential to address complexity and uncertainty in the current market context (Salamzadeh et al., 2022). Prospective scenarios are a technique used to anticipate possible futures by creating narratives that describe different paths that technology can follow. Prospective scenarios are a technique used to anticipate possible futures by creating narratives that describe different paths that technology can take. Methods such as scenario planning, backcasting and alternative narratives have been used to test whether the strategies configure the necessary robustness. This vision is presented as useful in the digital transformation, sustainability, and innovation that most startups and SMEs aim for (Kim & Seo, 2023; Salamzadeh et al., 2022; Vecchiato et al., 2024). This approach can be useful for helping companies prepare for different scenarios, as well as identifying potential opportunities and threats. However, prospective scenarios can be limited by the fact that the future is uncertain and can be influenced by a variety of unpredictable factors.

d) **Artificial intelligence and machine learning**

The implementation of predictive analytics in decision-making has been widely adopted in business in various markets. Predictive analytics underpinned by the integration of AI and Machine Learning (ML) facilitates real-time decision-making (Nweke, 2025). AI and ML are techniques that can be used to predict technological trends based on analyses of large data sets.

The most recent literature highlights the use of tools such as explainable AI (XAI), deep neural networks, and integration with business intelligence systems for scenario planning, innovation, and digital transformation (Blake & Asghar, 2024; Chotisarn & Phuthong, 2025; Kim & Seo, 2023; Sreenivasan & Suresh, 2022; Yadav et al., 2024). This approach can be useful for identifying patterns and trends that may not be perceptible through other techniques. However, the accuracy of predictions may depend on the quality of the data and algorithms used.

While the literature provides comprehensive frameworks for future forecasting, envisioning, and strategic innovation, the practical implementation of these concepts remains a significant challenge. To address this gap, the DC4DM project offers a valuable set of experimental outputs which will be analysed in this study.

7. Methodology

The present work is grounded in a qualitative and exploratory research approach, following established academic guidelines. According to Prodanov & Freitas (2013), exploratory research aims to provide more information on the subject being investigated. Similarly, Gil (2017), states that exploratory research aims to provide greater familiarity with the problem, with a view to making it more explicit or building hypotheses. Consistent with this perspective, exploratory studies often take the form of bibliographic research, relying on existing materials such as books, scientific articles, and case studies. The literature review conducted here explored the topic from multiple angles, considering not only theoretical frameworks but also practical applications of future forecasting and scenario planning techniques. In line to Gil (2017), the primary sources utilized in this work were drawn from bibliographic surveys and focused on pre-existing materials prepared by recognized experts in the field. Furthermore, as Yin (2018) notes, case studies are particularly effective in investigating complex, contemporary phenomena in depth. Embracing this approach, the present study adopts a conceptual review methodology, aimed at synthesizing and critically analysing key techniques related to future forecasting and scenario planning as they pertain to SMEs and startups. This research presents a review of selective academic literature on forecasting, strategic innovation and digital transformation. To achieve the proposed objective, sources were identified through academic databases (e.g., Scopus, Web of Science) and selected based on relevance, citation impact, and cross-sectoral application. Finally, this paper examines several outputs from the DC4DM project, synthesizing their principal theoretical and practical contributions. To mitigate potential bias, interpretations and

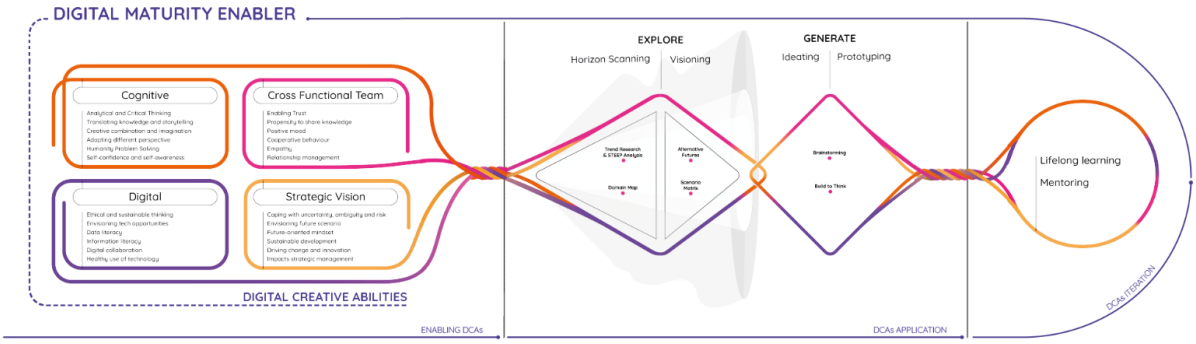
findings were triangulated with input from other project stakeholders, ensuring analytical validity. The findings lay the foundation for future empirical studies and offer practical insights for implementation in educational and strategic design contexts.

8. Applied Analysis of DC4DM Outputs

The European project the Digital Creativity for Developing Digital Maturity Future Skills (DC4DM), funded by the Erasmus+ program, emerged in 2020 with the aim of empowering professionals and future professionals with the necessary skills to face the challenges of digital transformation. It comes from a Consortium between several higher education institutions, startups, small and medium-sized enterprises and business incubators from different European countries. Evolving from its inception between 2020 and 2023, the DC4DM model has progressed from theoretical groundwork to practical implementation, offering a valuable educational framework for educators, businesses, and individuals seeking to foster Digital Creativity. Through thorough testing in Learning Labs (LLabs), the DC4DM toolkit is now poised for widespread adoption. Participation in programs such as the Digital Creativity for DC4DM, supported by the Erasmus+ program, can yield significant benefits for businesses, particularly SMEs and startups (Digital Creativity for developing Digital Maturity future skills, 2025).

The DC4DM educational model, focused on human, allows individuals and teams to envision and communicate future scenarios and design responses; it comprises a curated collection of freely accessible learning materials hosted on the dynamic EDU Box virtual platform, adaptable to the changing digital landscape and educational requirements (Vezzani et al., 2023). They sought to create a digitally mature community, foster the exchange of knowledge (Figure 4).

Figure 4: Digital Maturity Enabler.



Source: Digital Creativity for developing Digital Maturity future skills (2025).

The flexibility and adaptability of the DC4DM model render it suitable for diverse educational settings, effectively preparing participants for the challenges of the digital workforce. Engaging in initiatives like the Digital Media Learning Lab further enhances participants' readiness to tackle real-world challenges by integrating theoretical knowledge with practical application, equipping them to navigate uncertainty and competition in today's market. To empirically ground the conceptual discussion, four key outputs from the DC4DM project were selected and analysed as case studies. Each publication offers unique insights into the practical challenges and opportunities of applying future forecasting techniques within the entrepreneurial and educational ecosystems.

Bruno et al. (2024) suggest a training program on creativity and digital maturity. The DC4DM model was presented and applied in a real educational context - LLabs. The program was developed for both the academic context and the market, such as startups and incubators, to support digital entrepreneurship in the development of their ideas. Despite the small adjustments made, the program was considered replicable to different contexts, which allows strengthening the skills necessary for responsible innovation in a constantly evolving digital context. They suggest the implementation of this program in different realities in the labour market.

Ferreira et al. (2024) reflected on how to incorporate ethical considerations into the design of digital applications for health. They also sought to highlight the importance of thinking about how higher education curricula should

be aligned with the needs of the real market, startups and SMEs. They highlighted the role of DC4DM LLabs as a space for the exchange of knowledge between specialized startups and international student teams. They concluded that, even though several industries are already in the digitalization process, particularly the health industry, there are some barriers that must be overcome, namely the need to expand knowledge in the digital area. They found that programs such as DC4DM are important and make a great contribution to academia, so they recommend that the theoretical curricula of higher education institutions be aligned with practical applications.

Rana (2024) describes the Agile Future Creation (AFC) methodology, a novel innovation process designed to guide startups towards future-proof solutions. It's a future-proof approach that can help analyse changes in society to find signs. On the assumption that an external agent or facilitator is needed to contribute to the literacy of entrepreneurs, he considered that initial innovation workshops such as the one organized by DC4DM's LLabs can help develop the necessary knowledge.

Vezzani et al. (2023) sought to describe the DC4DM educational model and reflect on the experience of three test sessions, called DM Learning Labs, 10-days design-led workshops involving a great diversity of university students, diverse for country of origin and study background, start-ups, and several local mentors and stakeholders to co-design compelling future tech-scenarios. Seek to collect information on how to participate in the DM Learning LAB has impacted on the participants. Feedback from participants consistently underscores the benefits of a collaborative environment, instructor support, and opportunities for experimentation and exploration of emerging technologies.

The analysis of the outputs allowed us to understand the practical applicability of future projection approaches in SMEs and startups. The conclusions drawn are discussed in the following section, in the light of the literature reviewed and the results obtained.

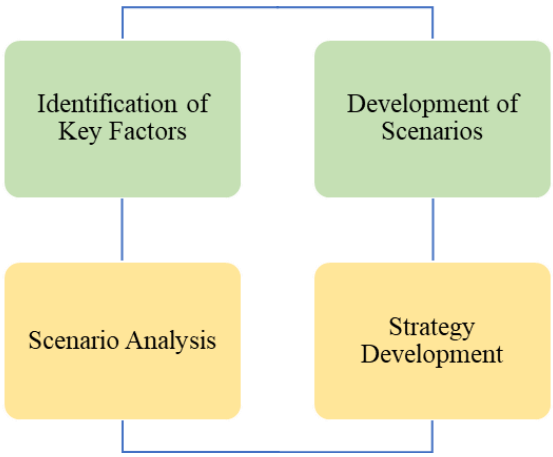
9. Conclusion, Theoretical and Practical Implications, Limitations and Future Research

To consolidate the concepts developed in the literature review and exemplify their practical application, this section analyses the main results obtained within the scope of the Design Competences for Digital Maturity (DC4DM) project. Through the synthesis of the outputs and good practices identified, it seeks to illustrate how future projection, and strategic thinking can be operationalized to strengthen the innovation capacity and resilience of SMEs and startups in contexts of high uncertainty.

In this paper, the importance of future prediction for SMEs and startups was explored, highlighting the need for a forecasting mindset and the use of future scenario projection techniques as vital to the survival of organizations. It was found that the concept of envisioning is fundamental to equipping startups and SMEs with the necessary skills to outline their future (Capatina et al., 2024). Planning for the future emerges as a strategic pillar for the entrepreneurial fabric. New methodologies (e.g. Magistretti et al., 2020) have been increasingly applied in combination with digital tools (e.g. Hokmabadi et al., 2024; Nweke, 2025), which enhances and amplifies strategic planning.

Future scenario projection was analysed as an analytical methodology that allows companies to anticipate and prepare for the challenges of uncertainty. In particular, at least four key steps were described: identification of key factors affecting the business, development of different scenarios, scenario analysis, and strategy development. These stages are visually represented in Figure 5 below.

Figure 5: Steps for future scenario projection.



Source: Authors.

The present research provides a practical and accessible framework for evaluating scenario projections. The practices of foresight and participatory design discussed, in line with recent literature (e.g., Abdelkarim et al., 2019; Bühring & Liedtka, 2018; Lehr et al., 2017), reinforce the thesis that the combination of critical thinking, scenario anticipation, and ethical sensitivity is essential to shape sustainable futures in the European entrepreneurial ecosystem.

In this context, the Design Competences for Digital Maturity (DC4DM) project emerges as a concrete example of how future literacy can be integrated into both educational and business environments. The analysed outputs demonstrate that methodologies such as foresight and envisioning not only empower students and professionals but also promote the creation of innovation-driven communities of practice within the entrepreneurial ecosystem (Bruno et al., 2024; Ferreira et al., 2024; Rana, 2024; Vezzani et al., 2023). The project also highlighted the importance of preparing SMEs for uncertain future contexts by promoting training in foresight and strategic envisioning. Scenario techniques allowed startups to visualize possible future trajectories and become more agile and resilient, as proposed in “Designing Future-Ready SMEs”.

From a theoretical perspective, this research contributes to bridging scenario-based design methodologies with entrepreneurial innovation practices—an intersection still underexplored in current foresight research. It extends understanding of how envisioning techniques, such as scenario prototyping and future artifacts, can enhance strategic adaptability in startups and SMEs. By integrating principles from strategic foresight and human-centred design into entrepreneurial education, the study offers a renewed conceptual lens for future-oriented skill development.

On a practical level, the findings offer tested methodologies for fostering collective envisioning processes. Initiatives such as the DC4DM Learning Labs illustrate how these techniques can be embedded in training programs to improve futures literacy and strategic planning. SMEs and startups can leverage these approaches to anticipate market shifts, technological disruptions, and societal changes—thereby improving their resilience and long-term viability. These contributions not only inform academic discourse but also serve as actionable strategies for entrepreneurs, educators, and policymakers aiming to future-proof the entrepreneurial ecosystem.

Still, important limitations remain. The analysis was focused on selected case studies, so generalizations to other contexts should be made with caution. Notwithstanding the valuable insights derived from the DC4DM project, it is important to acknowledge potential limitations. First, the analysis is grounded primarily in case studies from European contexts, many of which reflect design-led initiatives directly involving the project’s own partners. This raises the possibility of selection bias and limits the generalizability of findings to other geographic, economic, or cultural settings. Moreover, the insider perspective—while analytically enriching—requires careful reflection on interpretive subjectivity. These constraints reinforce the need for further empirical studies that test the

transferability of DC4DM-based methodologies in diverse entrepreneurial ecosystems, including those in underrepresented regions or sectors with different levels of digital maturity. In addition, the continuous evolution of emerging technologies imposes a permanent need to update the forecasting methodologies applied.

As directions for future research, it is recommended to carry out longitudinal empirical studies that evaluate the real impact of foresight and envisioning training on the competitiveness of SMEs. At the same time, it would be pertinent to explore the integration of artificial intelligence and machine learning tools (Nweke, 2025; Blake & Asghar, 2024) in supporting scenario projection, to expand the capacity for strategic anticipation in highly volatile environments.

In summary, preparing startups and SMEs for the challenges of the future implies a cultural transformation that goes beyond technological adoption. It is about cultivating a strategic, visionary, and ethically oriented mindset, as advocated in the DC4DM educational model and aligned with the emerging trends of sustainable innovation (Salamzadeh et al., 2022; Halima et al., 2022).

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