Foresight by scenarios – a literature review

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Foresight by scenarios – a literature review

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Abstract: The methods used in foresight studies are analysed under the approach of recent scenarios and applications, where new methods are evidenced. Sixty-six documents were analysed through a search equation in Scopus with the help of the software Vantage Point, taking into account criteria such as keywords, countries, methods used and applications; making use of co-occurrence matrices and cluster analysis. Nineteen new methods, techniques and tools were found, amongst which nano-tendencies, data mining, machine learning, genetic algorithms, and serious games stand out. In the same way, the stages for the construction of scenarios were identified and it was found that they do not fit into a single school or foresight approach.

Keywords: foresight; scenarios; foresight methods; stage management.

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1 Introduction

Foresight has been conceived and structured to explore the future, identifying factors of change, invariants, trends, key variables, objectives and actors, in order to anticipate situations and decision making; with the purpose of reducing uncertainty. Foresight has been designed to support management in the long term, trying to mitigate uncertainties caused by the changes that occur in the environment of organisations, institutions, sectors, regions and countries.

Various methods, techniques and tools, within methodological approaches that some identify as the French school (scenarios) and the Anglo-Saxon school (consultation experts, Delphi) have been used since the first applications of foresight. However, there are different methodological approaches that combine different methods. These combinations are accompanied by the emergence of new methods for conducting futures studies, which transcend the focus in one or both schools of foresight.

The purpose of this article is to analyse the methods used in foresight studies under the scenario method, to identify applications and to demonstrate new methods that can complement existing methods, techniques and tools. For this purpose, the paper is divided into three parts. The first part presents a theoretical framework on foresight and scenarios, emphasising the definitions proposed by some of the authors of the 66 documents analysed. The second part shows the methodology carried out, as well as a summary of the main results obtained around keywords, key phrases, authors, countries, institutions, and information that was obtained from the Vantage Point software. In the

end, a discussion about three axes is presented: techniques and methods used, stages for the construction of scenarios and some recent applications.

2 Theoretical framework

Foresight can be seen as a systematic, participatory and future intelligence gathering process and a medium- and long-term vision building process, aimed at current decisions and the mobilisation of joint actions (Jovane et al., 2003), in accordance with Schwab et al. (2003). Foresight refers to systematic points of view about the future in order to obtain results about the decisions that are used.

Some European writers state that futures studies almost go back to the origins of civilisation. Knowledge about the future came to human minds as early as more than two million years ago, when men learned to produce tools. Others mention the Manhattan Project as a starting point for futures studies in general. The future has been a topic of curiosity since the beginning of time. The first studies can be located in the '50s with scientists, still followed during the '60s and '70s. Scenarios originate in the RAND Corporation in the 1960s when RAND employed Herman Kahn, renowned for popularising scenario planning. On the other hand, Gaston Berger worked on the same topics in France, reflecting on the future of France, effectively shaping foresight into its initial form. Finally, the Delphi method for foresight by consensus, the probabilistic trend and cross-impact analysis methods were conceived in the RAND Corporation (Piirainen and Lindqvist, 2010). The birth of scenarios was based on the work developed by the RAND institute in the '70s, used in Royal Dutch/Shell, who were better prepared for the volatility of the oil prices of the time with that information. On the other hand, the scenarios were the basis for promoting a culture of learning and strategy in the organisation (Drew, 2006).

Graham et al. (2015) mention the work carried out by Gaston Berger, who expresses that current events reflect past decisions and that, in turn, the future will be aligned to every action taken today.

Due to their experience, several experts mention that the techniques used in scenarios are oriented towards business strategy with the purpose of helping strategic decision making. It is important to clarify that the activities developed for the generation of scenarios aim to strengthen decisions in all corporate areas built by all the actors related to the organisation. Game theory is one of the bases for the construction of future scenarios that have been used since its birth in planning processes carried out by the army, which allows to anticipate reactions in order to simulate the system of complex behaviour (Hirsch et al., 2013).

For Botha (2016), future thought is considered as an emergent discipline shown as a mental state, as a result of the intellectual capacity of human beings, taking into account their past experience with which they can project a future. Popper (2008) states that the selection of prospective methods is not always coherent or systematic, it is a process of multiple factors; the diamond of prospective works as an innovative analysis to better represent and visualise the combination of methods.

2.1 Scenarios

The analysis of scenarios has been applied in different domains. To predict trends in technology, different methods have been proposed for the analysis of scenarios (Mietzner and Reger, 2005). In the planning process, the technology portfolio is used to assist in the decision strategy and find resource allocation plans that fit the objectives of the organisation. The analysis of scenarios is used to develop future conditions and thus facilitate strategic action procedures and propose visions for the future (Weng and Lin, 2015).

Scenario planning is an effective foresight technique to deal with the speed and scale of disruptive innovation. Scenarios are a vision of future, it could stories built methodologically on future alternatives which can be the basis for today's decisions could be made (Graham et al., 2015).

Wack (1985), cited by Graham et al. (2015), explains that a good scenario must be convincing, internally consistent and challenging for strategic purposes. In addition, a scenario is not the prediction of a specific future. Rather, it can be considered better as a plausible description of what might happen (Moniz, 2006).

A scenario is an extensive and clear image of a possible future, not specific a forecast. It is an imaginative and plausible description of what might happen (Schwab et al., 2003).

De Geus (1988) expresses how the scenarios were used to develop an organisational learning culture within that company, in another study Van der Heijden (1996) describes the scenarios as an impulse towards a broad conversation on strategic issues within the teams of the In addition the National Intelligence Council & CIA (2004) carried out the planning of scenarios for macro global trends (Drew, 2006).

Additional studies for scenario analysis have been carried out by authors such as Wack (1985) through the analysis of multiple points of view and different perspectives on the future, Van der Heijden (1996) which considered multiple stakeholders and their interests.

Godet (1993), meanwhile, explains that prospective was designed to reduce the uncertainty caused by constant changes, which occur in the environment of an organisation, becoming a strategy planning tool, which allows to anticipate and to act later. The approach developed by Michel Godet is known to use a mixture of systems and procedures analysis tools, amongst these are the MICMAC that serves to identify the key variables, the MACTOR that analyses stakeholder strategies and the SMIC ProbExpert, which helps to determine the feasible scenarios, the usual steps are the systems analysis, retrospective analysis, the strategies of the actors, and sketch the Godet (1995) scenario.

Numerous contributions have been made on construction and generation of scenarios, only some of the most important ones found in this literature review are reported in this paper and with the search equation used in Scopus referenced in the methodology, it is not the objective of the paper to present a detailed explanation on all contributions and authors as it would be quite extensive and practically impossible in a single article, so it is expected that the reader has familiarity with the theme of scenarios.

3 Methodology

3.1 Phase 1

A search equation was made in the Scopus database, with the keywords foresight and scenarios, which yielded 76 documents of which 66 were analysed. The equation used was: TITLE-ABS-KEY (foresight W/2 scenarios) AND NOT Delphi.

3.2 Phase 2

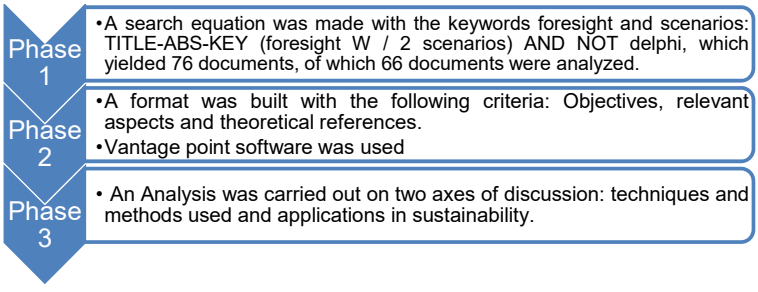
A format was built with the following criteria: objectives, relevant aspects and theoretical references.

Through the use of Vantage Point, the analysis of keywords and countries was carried out through cluster analysis and co-occurrence matrices.

3.3 Phase 3

Two axes of analysis were selected: techniques and methods used and main applications found in the chosen documents. In this case, it was evidenced that the topic with the highest citation in the papers was sustainability.

Figure 1 Phases of the methodology performed (see online version for colours)



Source: Own elaboration

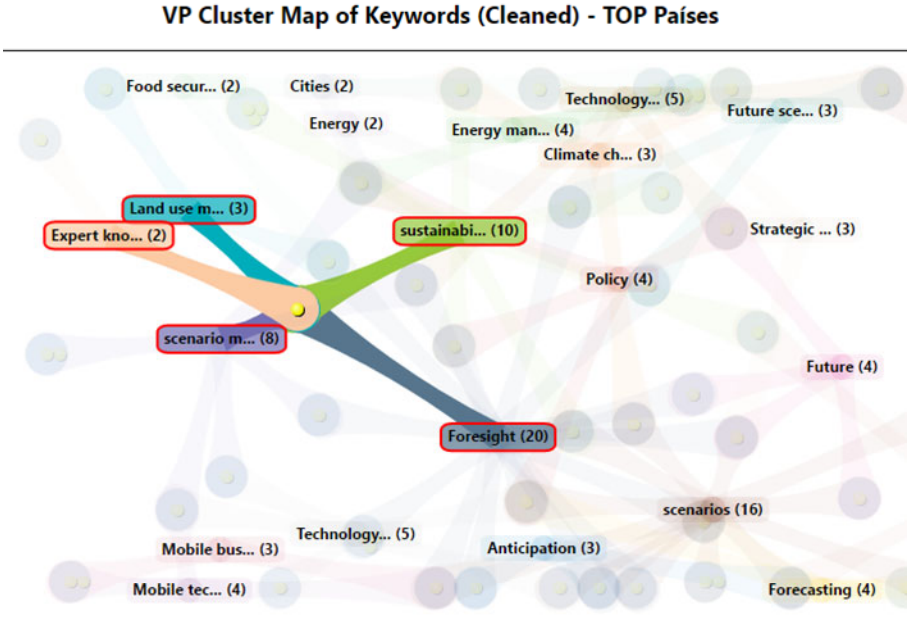
4 Results

According to the search equation used in Scopus, 76 papers were obtained, and a complete text access was found in only 66 of them. Aspects such as year, title, authors, country, journal, impact factor, Scimago ranking, keywords, abstract, methods used, objective, theoretical referents and applications in specific topics were analysed.

With the information obtained in the format at full reading level of the papers and analysis through the Vantage Point software, the following results were obtained:

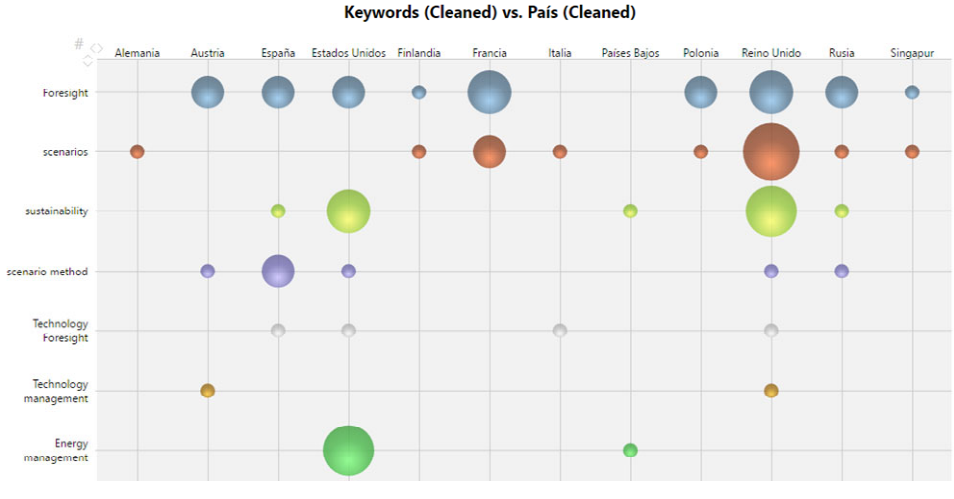
Figure 2 shows the map with the keywords along with the number of occasions in which it appears in the 66 documents. It is observed that foresight and scenario have a high frequency, something that is normal given that they are the words of the search equation. However, applications in sustainability stands out, so this topic was chosen as one of the axes of discussion.

Figure 2 Map of the most repeated keywords in the documents (see online version for colours)



Source: Vantage Point software

Figure 3 Keywords and countries with the highest number of publications (see online version for colours)

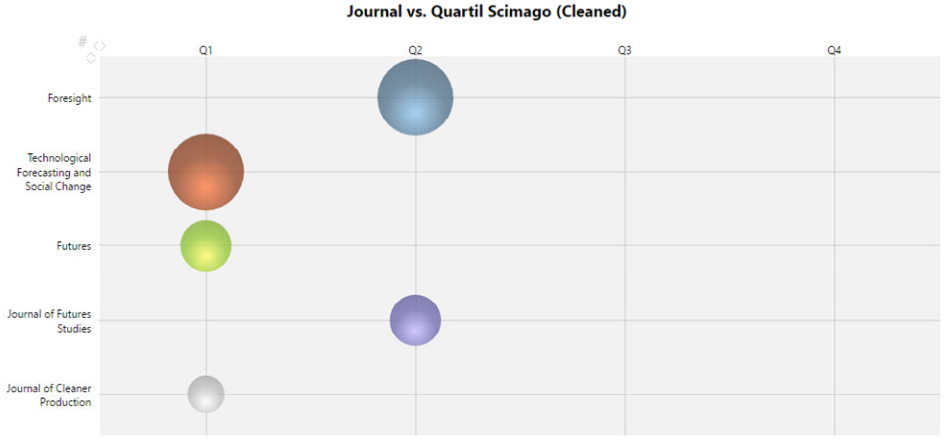


Source: Vantage Point software

Figure 3 details the keywords with the countries with the highest number of publications. It can be seen that the countries with the highest production in foresight are the UK, France, the USA, Spain, Austria, Poland, Russia, Singapore and Finland. In terms of technology management and technology foresight, the countries with the greatest

contributions are Austria, Spain, the USA, Italy and the UK, while for sustainability, the countries with the greatest contributions are the UK, the USA, Spain, Netherlands and Russia.

Figure 4 Most representative journals (see online version for colours)



Source: Vantage Point software

Figure 4 shows that the journal, foresight, technological forecasting and social change, futures, journal futures studies, journal of cleaner production, are the most representative in the 66 documents used and belong to quartiles Q1 and Q2.

Table 1 Methods and authors found in the documents

Methods	*Authors*
Data mining	Proskuryakova et al. (2018)
	Pospieszny (2017)
Cross-impact/structural analysis	De Lattre-Gasquet et al. (2017)
	Villacorta et al. (2011)
	Ratcliffe (2011)
Prescriptive analysis	Pospieszny (2017)
Machine learning	
Roadmapping	Hussain et al. (2017)
	Botha (2016)
	Dugarova et al. (2016)
	Vishnevskiy et al. (2015)
	Kang et al. (2014)
	Kazi et al. (2009)
	Drew (2006)
	Jovane et al. (2003)
Nanotrends	Botha (2016)
Wind-tunnelling	Glover et al. (2016)

Table 1 Methods and authors found in the documents (continued)

Methods	*Authors*
Backcasting	Horner et al. (2016)
	Eames et al. (2013)
	Stratigea and Giaoutzi (2012)
Multi-criteria mapping	Royuela et al. (2016)
Serious game	Bontoux et al. (2016)
Game cards	
Stakeholders	Read et al. (2016)
	Eames et al. (2013)
	Mahmud (2011)
	Drew (2006)
	Schwab et al. (2003)
SWOT	Read et al. (2016)
	Kang et al. (2014)
Focus groups	Surahman et al. (2018)
Science fiction	Graham et al. (2015)
MORFOL	Nair et al. (2014)
	Godet (2010)
	Hirsch et al. (2013)
Narrative simulations	Ceriani (2017)
Trend impact analysis	Nair et al. (2014)
PESTEL	Ringland (2010)
	Drew (2006)
Moral narratives	Booth et al. (2009)
Genetic algorithms	Kazi et al. (2009)
WILD CARDS	Schwab et al. (2003)
Systems dynamics	Hirsch et al. (2013)
Multicriteria analysis/SMIC	Kang et al. (2014)
	Nair et al. (2014)
Narrative capture	Raford (2012)
Mental models	Ringland (2010)
Sensitivity analysis	Villacorta et al. (2011)
	Keppo and van der Zwaan (2012)
Levenshtein distance	Villacorta et al. (2011)
State of the future index (SOFI)	Moniz (2006)

Table 1 shows the 29 methods found in the papers with their respective authors. Some of them are repeated in several studies while others, such as Semetsky et al. (2011) specifically analyse the emerging field of the educational research futures. The purpose of this paper was to evaluate the use of a five-step foresight process, and the application of the scenario method to know the alternatives that researchers might face in European

metrology research institutes. The five stages of foresight included: scoping, recruitment (participation), generation, action and renewal, and evaluation. Rhisiart et al. (2015) focused on the learning effects of the process scenarios in the participants, described how scenario activities change the capabilities of individuals and organisational systems to understand the nature and role of the future by what they perceive and what they do, using the futures literacy: A hybrid strategic scenario method (FL HSS), are only mentioned in one document. It is important to clarify that the Delphi method was also found in several studies, but the focus of this article is results presented by the scenario method.

There were also studies where a single focus of scenarios was mentioned, but they did not mention the method, technique or tool used. Mills (1981) sought to expand literature on the state of the art for residential development and the evolution of the housing stock, using models of perfect foresight, myopia and speculative landowner. Han et al. (2002) proposed to provide a useful route for the future of mobile commerce, developing a new framework of four scenarios for the foresight of the industry. Walden et al. (2007) proposed to explore the future adoption of mobile services in Finland through a longitudinal study. The analysis was based mainly on a numerical representation of the answers, and an aggregation technique by which the degree of acceptance/rejection (score average) of the service in the market was derived. Carlsson and Walden (2008) conducted a longitudinal study for the years 2003–2007 to analyse mobile value services in Finland, identifying the future value of mobile services. Uusitalo edt al. (2009) presented a case related to use of sceneries in a proactive risk assessment of telecommunications and electric power infrastructures. The purpose of the study was to discuss the existing practice and position the methods of IDEAS and SAGES scenarios, and to describe their contribution to the state of the art, where these methods offer tools so that the managers in exercise perform the planning of scenarios with professionals and experts in a flexible and effective manner. Bezold (2010) mentioned the main lessons of foresight studies in the six continents, such as in governments, corporations, organisations, companies, professionals, which entails understanding each one's own needs. Facer and Sandford (2010) outlined the various approaches to educational futures that are currently visible in the field, suggested four principles to support future thinking in educational technology, and described the methods used to investigate long-term socio-technical futures in the two-year Beyond Current Horizons Program. Van Der Lijn (2011) grouped future threats as planned in security foresight studies, carried out by related institutions, organisations and think tanks from around the world and added to each group the knowledge and opinions of the literature, through two groups: 'actors' and 'drivers'. 'Actors' include actors and phenomena, which can represent a direct threat while 'drivers' are an underlying cause or incentive for an actor or phenomenon. Skulimowski (2014) investigated the properties of a method of selection of compromise based on modelling the consequences of a decision as factors that influence decision making in later problems, in addition to proposing a model of networks of anticipation to decisions and optimisation multicriteria. Oyebode and Mindell (2013) reviewed government documents that demonstrate the contribution of the Health Survey for England survey data to each stage of the policymaking process: quantification of the problem of obesity in England, identification of inequalities in the burden of obesity, modelling possible foresight scenarios. Madaeni and Sioshansi (2013) examined the effect of delays in the response of consumers to price signals on the benefits of demand response in mitigating the costs of wind uncertainty. Through scenarios, the authors explored the evolution of foresight

methodologies, through future predictions by experts 'given' to one in which futures are nurtured through a dialogue between 'interested parties'. Skulimowski (2013) presented the properties of anticipation networks and proposed the reduction, transformation and computation method to select compromise solutions, for strategic planning problems of multiple criteria, applying scenarios. Masys et al. (2016) contribute to the discourse on the Dragon Kings that defend the continuous and concerted efforts to explore recent advances in the theory of complex networks, where 'Dragon-King' is of high probability and extremely high consequences. Besides, they suggested that the simulation of such can help predictability events such as natural hazards, floods, earthquakes, forest fires, tsunamis, extreme weather. Weng and Lin (2015) focused on the strategic planning of technology for organisations interested in developing or adopting mobile computing technology, using scenario analysis, evaluating two scenarios through axes of importance and risk with numerical indicators or ranges of low, medium and high value. Sikander (2016) critically analysed the role of scenarios in strategic foresight, indicating that scenario planning is not perfect, that its strengths and weaknesses are quite evident and, therefore, to succeed in a turbulent future, organisations can take advantage of the scenarios, while other tools can also be necessary complements. Siedschlag and Jerković (2017) presented descriptions of the problem space and planning scenarios to assess and manage security risks in a 2,035 time frame to support the future roles of the EU as a security provider for its citizens, addressing both countries – transboundary records and challenges in a global context.

5 Discussion

According to the analysis of the 66 documents, two axes of discussion related to the new and traditional foresight methods were identified by scenarios and with results which the papers emphasised most.

5.1 About the methods used in scenarios

In recent years, various methods, techniques and tools have impacted the application of foresight studies. Popper (2008) identified the methods in his 'Popper quadrant', however, there is still the doubt of whether new methods, techniques or tools which allow expanding or complementing Popper's proposal have appeared.

Among the methods that coincide with Popper, authors such as Drew (2006) combined scenario methods with technological maps and creative group processes, expert analysis. The author mentioned three paths that strategists can adapt to carry out disruptive innovations and technologies: structuring research with an appropriate range of experts and internet sources, creative approaches to group work, and strategic thinking and roadmapping techniques to develop scenarios. Kang et al. (2014) used methods such as SWOT, future strategies and technological roadmap. On the other hand, the objective of Vishnevskiy et al. (2015) was the development of an integrated approach of the work plan and the planning of scenarios through the methodology that combines roadmapping and scenario planning for the establishment of priorities of the public authorities in science, technology and innovation in Russia. In addition, Dugarova et al. (2016) conducted a study to improve the competitiveness of educational institutions in the Baikal-Russia region, using a scenario approach, expert panels and roadmapping. Botha

(2016) integrated scenario planning, strategic foresight, roadmapping and ideation techniques to describe future thinking skills course for industry executives and research groups. Finally, Hussain et al. (2017) presented the combination of technological roadmapping with the scenario method in a case study on the adoption of technology in the national health service of England.

Stratigea and Giaoutzi (2012) linked scenarios of retrospective policies in agriculture of the European Union for the year 2020 with the regional policy scenarios using backcasting. In addition, Eames et al. (2013) used opinions from key stalkeholders, backcasting and scenarios, through workshops to envision regional problems, which in future bases would be linked with innovation dynamics. On the other hand, Horner et al. (2016) used the backcasting technique to identify scenarios that project the potential of carbon in Brazil.

Schwab et al. (2003) conducted a study in Switzerland by the federal office of agriculture, where the methodology was carried out by stakeholders related to research in agriculture as producers, representatives of society and the environment, using the wild cards technique, which involved disruptive events that are included in the scenarios, that is, events with a probability continually judged as 'low' according to the present criterion but which would have great impact if it occurred. On the other hand, Mahmud (2011) sought to formulate a vision of the city towards the 25 years in Bulungan (North in Indonesia), using scenario planning through stakeholders making a consensus among the interested parties and formulating graphic and narrative scenarios that explore a future alternative for Bulungan. In addition, Read et al. (2016) described a study on the management of new technologies, using nanotechnology as a case example Benes, which served as a guide for the development of foresight scenarios that were the subject of the test exercise of stress based on stakeholders and analysis SWOT matrix. The term RFID is eliminated, in order to have coherence in the paragraph.

Hirsch et al. (2013) proposed integrating morphological analysis with a systemic numerical modelling. In addition, Godet (2010) emphasised two symmetrical errors: ignoring the existence of tools for foresight studies or analysing each bias or distortion in the answers through a morphological analysis. Nair et al. (2014) used foresight tools to identify emerging aspects and scenarios, using morphological analysis for flood risk management Bangkok-Thailand.

Other traditional methods identified by Popper (2008) that were also applied in the papers analysed were: multi-criteria analysis/SMIC, wild cards, SWOT, science fiction, multi-criteria mapping, MICMAC/Cross-impact, Delphi, survey, literature review, modelling, role play/acting, essay/scenario writing, scenario workshop, conference/workshop and expert panel. These methods were presented in one or two papers.

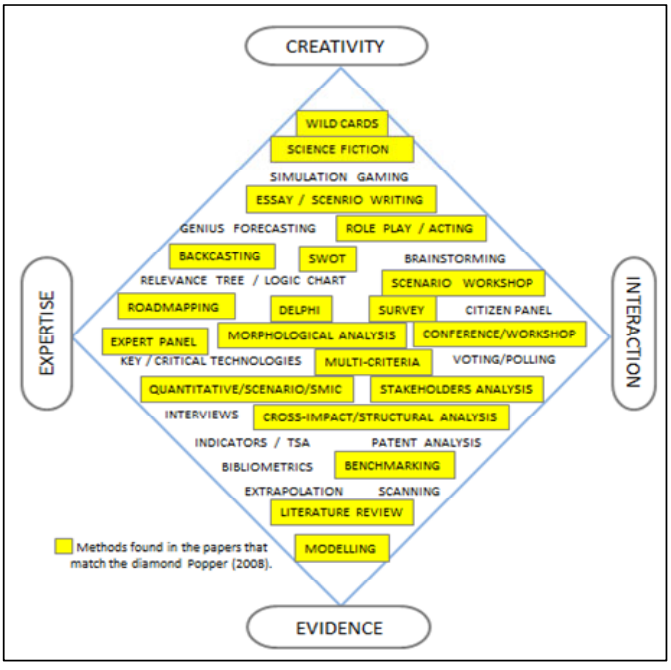
However, new methods, techniques and tools used for foresight studies were identified, different from those proposed by Popper (2008). For example, authors such as Moniz (2006) used the foresight method of constructing scenarios for policy analysis, in social sciences, using the index (SOFI), which is a statistical combination of indicators key and forecasts SWOT. Kazi et al. (2009) explained a next generation of information technologies in construction, using genetic algorithms in scenarios to coordinate project activities. Booth et al. (2009) proposed counterfactual scenarios as modal narratives, where the scenarios are oriented towards the future, focused on what could still be and the counterfactuals are narratives of what could have been. Villacorta et al. (2011) proposed a new multi-objective approach for assessing the impact of a small change in

some variables in a foresight technological study using the Levenshtein distance technique and a sensitivity analysis of the variables obtained by means of the MICMAC structural analysis when the input data contains errors. For this analysis, the authors used the algorithm called NSGAII in a case study with 50 variables in total. Keppo and van der Zwaan (2012) used the linear optimisation model from the bottom up to analyse uncertainties about the storage potential of CO_2 through a sensitivity analysis through the investigation of a series of scenarios under decision making of foresight. Ringland (2010) presented an approach and a set of qualities that allow strategic foresight to lead to renewal and, therefore, to survival, analysing the role of scenarios through mental models and PESTEL.

Raford (2012) developed a pilot project on the use of web collaboration to leverage large participations in the creation of emerging scenarios through a narrative capture. Using an online interface, participants from around the world answered four generic questions related to the short-term future of public services, given the level of financial uncertainty that is observed around the world. Hirsch et al. (2013) sought the benefits of quantifying scenarios through system dynamics as a foresight tool for strategic planning. Nair et al. (2014) propose a new methodology to reach scenarios without going through a structural analysis matrix of impacts crossed-multiplication applied to a classification (MICMAC), matrix of alliances and conflicts: tactics, objectives and recommendations (MACTOR) or systems and matrices of crossed impacts (SMIC), and replace it with and analysis of impact of trends, where the factors or key variables are obtained by the authors. Graham et al. (2015) proposed a structure to develop scenarios through focus groups as an element of new contribution on how scenarios can be written. Surahman et al. (2018) carried out a foresight structural analysis to detail the most important variables that must be management to determine the most important areas of improvement locally to allow short-term agricultural use of degraded peat bogs. Besides through focus groups, Botha (2016) described a course for future thinking skills for industry executives and research groups, which evolved the scanning of the environment through nanotrends, a remarkable alignment but with weak signals and uncertain impact. Bontoux et al. (2016) proposed the development of serious games that help players to get involved in systemic thinking and create alternative futures and new commitments among stakeholders creating scenarios through game cards. Glover et al. (2016) described an innovative foresight approach constructing scenarios with trilemma, using the wind-tunnelling tool. Pospieszny (2017) defined a direction for future research related to data mining to estimate the software and thus be able to optimise resources, improve product quality and, ultimately, increase the probability of successful completion of a project through a prescriptive analysis, combining scenario planning with machine learning, thus improving prescriptive models. Proskuryakova et al. (2018) presented the development of long-term scenarios and strategies in the water sector in Russia, combining methods, data mining and consultation with experts. Finally, Ceriani (2017) proposes scenarios derived from a semiotic approach that involves the development of narrative simulations from phases defined by the canonical narrative schema: mission, competence, performance and sanction.

The methods identified in the 66 papers were compared with Popper's (2008) diamond, and 20 new methods were found, which can be observed in the following modified diamond. See Figure 5.

Figure 5 Foresight diamond (see online version for colours)



Source: Adapted from Popper (2008)

Figure 6 Methods, techniques and tools used in studies of scenarios that complement Popper's diamond (see online version for colours)

Source: Own elaboration

The 20 methods that coincide with Popper's proposal have been highlighted in yellow. It is possible that others such as patent analysis, brainstorming and interviews have been carried out in the 66 studies analysed, but they were not explicitly mentioned in the documents.

Figure 6 mentions the 20 new methods, techniques and tools applied in the studies analysed. Although some of them were used only once, they constitute reference elements for the methodological designs of new foresight studies. Some of them are not new in foresight studies such as focus groups, systems dynamics, PESTEL. However, they are added to the list because they are new contributions to Popper's proposal.

5.2 About the stages for the construction of scenarios

According to the qualitative analysis of the papers, various paths or stages were found for the construction of scenarios, these stages, with their respective authors, are summarised in Figure 7.

In Figure 7, reviewing the stages proposed by all the authors analysed in this paper, and comparing their proposals with Popper's prospective methods, it is observed that in all the studies methods proposed by Popper were used: wild card, scenario writing, SWOT, key critical technologies, stakeholders analysis, scenario workshop, roadmapping, morphological analysis, swot, multi-criteria, quantitative/scenario/SMIC, cross-impact/structural analysis, literature review, modelling, scanning, interviews.

Compared to the new 20 methods found in Figure 6, it can be seen that in the stages of the proposed scenarios, only trend impact analysis, system dynamics, serious gaming have been used.

5.3 Recent applications

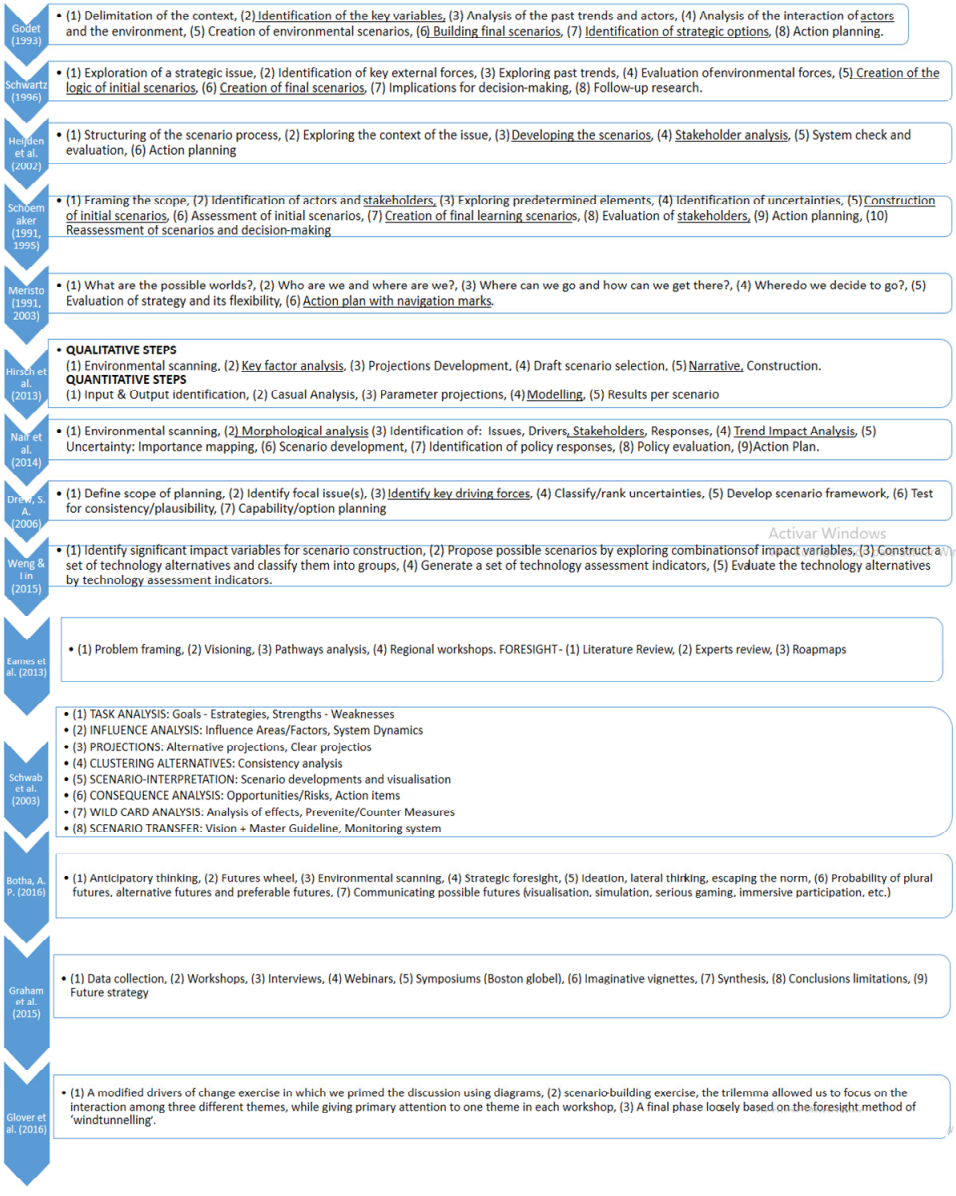
Sreenath et al. (2002) discussed the problem of the Nile River as a hypothetical situation, using a methodology to study the formulation of policies between 2000 and 2050 for the development of Egypt and the country of Ethiopia. Treyer (2007) presented the evolution of the international debate on the future scarcity of water in a historical perspective and studied the various projections, forecasts, foresight scenarios that are or have been discussed. Dawson et al. (2011) presented a method to quantify scales over time, the effectiveness of non-structural measures such as spatial planning of land use, insurance and flood-resistant construction. The integrated approach combines socio-economic and climate change scenarios with long-term land use models and flood risk analysis to generate maps and temporary series of expected annual damages.

Keppo and van der Zwaan (2012) analysed the uncertainties that exist about technologies such as the capture and storage of CO_2 and study a set of scenarios that cover a range of different climate objectives and technological futures. Foran et al. (2013) propose three objectives in the climate and two possible futures for storage of CO_2, generating six combinations to 2050 and making use of probabilities, combining analysis of scenarios and stochastic programming. One of the methodologies used is a modelling of energy systems which contains data from different geographical areas of the planet.

Eames et al. (2013) developed three archetypes that guide the vision for the development of future city-region in the UK, in order to generate transitions towards urban sustainability. On the other hand, Nair et al. (2014) presented an application of futures thinking to identify key factors, future scenarios and political options for flood

risk management in Bangkok-Thailand. The authors proposed policy options in scenarios, as well as time periods to carry them out.

Figure 7 Stages for the construction of scenarios (see online version for colours)



Source: Own elaboration

Other studies on sustainability were carried out by Barraqué and Isnard (2014), who presented a research project on the sustainability of water services in large cities, carried out by two associations for the sustainable cities program of the French Research Agency. Gallouj et al. (2015) present the tracking of the emerging dynamics in the

advance of the service economy and how through scenarios they observe the possible future trends in this sector, for the implementation of sustainable innovation policies in the period 2020. Graham et al. (2015) related the management of the urban supply chain and its role in the future planning of cities. The authors also studied resilience, smart cities and information and communication technologies.

De Oliveira et al. (2016) presented the development of a methodology to identify relevant technology teams for a sustainable energy system with low carbon emissions with this evaluate innovation opportunities within these technology groups in Brazil. Glover et al. (2016) examined the interactions between three issues that are probably significant for the international development policy and strategy in the coming decades. They wanted to explore possible concessions, tensions and synergies that could exist between the competitive objectives of human development.

De Lattre-Gasquet et al. (2017) built scenarios on land use and food security in Tunisia in 2050, while Tung (2016) proposed the development of possible scenarios for environmental sustainability for technology management in Taiwan. The three scenarios presented in this study were discussed from the perspective of energy, food and resources. In addition, Surahman et al. (2018) identified the most influential and sensitive variables that should be taken into account to determine the most important areas of improvement locally and allow the short-term agricultural use of degraded peatlands in a sustainable manner. On the other hand, Proskuryakova et al. (2018) developed scenarios for the water sector in Russia by the year 2030. The developed scenarios were characterised in three key factors: sustainability of water systems, use of water by households and industry and new water products and services.

6 Conclusions

In foresight studies where scenarios, several methods have been used which have been combined by the authors to achieve the final purpose of each study. The new methods, techniques and tools found in this review were: state of the future index (SOFI), Sensitivity analysis, narrative capture, genetic algorithms, trend impact analysis, narrative simulations, game cards, serious game, wind-tunnelling, nanotrends, machine learning, data mining. The studies analysed presented several thematic emphases, however, sustainability was the one of greatest frequency. These investigations were related to problems of large rivers and policy formulation, socio-economic and climate change scenarios, climate targets and technological futures, possible futures for CO_2 storage, vision for the development of city-region futures, risk management of floods, sustainability of water services in large cities, future planning of cities, critical technology groups for a sustainable energy system with low carbon emissions, competitive human development objectives, meta-scenarios that define the possible future performance of carbon, environmental sustainability for the technological management and scenarios, and long-term strategies for the water sector.

Several authors have proposed methods, techniques and tools that can be used in foresight studies. Based on Popper's proposal of 33 methods, 20 of them coincided in the 66 studies analysed. However, in this literature review, 20 new methods, techniques and tools were found, especially those related to information and communication technologies such as data mining, machine learning and artificial intelligence, techniques

that constitute novel contributions on the traditional way of approaching futures studies through scenarios.

Various proposals were found for the generation of scenarios, which involve stages that must be carried out for their final construction, however, the studies analysed in this paper do not directly relate their proposals to one or another prospective school, that is, It is not explicit a position or intention to relate their studies with the French, Anglo-Saxon school or an approach of another type, rather stages or phases are presented that are leading researchers to concretise their scenarios.

Several scenarios applications were found, in terms of technology management and technology foresight, the countries with the greatest contributions were Austria, Spain, the USA, Italy and the UK. While for the subject of sustainability, the countries with the greatest contributions are the UK, the USA, Spain, the Netherlands and Russia, now, issues of technology management and sustainability are of great concern and academic interest in other regions such as Latin America, so the findings in this paper could be reviewed to conduct their own studies.

This paper makes contributions for researchers and professionals related to studies of scenarios, management, forecasting and decision making, since they can find new trends in the face of new methods that impact the execution of future studies through scenarios, identifying possible applications in diverse knowledge areas.

The work also allows academics, businessmen and decision makers to have contributions from various authors on the various options for generating images of the future with the description of paths to reach it, understanding that in recent years studies have been generated to accept that there is no way or school to generate scenarios and that the alignment of approaches, cases, methods, techniques and tools can be a new alternative for the development of scenarios.

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