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Review article

Scenario analysis, from BigData to black swan

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A B S T R A C T

Scenario analysis is a set of methodologies and techniques with the goal of generating strategic insight for decision and policy makers. Our aim for this paper is to overview the scenario analysis field in relation to the relatively new paradigms of BigData. The purpose of such an effort is to clarify where scenario analysis stands today relative to the myriad of data analytics approaches. In an era where the hype about BigData is growing at a breakneck speed, what role scenario analysis can still play? And what kind of synergy it can use to leverage the advances made in other forecasting methods? This paper tries to provide some elements for an answer.

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1. Introduction

Since ancient times the importance of long-term planning had been pivotal, as Sun Tzu the famous Chinese general of 500 BCE is quoted to have said: "Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise before defeat". This quest for long-term planning and the anxiety surrounding the decision-making process continue into the modern age. To-day decision makers and strategic planners are more than ever faced with the challenge of an increasingly complex environment, adding to the external challenge is the internal one emanating from the human factor and human communication/psychology involved in the decision making process [1].

Scenario analysis[1] is one of the main tools of Strategic planning which is a complex and vast topic, [2] define strategic planning as "The systematic identification of opportunities and threats that lie in the future, which in combination with other relevant data provide a basis for a company's making a better current decisions to exploit the opportunities and to avoid the threats". This systematic identification implies an analysis of different scenarios that covers the full spectrum of possibilities, such an undertaking is difficult and fraught with pitfalls to say the least. In his book titled the rise and fall of strategic planning [3] argues that the rigidity of ***planning*** in strategic planning, is responsible for the decline of the practice. He distinguishes between strategic thinking and strategic planning, the former is fluid and analytical; the latter is

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[1] In the literature, Scenario Analysis (SA) is also called Scenario planning (sometimes Strategic Business Planning SBP) and Scenario thinking, in this paper we will use the term Scenario Analysis (SA) throughout.

rigid and top down. Thus, formulating a plan wide enough to cover every scenario is an exercise in futility; instead, he advocates that strategic planners make their contribution around the strategy-making process rather than inside it. They should supply the formal analysis or hard data that strategic thinking requires, so rather than crafting rigid plans they should act as catalysts who support strategy making by aiding and encouraging managers to think strategically.

Such an approach of using formal analysis and facts is becoming more accessible today with the advent of BigData analytics. However there are many questions, is scenario analysis (SA) still relevant in this context? And if so, how can it leverage the methods and tools of BigData? In this paper, we propose elements for answers and broad axis for such integration.

The first part of this paper presents an overview of what is a scenario, including its definition and its evolution.

The second part covers the different scenario analysis schools, classified as the Intuitive logic school, the Probabilistic Modified Trend (PMT) School, and La Prospective School. This section also outlines some of the most popular methods within these schools.

The third part of the paper will go over the characteristics of BigData analytics. In the third part, we analyze the correlation between the explorative/normative classification in SA and the predictive/prescriptive domains in BigData analytics. Finally, the fourth part discusses the broad lines of integration and leveraging of the BigData 3Vs (Volume, Variety, Velocity) in the context of SA.

2. Scenarios overview

The word scenario is an overloaded term, used in many contexts, such as cinematography or software engineering. The word origins comes from Italian and means *sketch of the plot of a play*,[2] a meaning that emphasizes a series of actions and events.

In software engineering, a formal definition was proposed by [4] using the approach of a sequence of events in a state machine.

The early known modern use of scenarios in a strategic planning context is credited to Von Clausewitz and Von Moltke, two 19th century Prussian military strategists [5].

In a more modern incarnation, [6] attribute the birth of scenario analysis to the inadequacies of linear forecast. The need presented by the frequent failure of simple extrapolation from the past. He traces the modern origin of scenario analysis to the work of the French philosopher Gaston Berger, dating back to the sixties, around the same time Herman Khan of the Rand Corporation [7,8] also pioneered the use of scenario analysis.

In the sixties, scenario analysis became an integral part of strategic planning methodologies. Companies such as General Electric and Royal Dutch Shell started using scenario analysis as the main tool for strategic planning [7].

Also in the 60s, [9] defined scenarios as: "Scenarios are hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision points". This emphasis on the notion of sequence continued until the eighties when new definitions started including the concept of consistency such as [10]: "An internally consistent view of what the future might turn out to be, not a forecast, but one possible future outcome".

Consistency is defined in the framework of classical logic as "A set is consistent if it does not entail a pair of contradictory opposite formulas" [11]. This notion of scenario consistency is crucial in the context of scenario analysis. To give an example, let us try to construct a scenario of a rocket ship launch, a consistent sequence of events translates into:
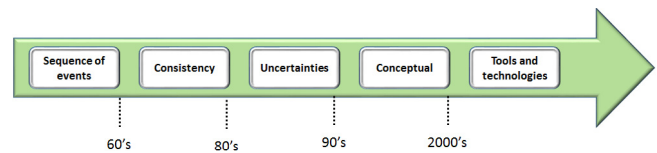
Fig. 1. Summary of scenario definition evolution of emphasis over time.

1. Fuel the rocket.
2. Countdown sequence.
3. Launch rocket.
4. Orbit earth.

A version that puts "orbit earth" before "launch rocket", is inconsistent, thus it invalidates the whole scenario.

In the nineties, the emphasis on uncertainties is introduced into the definition by [12]: "A tool for ordering one's perceptions about alternative future environments in which one's decision might be played out right". The uncertainty inclusion in the definition translates the focus on the probabilistic approaches taken in some scenario analysis methodologies used since the sixties.

In the two thousand, the emphasis was on conceptual [13]: "A scenario describes the developments, the dynamics, and the moving forces from which a specific conceptual future results". This use of conceptual accentuate the modeling aspect of the scenario creation exercise.

The definition evolution continued with [14]: "That part of strategic planning which relates to the tools and technologies for managing the uncertainties of the future". Quantitative approaches were in use from the early days of scenario analysis, their use experienced some decline [6] until the two thousand were they are experiencing a resurge, this resurgence may be explained by the advent of high performance and scalability tools that started appearing as part of the Internet and data revolution of the late nineties and early two thousand.

The trend (Fig. 1) seems to point in the direction of an increased need to quantitative tools and techniques [6], such a development will require that scenarios and scenario analysis have a solid formal foundation since quantitative and computing tools yield better results when dealing with formal systems.

Yet several authors surveyed the SA landscape, for instance, [15] States: "it is necessary to note that, even among the most prolific writing on scenarios it was difficult to find crisp definitions that capture the true meaning of scenario planning".

Similarly [6,5] and [7] come to the same conclusion. Based on our research and to our knowledge, this state of affairs described here remains in order.

However a key step towards formalism started with a taxonomical effort for different scenario types, like the effort undertaken by several authors who proposed a high-level categorization for scenarios [16,13], it divides scenarios into two big families: Explorative and Normative, (Table 1) summarizes these two categories.

Without a rigorous evaluation and analytical methodologies, scenarios have a limited value as standalone conceptual tools, therefore to take full advantage of their potential they need to be processed within a framework that allows the synthesis of diverse sources, like data and the wide spectrum of expert opinion.

In Section 3, we proceed to review the different schools of scenario analysis and give summarized steps regarding their approach.

3. Scenario analysis methodologies and techniques

Scenario analysis is a wide-ranging field concerned with strategic and long-term planning, typically for highly complex issues.