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Axiomatic foundation and a structured process for developing firm-specific Intuitive Logics scenarios

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Axiomatic foundation and a structured process for developing firm-specific Intuitive Logics scenarios

This paper presents an axiomatic foundation for developing firm-specific scenarios in the tradition of the Intuitive Logics School (ILS), a structured scenario creation process built on that foundation, and its application using a case study. The ILS outlines a high-level scenario-development process, but without a theoretical basis or prescriptions for executing different process steps. The lack of theoretical grounding has led to a proliferation of methods for developing scenarios, without any basis for comparing them. We fill this gap in the literature by articulating a set of axioms characterizing the nature of human knowledge about the business environment and scenarios as depictions of that environment. Using this theoretical foundation, we devise a structured process for developing scenarios. Finally, we demonstrate this process by applying it to develop four scenarios for a firm in the U.S. healthcare sector.

Keywords: Scenario creation, Scenario development, Scenario planning, Intuitive Logics

1 Introduction

Scenario planning is a long-range planning process developed by practitioners [1], and used widely by government and corporate planners for over half a century [2] for formulating strategies (e.g., Refs. [3-7]) and making sense of ambiguous developments in the business environment [8, 9]. Scenario planning is not a singular method; rather, it is an umbrella term encompassing at least three schools of thought with different underlying philosophies guiding the creation and application of scenarios [2]. As many as 23 techniques for developing scenarios [10] and at least ten approaches to using scenarios [5, 11] have been identified. However, barring a few exceptions [12-14], most of the scenario methods “are poorly defined, have no theoretical justification [… and] are highly prescriptive in nature” [15]. Despite the “extraordinary challenge in intellectual and methodological
terms” in the practice of foresight, the “methodological accounts [, if available] are usually (very)
short descriptions of some main steps or are confined to a simple scheme” [16, p. 11]. The lack of
“theoretical and axiomatic underpinning of [scenario planning, compared to] other decision-analysis
tools, such as decision analysis and statistical forecasting” is attributed to the fact that the method
“has been developed largely by practitioners” [17, p.2]. This is not a mere academic inconvenience,
but also a problem for practice as evidence from practice shows that scenario development is not a
straightforward task and requires considerable skill [15]. Since scenario development processes are
normative guides, decision theorists would argue that they should be “evaluated by their theoretical
adequacy” [18, p.17]. A theoretical foundation could improve “methodological credibility” of the
scenario development process and render the scenarios developed using the process more
“trustworthy” [19]. Additionally, such theoretical grounding could also make it easier to evaluate
and compare the numerous “highly personalized practices” [20].

The research presented in this paper seeks to address this gap in the literature. Our work
addresses scenario development in the Intuitive Logics School (ILS), which is the most widely used
scenario method [2, 5, 10]. The guidelines for developing ILS scenarios are provided in Peter
Schwartz’s book [21], which is considered the primary reference for ILS [14]. The book does not
provide a theoretical basis for developing scenarios, and discourages structured approaches for
scenario creation arguing [21, p.30] “you cannot create scenarios from recipes.” Against this
backdrop, the present work makes three specific contributions. First, we provide a theoretical
foundation for scenario development in the form of a set of axioms. Second, we show that this basis
can be used to discern a correct process for developing scenarios. We use the phrase “a correct
process” to suggest the possibility of at least one incorrect and potentially multiple correct ways to
develop scenarios – remaining consistent with the sentiment that “there is no one right way to
design scenarios” [22, p. 67] (emphasis added). Our only additional contention is that there could be
an incorrect way to design scenarios, where correctness is defined by conformity of the process to
the axioms. Third, we demonstrate the process by applying it to develop scenarios for a firm in the U.S. healthcare sector.

The remainder of this paper is organized as follows. We begin with an overview of the current state of the scenario planning literature: we present the generic ILS scenario development process [22], highlight the difficulties we encountered first-hand in applying the ILS process, which motivated this research, and summarize the key attempts at theorizing scenario creation (Section 2). Following this, we introduce our theoretical foundation for the scenario development process (Section 3). This consists of definitions of the terms used in the scenario creation process, and a set of axioms regarding the nature of employees’ and experts’ knowledge about the business environment and regarding attributes of the scenarios as depictions of this environment. Using these axioms, we prescribe a structured process for developing scenarios and demonstrate it by applying to a case (Section 4). Finally, we discuss the implications of this research for theory and practice, highlight its limitations, and suggest a few directions for the future research (Section 5).

2 Scenario development in the Intuitive Logics School

Scenario planning rests on the assumption that “events do not just happen at random, but they are related to each other through a structure where causes drive effects and one event leads to another” [23, p.105]. The Intuitive Logics School (ILS) scenarios are created in a set and embody this structure qualitatively. The scenarios in a set contain certain trends that remain identical in all scenarios and critical uncertainties that take different values in different scenarios.

2.1 ILS scenario development process

Schwartz [21] provides an eight-step process for creating and applying scenarios, which is considered the primary reference for the method [16] and “the best overall guide to process” [5, pp.81-2]. The first six steps describe the process of scenario development and are presented below.
The last two steps—identification of implications and indicators—describe scenario use, and are outside the scope of this paper.

1. **Identify focal issue or decision**: A set of scenarios is developed to help an organization deal with a specific issue or decision. The first step is to explicitly state this *focal issue* or *focal decision*. The scenarios are custom-made for the organization to address this issue.

2. **Identify key factors in the local environment**: Next, key factors affecting the issue are identified. Key factors are those elements, either internal to the organization or parts of the external environment, that influence the success of the focal decision.

3. **Identify driving forces**: Driving forces are the “driving trends in the macro-environment that influence the key factors identified” in the previous step [21, p.227]. These are different aspects of five domains of the environment—Society, Technology, Economy, Environment, and Politics (abbreviated as STEEP)—that “move the plot of a scenario, that determine the story’s outcome” [21, p.107]. Once identified, driving forces are separated into two groups: certain trends and critical uncertainties. Trends are those elements whose outcome is inevitable and can be known fairly accurately over the study’s planning horizon. Critical uncertainties are the forces whose outcomes cannot be predicted over the planning horizon.

4. **Rank by importance and uncertainty**: Next, the key factors and driving forces are ranked by two criteria: first by their importance for the success of the focal issue, and then by degree of uncertainty in their future state over the planning horizon. The goal is to identify [21, p.228] “two or three factors or trends that are most important *and* most uncertain” to form the scenario logic, which is chosen in the next step (emphasis in the original).

5. **Select scenario logic**: Scenario logic is the set of “axes along which the eventual scenarios will differ” [21, p.229]. Schwartz informs that “determining these axes is among the most important steps in the entire scenario-generating [sic] process.” Typically, the ILS scenario
logic consists of two elements, and the combinations of their high and low values are used to seed four scenarios. This approach is “assumed to be a kind of standard method” [24, p.19].

6. *Flesh out the scenarios*: Finally, the values of the remaining key factors and driving forces are specified and all elements are elaborated in each scenario. These distinct elements are then woven “together in the form of a narrative” [21, p.231], which describes the world in the scenario and explains how we transition from the present state to that world.

2.2 Challenges experienced in practicing the ILS scenario development process

We applied the scenario development process mentioned above in six cases: chemical manufacturing (2 cases), government agencies (2), pharmaceutical distribution (1), and retail (1). We encountered three types of challenges in these instances.

2.2.1 *Lack of systematic approach to develop scenarios*

The ILS scenario development process lists *what* steps to follow, but does not prescribe *how* each step in the process should be performed. This raised three specific questions in executing each process step in our scenario projects:

- Who should execute each step, and what data sources should be used?
- What methods should be used for gathering the necessary information?
- What is the rationale for making the above choices?

2.2.2 *Imprecise definitions and inconsistent use of terms*

Scenario planning literature uses several terms – *key factors, driving forces*, etc. – to describe the business environment, but does not define them. Precise definitions of these terms are necessary as the scenario development process refers to different terms in different steps. In lieu of precise definitions in the seminal work [21], authors of the subsequent works (e.g., Refs. [22, 23]) have used various terms to illustrate the same aspects of the scenario creation process. For instance, van
der Heijden [23, p.226]—one of the most prolific scholars of scenario planning [25]—uses terms *business factors* and *business variables* interchangeably to refer to the “relatively obvious, relatively close-in issues that shape organizational success or failure”, which are called *key factors* and *key local factors* by Schwartz [21]. Van der Heijden uses term *environmental factors* to describe [23, p.226] “contextual variables related to environmental aspects driving business factors” or [p.114] “circumstances in the environment that could have a major impact on our business, but are essentially outside our own control.” Both these interpretations of the term seem to refer to macro factors that shape the business environment, but are outside the span of control for any single organization. This parallels Schwartz’s description of *driving forces* as the environmental variables, which “as individuals, or even as companies, we have little control over” [21, p.113]. Furthermore, Schwartz sometime uses terms *driving forces* and *driving trends* interchangeably, while also using the term *trend* to refer to predetermined elements of the environment, which are distinct from the other type of driving force: *uncertainty*.

This semantic confusion has been noted by Bradfield, *et al.* [2, p.796] in their extensive review of the scenario planning literature: they note, “the literature reveals a large number of different and at times conflicting definitions.” Bishop, *et al.* [10, p.6] also criticize the scenario planning literature by pointing out that “even the most basic vocabulary is used every which way in this field”. While the essence of Schwartz’s message could be understood from a close reading of his book, the lack of a well-defined terminology made it difficult to communicate the process to the sponsors of our scenario studies.

### 2.2.3 Difficulty of choosing axes of scenario logic

Schwartz [21] notes that choosing scenario logic is “among the most important steps” in the entire scenario creation process. However, the literature does not provide a systematic method for performing this crucial task; rather, choice of the scenario logic seems to be a highly subjective
decision. While very little has been published about actual methods used for developing scenarios, one ethnographic study of scenario creation by professional futurists revealed that even these experienced futurists struggled to choose a scenario logic in the studied project. The study showed that the futurists could not agree on the choice of scenario axes after several rounds of discussion, and when two driving forces out of three competing candidates were chosen as the axes, some team members criticized the selection and expressed frustration that “the scenario axes were imposed on them without their consent” [24, p.21]! We have experienced difficulty in choosing scenario logics in several of our own scenario studies, and have no reason to believe that the findings in the above ethnography are exceptions.

2.3 Extant attempts at theorizing scenario development

The scenario planning literature has seen a few attempts of theorizing the scenario development process in recent years. Chermack [11, 26] is one of the first to provide a theoretical model. He calls his work “preliminary in nature” [26, p. 59] as it consists of a rather broad compilation of concepts and propositions linking them. MacKay and Tambeau [27] use structuration theory—which describes how social structures evolve through a reciprocal relationship between the agents and the structure that constraints agency—as a basis for developing scenarios. Their approach models interpretations of representative agents to predict how the system may evolve through the agents’ actions. However, predicting the effects of one’s actions on the entire social structure—and hence, the resulting scenarios—can be difficult to envision for boundedly rational scenario creators [28] since, as the authors admit themselves, the changes result “often through the unintended consequences of action” [p. 676] and uncertainty in the future results from “complexity of agency-structure interactions” [p. 682] (emphasis added in both quotes). Sarpong [29] argues that scenario thinking could be theorized as a social practice, where memory of the past, perception of the present, and prediction of the future together enable making sense of the environment. Although
Sarpong’s framework falls far short of being labeled a theory, the temporal element of strategy-making has recently been elucidated in a theoretical model of practice of strategy making [30]. Burt [31] provides a method for developing scenarios for a system by mapping its causal loops and showing how disruptive innovations could alter the business-as-usual in the system. This appears to be a useful process for developing scenarios; however, no theoretical foundation is provided for creating the system’s causal loop diagrams. Overall, scenario planning scholars have started proposing alternate theoretical models for the scenario development process. However, the literature still lacks a theoretical framework to guide scenario creation by a group of boundedly rational individuals with a limited knowledge of the system they are creating scenarios for.

3 Scenario development: Theoretical foundation

In this section, we address the first part of our research motivated by the challenges mentioned in the previous section. We provide a conceptual model of the business environment and define the terms used in scenario development (Section 3.1). Following this, we present a set of axioms as the theoretical basis for developing scenarios (Section 3.2).

3.1 Terminology

Scenario planning takes an open systems perspective on organizational strategy [9] treating organizations as interdependent on the environment. An organization’s environment is the set of “variables not subject to complete control by the organization and hence not contained within [its] closed system of logic” [32]. Environment is the “store of resources as well as a source of opportunities and constraints, demand and threats” [33] for the organization, and can affect the organization “through the process of making available or withholding resources” [34, p.61]. While organizations cannot eliminate their dependence on the environment, they “seek to place their boundaries around those activities which if left to the task environment would be crucial
Although the leaders of an organization, by definition, cannot control any aspect of the environment, they do have some discretion to “select the types of environment in which they will operate […] and] may command sufficient power to influence the conditions prevailing within environments where they are already operating” (emphases added) [35]. An organization may manipulate the environmental variables by either bringing them under its control through mergers, vertical integration, etc. or managing its dependence on them through joint ventures, overlapping boards of directors, etc. [36], or through lobbying the governments. The part of the environment amenable to an organization’s influence is sometimes referred to as its transactional environment [37] where, as described by van der Heijden, “the organization is a significant player, influencing outcomes as much as being influenced by them” [23, p.115]. He calls the part of organization’s environment, “which has important repercussions for the organization but in which it has little or no influence” its contextual environment. Thus, an organization’s ability to control and influence helps distinguish different parts of the environment. The idea that an organization may not have the ability to shape evolution of its environment is also reflected in the term “policy-free” scenarios, which is used to indicate that the developed scenarios are “upshots of interplay between various driving forces in which it is assumed that the client of the foresight would not act” [16, p. 43]. This characterization of the relationship between organization and environment provides the basis for defining the key terms used in the scenario development process. The terms are defined below; their definitions are also presented in the form of a flowchart in Fig. 1.

- **Focal decision**: A decision about organizational action or structure (thus, amenable to the organization’s control) to be made using the scenarios being developed.

- **Local factor**: An element of the organization’s external environment (thus, not amenable to the organization’s control), which the organization can influence.
• **Driving force:** An element of the organization’s external environment (thus, not amenable to the organization’s control), which the organization cannot influence. Driving forces are further classified into two types for creating scenarios:
  
  o **Trend:** The driving force whose value over the planning horizon can be predicted with reasonable accuracy.
  
  o **Uncertainty:** The driving force whose value over the planning horizon cannot be predicted with reasonable accuracy.

The above terms are schematically presented in Fig. 2. The variables related to the *focal decision* are contained in a black box. This black box encompasses the internal variables that the organization has full control over and wants to define by making the focal decision. The *focal decision* in the box is surrounded primarily – but not necessarily entirely – by *local factors*, which occupy the gray area inside the inner circle with a dashed circumference. The local factors are surrounded by *driving forces*, which occupy the dotted area inside the outer circle with a solid circumference. The area between the box and the smaller inner circle with a dashed circumference is the transactional environment; the area between the inner circle and the outer circle with a thick circumference is the contextual environment. *Local factors* lie in the organization’s transactional environment, and the organization’s contextual environment contains the *driving forces*. Note that our definitions leave open the possibility that some driving forces *may* lie in the organization’s transactional environment (which will occupy the dotted area between the black box and the inner circle with a dashed circumference). The rationale behind this is that an organization is likely to have some way to influence most of the aspects of its transactional environment, but may also have some aspects in the transactional environment that it has no ability to influence.
3.1.1 Example of focal decision, local factors, and driving forces

An example of a focal decision is a firm’s manufacturing strategy for a particular product line. The components of the focal decision include internal elements the organization has to specify, such as whether to make or buy each product, production technology (or vendors) to use, production capacity needed, location(s) of manufacturing facilities (or vendors), etc. These elements are affected by local factors such as demand for the product, variation in demand over time, reliability of raw material and component supplies, etc. The firm does not control these factors, but can influence them. For example, demand can be influenced through advertising and pricing; seasonal variation in demand can be influenced through sales promotions; reliability of supply can be influenced by in-sourcing or creating long-term contracts with suppliers; and so on. The local factors are affected by driving forces, such as environmental consciousness of society, business tax policies, trade regulations, advances in information technology, etc. These are the macro forces that the firm cannot influence. They generally affect the firm indirectly by influencing the local factors. For instance, “Population of 20-64 year old adults” may influence the demand for the firm’s product; “Price of crude oil” may influence product demand and the firm’s transportation cost; “Trade regulations” may affect access to foreign suppliers, the cost of supplies, and the reliability of supply; and so on. Among these examples, the “Population of 20-64 year old adults” can be predicted fairly accurately for a planning horizon of five-years; therefore, it is a trend. On the other hand, the “Price of crude oil” may not be predicted reasonably accurately over the same period; therefore, it is an uncertainty.
3.2 Axiomatic foundation for the scenario development process

This section articulates the axioms about the knowledge of local factors and driving forces of the individuals involved in the scenario creation process. The knowledge perspective is important, to the point of codifying it in a set of axioms, in the scenario creation process because “environments have multiple dimensions […] and these dimensions are not given characteristics of the field but rather constructed through interpretations of the actors who make up the field” [38, p.687]. Creating scenarios involves marshalling the disparate chunks of relevant knowledge from multiple individuals to build visions of plausible future to tackle the focal issue. The following axioms state where this relevant knowledge may be located. While some may seem more obvious than the others, each axiom is accompanied by a brief justification from the extant literature.

Commitment and support from the top leader(s) is necessary for the success of any major project in an organization. Schoemaker [39] lists “failing to gain top management support early on” as the first in his list of twenty pitfalls that can derail a scenario project. Involvement of the leader from the beginning ensures that the focal issue chosen for the scenario project is an appropriate strategic issue for the organization to pursue. This is especially important as scenario planning projects require commitment of time from senior managers, and may not show immediate, tangible benefits. A leader is also in a position to assemble an appropriate group of people from the organization to participate in the project. Therefore,

**Axiom 1: It is necessary that the scope of a scenario project is defined by the leader of the organization responsible for the focal issue for the project to succeed.**

Human knowledge of the business environment is a key ingredient of the scenarios. It has been acknowledged that the knowledge relevant for making a complex decision—such as, formulating an organization’s strategy—is distributed among several individuals [40, 41], and could possibly not be acquired by a single person [42]. The omniscient individual may not exist as humans are only
boundedly rational [28]. Human attention is a scarce resource, and employees of an organization allocate their attention to a limited number of internal and external elements [43]. The elements attended by each individual depend on the person’s professional background [44, 45] and role within the organization [46]. The allocation of attention is “not uniform throughout the [organization but] differentiated according to the division of labor inherent in the firm’s rules, positions, players, and resources” [43, p.199]. Empirical evidence supports these arguments, showing “striking differences in the form and richness of the taxonomic mental models held by managers both within and between companies […] where] the diversity seems to reflect differences in the roles particular actors perform within their organizations” [47, p.533]. As a result, “knowledge of the circumstances of which we must make use […]exists] solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess” [40, p. 519]. Tsoukas expounds the implication of this for strategic planning: “in order for corporate planners to formulate a strategy, they would need, among other things, to be in possession of knowledge which is, to a large extent, fundamentally dispersed”. The next axiom flows from this.

**Axiom 2: An individual member of an organization is knowledgeable about only a subset of the elements in organization’s environment. Furthermore, different individuals in the same organization are knowledgeable about different parts of the environment.**

While the relevant knowledge is dispersed among several individuals, what each individual knows also depends on how the person applies his/her knowledge. Psychologist Diane Halpern [48, p. 26] talks of an old saying in psychology that “the head remembers what it does.” The information that is most frequently retrieved and used by the mind becomes most readily available. This is why specialization in particular area of knowledge is recommended for improving “efficiency in knowledge production”, i.e. acquiring, storing, and creating knowledge [49, p. 112]. Individuals are more knowledgeable about “the particular circumstances of time and place” relevant to their routine
decisions than external experts [40]. In making operational and tactical decisions, individual employees have to account for different elements in the organization’s transactional environment that influence those decisions. Because of their routine interactions with it, the organization’s employees (particularly, middle and senior managers) are likely to have a more nuanced understanding of the transactional environment, and hence the local factors, compared to an external expert.

**Axiom 3: Compared to external experts, middle and senior managers in an organization are more knowledgeable about the local factors in their organization’s environment.**

While local factors are known to the organizational managers, driving forces “are less obvious, and often remain off [their] radar” [23, p. 227]. Driving forces, however, have been identified by scenario practitioners from individuals in the organization using techniques such as influence diagrams or asking ‘why’ repeatedly. The process of soliciting driving forces from organizational individuals—either using deliberate methods or through voluntary introspection by individuals—is typically inside-out: it starts from the knowledge of organization’s local factors and extends outside to identify driving forces that may influence those factors. Alternatively, driving forces can also be found from external experts and market research databases. Such external sources provide information about the general macro-level environment; not all of the macro-level driving forces identified by these sources may be relevant to the organization or its industry. The collection of driving forces identified from the external experts, thus, provides an outside-in perspective. The driving forces obtained from experts will also depend on the collection of experts consulted. There is no guarantee that the collection of driving forces obtained from external experts will comprehensively include those identified through the inside-out search from the organizational personnel, or vice versa. Thus,
**Axiom 4:** Neither a collection of external experts nor a diverse group of personnel from the organization can be guaranteed to know of all the driving forces the other group is aware of.

Local factors are in the immediate vicinity of the organization and have a direct impact on it. On the other hand, most of the driving forces are separated from the organization and affect the organization only through the local factors. Managers are known to spend more time on the issues in the transactional environment, which consists primarily of local factors, and less on the contextual environment, which is primarily comprised of driving forces [8]. Thus, it is easier for an individual from the organization to envision the impact of a local factor, compared to that of a driving force, on the focal decision.

**Axiom 5:** It is easier for the member of an organization to understand how a local factor, as opposed to a driving force, affects the focal decision.

Individual members of an organization, compared to external experts, also have a better understanding of their organization’s internal elements. The ongoing process of sensemaking [50, 51] gives the individuals ample opportunities to understand how changes in various aspects of the local environment affect their organization. Therefore, the individual members of the organization, especially middle and senior managers, are likely to have a better understanding of how a local factor affects the focal decision than external experts. So, while Axiom 3 states that the managers know better than external experts which local factors affect the focal decision, Axiom 6 states that the managers are better informed about what effect any given local factor has on the focal decision. Thus, Axiom 3 states that organizational members will identify more local factors than external experts; Axiom 6 states that the organizational members will be more accurate judges of impact of local factors on focal decision.
Axiom 6: Compared to an external expert, individual members of the organization have more accurate knowledge of the effect of a local factor on the focal decision.

Identifying the relationship between driving forces and local factors involves answering the question, such as “does driving force X affect local factor Y?” To answer this question well, one needs to have a good understanding of the respective driving forces and local factors. The middle and senior managers of an organization dealing with the focal decision are familiar with the local factors. While they may not be knowledgeable of all the relevant driving forces, the middle and senior managers are also experienced enough to judge, individually, whether a given set of driving forces can affect the local factors in their environment. Thus, the individual middle and senior managers of an organization can be assumed to be capable of correctly stating whether a driving force affects a local factor.

Axiom 7: Individual middle and senior managers in an organization can correctly state whether a particular driving force influences the magnitude and/or direction of a particular local factor in the organization’s environment.

Scenarios are pictures of the external environment, which can be described in terms of either driving forces, local factors, or both. Driving forces are outside an organization’s scope of influence and need to be accommodated in the organization’s strategy. Therefore, they are ideal candidates for developing scenarios. On the other hand, an organization has the ability to influence the local factors in its environment. Stipulating specific values of local factors in a scenario rules out the decision-makers’ ability to identify strategies to influence them. Therefore, local factors should not be mentioned in the description of a scenario.

Axiom 8: Scenarios should be described using driving forces only; they should not specify values for the local factors.
For a scenario to be useful, decision-makers have to believe that their organization could encounter the world described in the scenario in future. Believability is achieved when each scenario is *internally consistent* and *plausible* [23, 52] in the eyes of scenario users. One of the common pitfalls of the scenario creation process is the failure to tell a dynamic story narrating how we “get from today to the future world projected in the end-state description” [39, p. 429]. This is why scenario scholars recommend that scenarios be described such that they “grow logically from the past and the present and reflect current knowledge” [23, p. 225]. Scenarios do not need to be projections of trends believed to highly likely to grow from the past and the present; they could also be “peripheral scenarios” [53] that occur when driving forces take values that have low probability, but are plausible. Ducot & Lubben [53, p. 54] describe these scenarios as following “a line near the surface of the cone of possibilities” connecting the present to the future scenario.

**Axiom 9:** For it to be judged plausible, a scenario should (i) be internally consistent and (ii) describe how the world transitions from today to that scenario using the socioeconomic and technical artifacts present today, which are not disputed by the organization’s members involved in creating and using the scenarios.

### 4 Results: Scenario development process and its application

The guidelines for creating a structured approach for developing scenarios based on the axioms presented above are summarized in Table 1. Using these guidelines, we created a scenario development process for the Intuitive Logics School. This section presents the structured process and then illustrates it by applying to a case.

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INSERT TABLE 1 ABOUT HERE

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4.1 Scenario development process

4.1.1 Step 1: Define scope of the scenario planning project

The leader of the organization whose focal question is to be answered should define the project scope and select the project team (Axiom 1). Defining the scope of a scenario planning project consists of specifying three variables: stating the focal decision to be made using the scenarios, delineating the part of the organization about which long-range planning decisions could be made, and specifying the time horizon to be considered in the study. Once the project scope is defined, a project team should be selected. The members of this project team are the sources of the data used for developing scenarios. The team should have representatives from all the functional areas in the organization that are included in the project scope, as well as the functions that are highly related to those within the scope (Axiom 2). The members of the team need to be knowledgeable about the function and have the authority to implement any changes in the function resulting from the project.

4.1.2 Step 2: Identify key factors in the local environment

Organizational members are more knowledgeable about the local factors relevant to the focal decision than external experts, and hence are the source of this information (Axiom 3). These individuals are identified by the organizational leader sponsoring the scenario project in Step 1. Obtaining local factors from the team members is a process of knowledge elicitation, where the researcher obtaining the information has to take a systematic approach that can extract each team member’s relevant knowledge as completely as possible and without adulterating the team member’s knowledge with the researcher’s own thoughts. Taking the following two steps ensures that both these goals are met:

- Inform the team-members in advance what type of information is expected from them. This requires that the team members are aware of the goal and scope of the project, and familiar
with the definitions of terms, such as ‘business environment’, ‘local factors’, etc., used in the process.

- Use an exploratory – as opposed to a confirmatory – approach for obtaining the information [54]. The explanatory approach assumes that the researcher does not know of all the concepts considered relevant for the focal issue by the project team member (Axiom 3), and hence relies on the use of open-ended questions.

The researcher may use generic knowledge elicitation methods such as semi-structured interviews [55] or brainstorming [56], or employ specialized techniques such as interactively elicited knowledge maps [57], verbal protocol analysis [58], text-based causal mapping [59], etc. Various knowledge elicitation techniques have been evaluated by organizational researchers [59-62], and are not covered in this paper.

4.1.3 Step 3: Identify and assess driving forces

This step involves identifying driving forces that may affect the organization and assessing whether their value over the planning horizon is predictable (“trend”) or not (“uncertainty”). Since neither a collection of external experts nor a group of individuals in the organization alone can be guaranteed to have a comprehensive knowledge of the driving forces that may be relevant for a scenario study (Axiom 4), both external experts and project team members should be used as the sources of driving forces for the study. Information about driving forces is obtained from external experts using interviews, via documents authored by them, or through industry research reports. Information related to driving forces can be elicited from the project team member in the same session as the one used for obtaining local factors.

Once a list of driving forces is compiled, the predictability of each force over the planning horizon is evaluated. Van der Heijden warns that “deciding the boundary line between the predictable and the uncertain is not a trivial matter” [9]. One way to do this is to list the different
values of each driving force predicted by the interviewees and in the industry research reports, and then deduce the level of uncertainty about the driving force from the diversity of opinions of different informed experts. The uncertainty is described qualitatively, and could be either “High”, “Medium”, or “Low” (trend). When in doubt about the appropriate level of uncertainty for a driving force, assume a higher level of uncertainty.

4.1.4 Step 4: Rank by importance and uncertainty

This step involves ranking the key factors and driving forces – by their impact on the focal decision and uncertainty over the planning horizon – for choosing the scenario logic. Scenarios need to be described only in terms of driving forces (Axiom 8). Therefore, the desired output of Step 4 is the ranking of driving forces by impact and uncertainty. The uncertainty of each driving force has already been evaluated in Step 3; one method for calculating impact is described below.

Compared to an external expert, the members of the project team are better informed about the effect of an element of the environment on the focal decision (Axiom 6). However, the team members are more likely to have a better idea of how a local factor—not a driving force—affects the focal decision (Axiom 5). Therefore, the first step in evaluating the impact of a driving force is to ask the project team members to assess the impact of a local factor on the focal decision. This assessment can be completed using a structured questionnaire; the impact can be evaluated on a 5- or 7-point scale. The absolute value of impact is more important than the direction of impact. Therefore, the two extreme values of the scale used for reporting impact could be: “No impact” and “Extremely strong impact”. Ideally, impact of all local factors identified in Step 2 should be assessed. To ensure that all respondents have a uniform understanding of the local factors listed in the questionnaire, the factors should be worded by following the guidelines for writing good survey questions (e.g., Ref. [63]), such as, using terms that are uniformly understood by the respondents, providing definitions where necessary, not asking multi-barrel questions, etc. The questionnaires
should be completed individually by project team members. The impact of each local factor is the average of the evaluations of all team members. Local factors whose assessed impact is highly variable should be explored further, as they may not have been understood well by the project team members.

The next step is to use the impact of local factors to calculate the impact of driving forces. For this, we first need to establish whether a driving force influences a local factor. This is done by the project team members (Axiom 7), by denoting whether a driving force affects a local factor. If the exercise has \( n \) driving forces and \( m \) local factors, the team members need to evaluate \( n \times m \) relationships. The number of evaluations can be kept to a manageable number by choosing only a subset of local factors—key local factors—for the mapping exercise. The factors chosen as key local factors should represent all important domains relevant to the focal decision, with the factors having the highest impact within each domain being selected.

The mapping between driving forces and key local factors is accomplished using a structured questionnaire asking questions of nature “Does <Driving force> influence <Key local factor>?“ (binary answers: Yes/No), or “How strongly does <Driving force> influence <Key local factor>?“ (with at least three choices: “No effect”, “Weak effect”, and “Strong effect”). The relationship is presented numerically on a 0-1 scale. The questionnaire should be completed by each team member individually; the strength of the relationship between a driving force and a local factor is the average of all assessments. The impact of a driving force is calculated as follows:

\[
(\text{Impact of key driving force } F) = \sum_{i \in \text{all key local factors}} (\text{Impact of key local factor } i) \times (\text{Strength of relationship between local factor } i \text{ and driving force } F)
\]

The key local factors cease to play a role in the scenario creation process once their mapping with the driving forces is complete, as the scenarios are defined using driving forces only (per Axiom 8). However, our experience suggests that local factors are useful during scenario application to understand the implications of driving forces in more tangible terms.
4.1.5 Step 5: Select scenario logic

The typical scenario logic in the ILS consists of two environmental elements; combinations of the two extreme values of the two provide four scenario seeds. Since the scenarios are described using driving forces only (Axiom 8), the scenario logic will consist of the driving forces that have the greatest impact on the focal decision (determined in Step 4), have high or medium level of uncertainty (determined in Step 3), and are not highly correlated. Two driving forces are considered to be highly correlated if they have similar influence on the key local factors. The purpose of choosing driving forces with low correlations to define the scenario logic is to ensure that the resulting scenarios are diverse in terms of their impact on the organization’s transactional environment. Correlations between all driving forces are calculated using the strength of the driving force’s relationship with the key local factors.

Armed with the information about (a) impact and (b) uncertainty of each driving force, and (c) correlations between all pairs of driving forces, the project facilitators are ready to choose driving forces to form the scenario logic. Project team members should be involved in choosing the scenario logic, so that they accept the logic and the scenarios developed subsequently. Choosing scenario logic is not an exact science, and multiple candidate scenario logics should be evaluated before settling with one. To begin, two driving forces with (a) high impact (not necessarily, the highest), (b) medium or high level of uncertainty, and (c) low correlation between them should be selected as the first candidate scenario logic. The resulting four scenario seeds should be discussed with the project team to evaluate if they could lead to four very different and interesting scenarios. This process should be repeated with a few more scenario logics consisting of two driving forces chosen as mentioned above. Our experience suggests that generally two to four candidate scenario logics could be evaluated before selecting one to create scenarios for that project.
4.1.6 Step 6: Flesh out the scenarios

The last step in the scenario creation process involves specifying values of all driving forces, in addition to the two selected as part of the scenario logic. First, the values of all driving force identified as trends are specified; each trend takes the same value—it’s expected value over the planning horizon—in every scenario. Next, the values of all remaining driving forces are assigned, starting with the force with the most impact and continuing in the descending order. The value of each driving force in each scenario is specified so that it is consistent with the values taken by other driving forces already specified in the scenario. This ensures that the scenario is *internally consistent*. Also, for each pair of highly correlated driving forces, an attempt should be made to create all four combinations of their high and low values in the four scenarios as much as possible.

The structures for all scenarios should be validated for *plausibility* and *internal consistency* by the project team. The information gathered during industry research is useful to inform how the proposed combination of driving forces suggested in the scenario structure could come about. Once the structures are validated, narratives are developed for each scenario. The narratives should describe the scenario vividly and also mention how the world can transition from today to the world described in the scenario using the artifacts that exist today. This helps improve the plausibility of the scenario in the minds of its users (Axiom 9). It may be necessary to conduct additional industry research when developing narratives, to find specific examples of technologies, political developments, etc. present today that can be used to show how a driving force can take a specific value in each scenario. A professional story-writer could be hired to develop the narratives; however, scenario structures and the material for writing the narratives should be provided by the project team.

The last step in the scenario creation process is to assign a vivid name to each scenario [21, 22, 23]. Capturing the essence of a scenario in a title makes the story easy to remember and reference in the strategy discussions [52]. Brainstorming with the project team is effective for
generating ideas for the names. Before brainstorming, each team member should have read the scenario. The names each person proposes provides some idea about how s/he understands the world described in the scenario. The final name should be chosen by the project team. Our experience suggests that a project team may change the scenario names as the members become more familiar with the scenario.

4.2 Application of scenario creation process: Medford

Medford is a distributor of pharmaceuticals and medical supplies in the U.S. A scenario planning exercise was conducted with the pharmaceutical distribution business of the firm in 2010-11. Medford was (and still is) operating in a highly complex business environment shaped by a variety of driving forces, with the future of many being highly uncertain over the five year planning horizon of the study. For instance, the U.S. economy was weak and its recovery was hard to predict. The nature of the regulatory environment in the U.S. healthcare sector was uncertain: the Patient Protection and Affordable Care Act had been challenged in courts, it was not clear if most U.S. states would enact pedigree regulations and if they would be different from the two state regulations already slated to come in effect (Florida and California). The nature of pharmaceuticals was changing: the proportion of branded drugs was certain to reduce, and the growth in biologic drugs was uncertain. All these driving forces would shape the local factors in Medford’s environment depending on how they evolved, and the supply chain assets needed for different environments could be different. For this reason, Medford decided to use scenario planning to gain some clarity over how the firm should think about its supply chain strategy.

4.2.1 Step 1: Define scope of the scenario planning project

The scope of the project was defined with the Senior Vice President of Medford’s pharmaceutical distribution supply chain, who sponsored the project, in a face to face meeting with the first and the third authors of the paper. The scope of the project was limited to on the pharmaceutical distribution
business of the firm in the U.S. The focal question for the scenario planning project was: *what supply chain strategy should Medford adopt for pharmaceutical distribution to support the business over next five years.* The project sponsor identified a diverse group of 25 mid- and senior-level managers to participate in the project. These managers came from 11 different functions (including Operations, Inventory Management, Strategic Planning, Account Management, Procurement, Information Technology, Human Resources, Health Environment & Safety, etc.) and from four hierarchical levels (mostly Vice Presidents) in Medford. In summary, five variables related to the scenario projects were specified:

- **Focal decision:** Supply chain strategy
- **Business and market to focus:** Pharmaceutical distribution in the United States
- **Functional areas to include:** 11 functions (Operations, Procurement, Transportation, Account Management, IT, Quality/Regulatory, Strategic Planning, Human Resources, etc.)
- **Planning horizon:** Five years
- **Project team members:** 25 mid- and senior-level managers from 11 functional areas

### 4.2.2 Step 2: Identify key factors in the local environment

Local factors were identified using qualitative interviews with the 25 project team members. All interviews were conducted by the first author over phone and recorded with explicit consent of each respondent. Each team member was informed of the nature of the interview one day in advance. To identify relevant environmental elements, each team member was asked to “describe the business environment in which Medford would operate five years into the future”. The interviewer listened to the conversation carefully, noted down all the “markers” [55] in the information provided by the respondent. The interviewer asked follow-on questions using the markers; no probes were used. The interview continued until the respondent mentioned that s/he had nothing more to add. On average interviews lasted for one hour. Qualitative coding [64, 65] of the recorded interviews, also
conducted by the first author, yielded 55 features of the business environment. Of these, 37 were identified as local factors; the remaining 18 described aspects of different driving forces.

4.2.3 Step 3: Identify and assess driving forces

Driving forces were gathered through interviews with the project team members (internal source) as described above, and IBISWorld industry research databases [66] and additional desk research (external source), also conducted by the first author. In 2010, IBISWorld published reports for 681 industries classified by 5-digit North American Industry Classification System (NAICS) codes. 15 of these industries were deemed relevant to the pharmaceutical distribution supply chain. They included branded and generic pharmaceutical manufacturing (NAICS: 32541a, b), drug wholesaling (42221), pharmacies and drug stores (44611), life and health insurance (52411a, b), health & welfare funds (52512), primary care and specialist doctors (62111a, b), home care providers (62161), general and specialty hospitals (62211, 62231), nursing care facilities (62311), retirement communities (62331) and biotechnology (NN001).

Each IBISWorld industry report lists the Key External Drivers for the industry. The key external drivers from 15 industries were compiled to produce a list of 47 unique drivers. Coincidently, the interviews with the project team members also yielded 47 different aspects of driving forces. While the exact number of drivers from each source is not important, the numbers show that both sources were equally important in identifying drivers. The key drivers from the IBISWorld reports and those provided by the project team members were compiled into a single database. Similar drivers were grouped together and identified as aspects of a larger driving force. The grouping was first performed by the first and the third author, and then reviewed by the project team. In all, this exercise produced a list of 16 unique driving forces that shape Medford’s external environment. Using the IBISWorld predictions of various drivers grouped under one driving force and from interviews with the Medford team members, each driving force was judged to be either a
trend (predictable over 5-year planning horizon) or an uncertainty (not predictable over the planning horizon). This divided 16 driving forces into 14 uncertainties and 2 trends (presented in Table 2).

4.2.4 Step 4: Rank by importance and uncertainty

First, impact of local factors on the focal decision was evaluated using a questionnaire, where each item was described as taking a particular value (e.g. “Customers will choose distributor based only on price”, “Pharmacies will bypass distributors and buy directly from manufacturers”, etc.). The team members rated the impact of each on a 5-point scale. 20 team members completed the paper-based questionnaires at a workshop; five members joined remotely via telephone and completed the questionnaires using an online survey tool. However, some of the team members working remotely did not hear instructions for completing the survey due to connection difficulties in the conference. Therefore, all five remotely completed questionnaires were omitted from the analysis.

A similar approach was taken to evaluate the uncertainty of each driving force. The team members assessed the uncertainty of each key local factor, which was then extrapolated to the driving force. Team members evaluated the impact of each local factor before evaluating its uncertainty. The questionnaire evaluations provide two types of uncertainty regarding the future state of a local factor: uncertainty perceived by an individual respondent and expressed in his/her evaluation, and uncertainty within the group as expressed in the spread of evaluations. A metric that combined both these uncertainties into one, coefficient of variation (COV), was used.

The purpose of computing the impact and uncertainty of local factors is to transfer those values to driving forces by establishing a relationship between driving forces and local factors. To reduce the workload on the project team members, the subsequent analysis was conducted using a subset of local factors that had the most impact on the focal decision and were most uncertain over
the five-year planning horizon. Fig. 3 shows the impact and uncertainty values of all factors surveyed. 13 of these factors (enclosed in the circle in the figure) stand out as being most impactful as well as most uncertain. These are the key local factors affecting Medford’s supply chain strategy.

Strength of the relationship between key local factors and driving forces was evaluated by Medford project team members by answering a series of questions, with “Yes” or “No” answers, of form: “Does driving force DF affect key local factor KLF?” To prevent the biases of individual members from affecting the matches, more than one team member was asked to answer the above question for every driving force – key local factor (DF-KLF) pair. Having each team member evaluate every DF-KLF pair would have meant completing 182 evaluations (14 driving forces x 13 key local factors) by each person. To minimize the demand on these executives’ time, we assigned six randomly chosen driving forces to each team member, who then evaluated their relationship with all 13 key local factors. Thus, each member answered the above question 78 times (6 driving forces x 13 key local factors). As a result, each of the 14 driving forces was evaluated, for its relationship with the 13 key local factors, by at least five and up to eight members of the project team. The strength of each DF-KLF relationship is the proportion of members evaluating the relationship who judged the driving force to affect the factor.

Table 3 presents the result of this analysis. The first two columns list the 14 uncertain driving forces and the number of respondents evaluating their relationship with key local factors. The factors are listed in the top row in the next 13 columns; impact and uncertainty of each is listed in the two rows below. The value (in range [0, 1]) in a cell shows the strength of the relationship between the driving force and key local factor in the corresponding row and column, respectively. The impact (uncertainty) of each driving forces is calculated by adding the products of the strength
of its relationship with each key local factors and the impact (uncertainty) of the latter. The last two columns show the impact and uncertainty of each driving force.

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INSERT TABLE 3 ABOUT HERE

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4.2.5 **Step 5: Select scenario logic**

Instead of blindly choosing the two most impactful and uncertain forces, five uncertainties with the most impact were short-listed, and different pair combinations were evaluated as potential scenario logics. In each case, team members gave a brief description of the four scenarios created by taking combinations of high and low values of the two scenario axes. The project team considered four such pairs and decided that the following two driving forces had the best potential to generate four scenarios that were most different from each other and could provide interesting insights:

- Complexity of U.S. healthcare supply chain
- Health of the overall U.S. economy.

The combinations of the high and low values of these drivers provide four scenario seeds.

4.2.6 **Step 6: Flesh out the scenarios**

Of Medford’s 16 driving forces, two were classified as trends and 14 as uncertainties over the planning horizon of the scenario study. Each trend takes the same value in each of the four scenarios. For each uncertain driving force, two plausible extreme values are specified, with each value being assigned to the force in at least one scenario. Initially, the two extreme values are defined only broadly and qualitatively, and elaborated when writing scenarios. Based on the industry research, the high and low values for each uncertainty and the two trends were specified as shown in Table 4.

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INSERT TABLE 4 ABOUT HERE

(30)
This scenario structure specifies the values of only two driving forces in each scenario. Next, values of the remaining driving forces are described in each scenario. Two additional criteria were used when prescribing the values taken by each uncertain driving force in every scenario: internal consistency and variation among highly-correlated driving force pairs:

- **Internal consistency**: High or low value of each uncertain driving force was assigned to each scenario by judging which value would be consistent with the already specified driving forces in the scenario. After values of all driving forces were specified in each scenario, the complete structure was validated by the Medford project team members for internal consistency to correct any judgmental errors in the initial assignment.

- **Variation among highly-correlated driving force pairs**: This criterion, not specified in the scenario planning literature, was deliberately used to generate cross-scenario variation in highly-correlated driving forces. For such pairs of driving forces, an attempt was made to assign each of the four high-low value combinations to one of the four scenarios. Pearson’s correlation was calculated for every pair of driving forces using the strength of association between a driving force and the vector of local factors (values shown in Table 5).

Starting with the highest correlation (0.92, between “Consolidation within healthcare sector” and “Cost pressure in the healthcare sector”), each of the four combinations of the correlated pairs – (high, high), (high low), (low, high), (low low) – was assigned to one of the four scenarios, while maintaining internal consistency of the scenarios. It was possible to create all four combinations of the six pairs of highly-correlated driving forces: DF5 and DF6 (correlation=0.92), DF3 and DF14 (0.71), DF3 and DF9 (0.67), DF8 and DF9 (0.63), DF1 and DF6 (0.61), and DF12 and DF14 (0.58).
It was not always possible to create such combinations for highly-correlated driving forces because of the violation of internal consistency, such as in case of DF5 and DF7 (0.70), DF4 and DF12 (0.69), DF10 and DF12 (0.68), and DF13 and DF14 (0.60).

The initial scenario structure developed using this procedure above was validated by the project team members. The team members were asked to check the scenario structure for two types of issues: implausibility of values taken by driving forces and violation of internal consistency within a scenario. The project team identified issues in all four scenarios. In some instances, information from industry research was available to argue in favor of the initial scenario structure, despite the team’s objection(s). In those cases, the team was informed how the proposed scenario structure could come about, using the factual information obtained from industry research. In all such cases, the team members agreed with the plausibility and/or internal consistency of the scenario structure upon seeing this additional information. If no information from industry research existed to resolve the conflict, necessary changes were made to the scenario structure as recommended by the team. Table 6 shows the final scenario structure. The cells with bold text are the ones where the team had asked to change the value in the initial structure, but later agreed to keep the original value based on the additional information. The cells with bold and italicized text are where the value of the driving force was changed per the team’s recommendation. The remaining cells are the ones whose value was not disputed.

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 INSERT TABLE 6 ABOUT HERE
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Updating the scenario structure based on the project team’s feedback had two notable effects. One, some of the deliberate variations in four out of six pairs of highly correlated driving forces created across the four scenarios were lost. In the final scenario structure, the pair DF3-DF14 had only two variations across the four scenarios; three other pairs—DF3-DF9, DF8-DF9, and DF12-DF14—was
left with three out of four possible variations across the four scenarios. Two, the driving force “Overall focus on drug security and safety” (DF11) changed from being an uncertainty to a trend, as all four teams strongly argued that over the five-year planning horizon, the “Overall focus on drug security and safety” in the socio-political environment could be only “High”.

After finalizing the scenario structure, scenario stories were written. For this, additional industry research was conducted. This research, however, was different from the one conducted at the beginning of the project. This research sought to find specific examples to argue how a driving force can take a specific value in each scenario. This was done to improve plausibility of the scenarios (per Axiom 9). Since each uncertain driving force takes two extreme values, it is necessary to find evidence to support how the driving force could evolve, from its present state, in either direction. For example, driving force “Climate-sensitivity of drugs and treatments” (DF3) takes value “temperature-sensitive drugs” in scenarios 2 and 3; and value “temperature-insensitive drugs” in scenarios 1 and 4. Given below is an example how “climate-sensitivity of drugs and treatments” in year 2016 was described in the scenarios:

Description in scenarios 2 and 3:

“Combined with advances in the related fields, such as genetics and computational biology, biotechnology has produced a vast array of biopharmaceuticals that target the underlying causes—not mere symptoms—of many serious diseases. The fruits of mapping of the human genome have begun paying off in the form of gene therapy products. These biologic products contain living organisms and need to be maintained in controlled climate from the time they are manufactured toll they are introduced into a patient’s body.”

Description in scenarios 1 and 4:

“While many biopharmaceuticals require cold chain transportation, not all do. In fact, a significant proportion of biopharmaceuticals can now be delivered without refrigerated transportation. The supply chain innovations—such as sugar drying technology developed at
Nova Bio-Pharma and University of Oxford, for delivering vaccines in tropical African nations that lack a reliable cold chain network—have made their way into the biologic supply chains in the U.S. Biotech companies continue to spend research dollars on making their products amenable to sugar-drying storage and distribution. Because of this, a very small fraction of the volume of drugs delivered needs cold chain transportation.”

Lastly, each scenario was assigned a vivid name that represented its essence [21]: Frenzy (Scenario 1), Innovo-Nation (Scenario 2), Hiber-Nation (Scenario 3), and Zen (Scenario 4).

The scenario planning engagement between Medford and the research team began in June 2010 and ended in September 2011. It took about eleven months from the start of the project until the scenarios were finalized. While this may seem excessively long, note that Medford and the research team were engaged in a collaborative research project, where learning through the process was just as important—if not more—as developing the scenarios. The project team had remained engaged with the researchers during the entire scenario-creation process. One member of the project team (a Vice President of Operations) gave the following feedback voluntarily: “for me personally and my own professional development I found the experience challenging yet rewarding. The times we as a team engaged and shared our thoughts openly was the most rewarding...learned new things, stretched the brain cells and found where at times my thoughts may be ‘out there’ that others were feeling the same thing”.

5 Discussion

This paper seeks to fill the well-known void of a theoretical foundation to the process of scenario development. It attempts to do so by defining the terms commonly used in the scenario literature, providing a set of axioms to guide scenario creation, and deriving a systematic process from those axioms and demonstrating its application. Below, we summarize how this approach compares to
some of the notable theorizing attempts in the scenario literature, identify our main contributions, highlight the limitations, and suggest some avenues for future research.

5.1 Comparison to the existing theorizing attempts

Chermack [26] made one of the first attempts at theorizing scenario planning, which he described as “preliminary in nature”. Our framework differs from Chermack’s in that we focus only on scenario development but provides a more nuanced set of axioms to guide the scenario creation process. The depth of theoretical basis also sets our framework apart from Saypong’s [29]. MacKay and Tambeau [27] used the structuration theory as a theoretical basis for developing scenarios. The roles of agency and structure—i.e. the ability and inability to influence a social system, respectively—from this theory are captured in our use of ability to influence conditions in the environment. However, our framework explicitly recognizes the bounded rationality of scenario creators and does not rely on the representative agents’ ability to correctly predict the consequences of their actions, which, according to the authors, are often unintended. The explicit treatment of bounded rationality in our axioms also sets our model apart from Burt’s [31] by stating which agents are likely to be more knowledgeable about different parts of the organizational environment being presented in the future scenarios.

5.2 Contributions

This research makes at least three contributions to the scholarly literature on scenario creation. The first contribution is the axiomatic foundation for developing scenarios. This serves two purposes. On one hand, it helps one discern an appropriate way to develop scenarios; on the other hand, it makes the “practitioner’s art” [21] open to scholarly critique—and improvement—by making the underlying assumptions explicit [67] and thus improving the methodological credibility of the process [19]. Systematic approaches have been developed to improve other business processes considered art, such as design [68, 69], creativity [56, 70], process improvement [71], etc. We
believe that scenario development would benefit from such an approach as well. The second contribution is the detailed scenario development process, which makes the generic Intuitive Logics School process operational. As articulated by Harries [72, p.800], “verification that a method or technique has been implemented is clearly a prerequisite to its validation or evaluation, especially when other nominally similar methods exist, as they do in scenario planning.” The third contribution is the precise definitions of terms used in the scenario creation process. This allays the challenge of working with “different and at times conflicting definitions” of the terms [2].

In addition, this research also has a few practical benefits. First, the scenario development process shows how to systematically combine the knowledge of organizational members with the expertise outside the organization, by leveraging the strengths of each, to develop a set of scenarios customized for a specific long-range decision. Second, the process requires the project team members to make explicit connections between the driving forces and the local factors. This step forces the participants to explore how macro-level environmental forces—which may get left out of scope of a quantitative planning process due to their unwieldy nature—can change the micro-level environmental factors that are easier to define in a quantitative model. The participants in several of our scenario workshops have mentioned that the discussions within the team about the nature of relationship between different pairs of driving forces and key local factors were enlightening. While our claim is rather anecdotal, several researches have noted the benefits of participating in the scenario development process [1, 9, 21, 73]. Scenario practitioners have also noted that “as scenario planning becomes more widely used [routinizing it using...] the right structured process can certainly help teams to extend their capabilities” [5, p.191].

5.3 Limitations

The scenario creation process presented here is not without limitations. The biggest limitation is the flip-side of its strength: a step-by-step guide for creating scenarios. Given such a systematic
process, it is easy to get into an “auto-pilot” mode and go through the motions of completing various process steps without fully engaging in the process. Users of these processes need to guard against this tendency. In the Medford example, we allowed the project team members to alter the scenarios (in Step 6) developed using the process to make the scenarios more plausible in their minds. This eliminated some of the deliberately generated variations in the pairs of highly correlated driving forces. We believe that scenario users should have the final say in the scenario structure, after letting the process run its full course. However, we do not have concrete suggestions for when the process should be allowed to be superseded by user input.

A second limitation is the use of quantitative tools. Managers and planners love numbers; converting an amorphous continuum of qualitative data into a number simplifies analysis. There is a danger of losing sight of the larger picture by focusing on the numbers alone. The quantitative methods used in the process here should be used only to focus the discussion. For instance, quantitative values of driving force impact should be used to separate the most impactful driving forces from the least impactful ones, but not to outright discard a driving force from consideration as a scenario axis because its impact is a fraction lower than the next most impactful driving force.

Thirdly, the quality of the data – both qualitative and quantitative information about environment, analyses, insights, etc. – generated and captured in this process is a function of the people participating in the process as well as the group dynamics. If the scenario-creation process does not involve a diverse team, the process by itself is less likely to develop a diverse set of scenarios. Additionally, diversity of the input from individuals could be lost if the group suffers from concurrence-seeking tendencies like groupthink [74]. Selecting individuals from diverse perspectives and not quashing the diversity of opinion are important for the success of the scenario project.

Finally, the approach presented in this work is geared towards developing firm-specific (i.e., corporate) scenarios, and does not seek to address the challenges faced in policy-oriented foresight
highlighted by van Asselt, et al. [16, pp. 50-56]. A set of axioms or guiding principles for policy foresight would be a useful complement to this work.

5.4 Opportunities for future research

In addition to the above, many opportunities for further research lie in the area of scenario creation. The foremost that became evident in this research was the need to compare different scenario creation methods. Such a comparison can determine the relative merits of different scenario creation processes. One may compare two sets of scenarios, created using two different approaches, to evaluate if one approach is superior to the other in terms of the quantity and/or quality of insights produced. Such results can inform the literature that empirically examines the cognitive effects of using scenarios [12,76,77]. One may also compare the output of various steps in the process by judging the quantity and/or quality of output (e.g. local factors identified, driving force-local factor associations made, etc.). Future research may perform empirical tests of the different scenario creation methods. Anecdotal evidence suggests that participation in the scenario creation process itself has benefits. One may test how participating in different steps of the scenario creation process (such as mapping driving forces to local factors) influences the participants’ understanding of their organization’s business environment and whether it makes the participants more sensitive to small changes (i.e. weak signals) in the environment. Finally, this paper presents a structured approach for creating scenarios in the Intuitive Logics tradition. However, it is not necessary to restrict ourselves to this school. By gaining better understanding of the process, one could engineer new processes for creating scenarios. Presenting those processes in an objective, replicable manner can make them amenable to comparison against other scenario-creation processes.
6 Conclusion

Scenario development has been described as a “practitioner’s art” [23]. The absence of a theoretical foundation [67] has led to a proliferation of scenario creation methods, with no easy way of critiquing or comparing them. This has been noted as one of the limitations of the scenario planning literature by the field’s leading scholars [20, 75]. The present paper takes a step in addressing this limitation. We provide a theoretical basis for developing scenarios in the form of a set of axioms, apply it to create a structured process for developing scenarios, and illustrate the process by applying it to create four scenarios for a U.S. pharmaceutical distributor. We hope that the explicit statement of axioms and the structured process presented in this work not only benefit the practice of scenario creation, but also contribute to theoretical advancement through their scholarly critique.

7 References


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Can the organization *control* the element?

Yes

No

Can the organization *influence* the element?

Yes

No

Element of Focal Decision

Local Factor

Driving Force

Is value over planning horizon *predictable*?

Yes

Trend

No

Uncertainty

Figure 1: Terms used in the scenario development process
Figure 2: Variables in scenario creation process
Figure 3: Impact and uncertainty of local factors
### Scenario Development Process Step

<table>
<thead>
<tr>
<th>Scenario Development Process Step</th>
<th>Data Source</th>
<th>Data Collection Method</th>
<th>Expected Output</th>
<th>Relevant Axioms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Define scope of the scenario planning project</td>
<td>Leader of the organization</td>
<td>Discussion</td>
<td>Statement of focal decision</td>
<td>1</td>
</tr>
<tr>
<td>2 Identify key factors in the local environment</td>
<td>Team members</td>
<td>Interview, Brainstorming</td>
<td>List of local factors</td>
<td>3</td>
</tr>
<tr>
<td>3 Identify and assess driving forces</td>
<td>External experts and team members</td>
<td>Industry research</td>
<td>List of driving forces</td>
<td>4</td>
</tr>
<tr>
<td>4 Rank by importance and uncertainty</td>
<td>Team members</td>
<td>Questionnaire</td>
<td>Impact of each local factor on focal decision</td>
<td>5, 6</td>
</tr>
<tr>
<td>5 Select scenario logic</td>
<td>Team members</td>
<td>Discussion</td>
<td>Scenario seeds</td>
<td>8</td>
</tr>
<tr>
<td>6 Flesh out the scenarios</td>
<td>Team members</td>
<td>-</td>
<td>Validated scenario structures</td>
<td>8, 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Narratives for each scenario</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scenario names</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1: Guidelines for developing structured scenario development process**
Driving forces in Medford’s environment | Number of drivers by source
---|---|---
| | IBISWorld | Medford | Total |
**UNCERTAINTIES**
• Availability of healthcare workers | 5 | 1 | 6 |
• Availability of information and technology solutions for healthcare management | 3 | 2 | 5 |
• Climate-sensitivity of drugs and treatments | 1 | 2 | 2 |
• Complexity of US healthcare supply chain | 0 | 6 | 6 |
• Consolidation within healthcare sector | 6 | 4 | 7 |
• Cost pressure in the healthcare sector | 4 | 5 | 8 |
• Health of the overall U.S. economy | 7 | 1 | 8 |
• Health-consciousness of average citizen | 3 | 4 | 6 |
• Location where majority of healthcare is provided | 1 | 1 | 2 |
• Nature of reimbursement policies | 0 | 4 | 4 |
• Overall focus on drug security and safety | 0 | 1 | 1 |
• Participation of government in the healthcare sector | 4 | 4 | 7 |
• Proportion of generic drugs in the drugs consumed | 6 | 6 | 9 |
• Volume of drugs sold in the US | 1 | 3 | 4 |
**TRENDS**
• Average age of the US population | 6 | 1 | 6 |
• Environmental consciousness of the society | 0 | 1 | 1 |

Table 2: Driving forces in Medford’s environment and underlying drivers
<table>
<thead>
<tr>
<th>Driving Forces (DF)</th>
<th>Number of DF-KLF evaluations</th>
<th>Key Local Factors (KLF)</th>
<th>Impact of driving force</th>
<th>Uncertainty of driving force</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Availability of talent</td>
<td>Competition among the Big-3 Distributors</td>
<td>Customers Logistics expectations</td>
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<tr>
<td>Absolute impact of key local factor</td>
<td>1.26</td>
<td>1.55</td>
<td>1.65</td>
<td>1.32</td>
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<td>COV of uncertainty of key local factor</td>
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<td>0.95</td>
<td>1.64</td>
<td>1.08</td>
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<td>0.86</td>
<td>0.29</td>
<td>0.57</td>
</tr>
<tr>
<td>DF2: Availability of IT solutions for healthcare management</td>
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<td>0.43</td>
<td>0.86</td>
<td>0.43</td>
</tr>
<tr>
<td>DF3: Climate-sensitivity of drugs and treatments</td>
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<td>0.00</td>
<td>0.88</td>
<td>0.38</td>
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<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td>DF5: Consolidation within healthcare sector</td>
<td>7</td>
<td>1.00</td>
<td>1.00</td>
<td>0.71</td>
</tr>
<tr>
<td>DF6: Cost pressure in the healthcare sector</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>DF7: Health of the overall U.S. economy</td>
<td>8</td>
<td>1.00</td>
<td>1.00</td>
<td>0.63</td>
</tr>
<tr>
<td>DF8: Health-consciousness of average citizen</td>
<td>7</td>
<td>0.00</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>DF9: Location where majority of healthcare is provided</td>
<td>7</td>
<td>0.43</td>
<td>0.71</td>
<td>0.29</td>
</tr>
<tr>
<td>DF10: Nature of reimbursement policies</td>
<td>6</td>
<td>0.50</td>
<td>0.83</td>
<td>0.33</td>
</tr>
<tr>
<td>DF11: Overall focus on drug security and safety</td>
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<td>0.00</td>
<td>0.57</td>
<td>0.14</td>
</tr>
<tr>
<td>DF12: Participation of government in the healthcare sector</td>
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<td>0.43</td>
<td>1.00</td>
<td>0.57</td>
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<tr>
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<td>0.17</td>
<td>1.00</td>
<td>0.67</td>
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<tr>
<td>DF14: Volume of drugs sold in the US</td>
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<td>0.14</td>
<td>1.00</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Table 3: Analysis of driving forces: Strength of relationship with key local factors, impact, and uncertainty
<table>
<thead>
<tr>
<th>Driving force</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNCERTAINTIES CHOSEN AS SCENARIO AXES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity of US healthcare supply chain</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Health of the overall U.S. economy</td>
<td>Stronger</td>
<td>Weaker</td>
</tr>
<tr>
<td><strong>OTHER UNCERTAINTIES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of healthcare workers</td>
<td>Abundant</td>
<td>Scarce</td>
</tr>
<tr>
<td>Availability of information for managing healthcare</td>
<td>Abundant</td>
<td>Not much different than today</td>
</tr>
<tr>
<td>Climate-sensitivity of drugs and treatments</td>
<td>Temperature-sensitive drugs</td>
<td>Temperature-insensitive drugs</td>
</tr>
<tr>
<td>Consolidation within healthcare sector</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Cost pressure in the healthcare sector</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Health-consciousness of average citizen</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Number of locations where majority of healthcare is provided</td>
<td>Much higher than today</td>
<td>Lower or about the same as today</td>
</tr>
<tr>
<td>Nature of reimbursement policies</td>
<td>Outcome focused</td>
<td>Treatment focused</td>
</tr>
<tr>
<td>Overall focus on drug security and safety</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Participation of government in the healthcare sector</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Proportion of generic drugs in the drugs consumed</td>
<td>Much higher than today</td>
<td>Not much different than today</td>
</tr>
<tr>
<td>Volume of drugs sold in the US</td>
<td>Much higher than today</td>
<td>Not much different than today</td>
</tr>
<tr>
<td><strong>TRENDS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average age of U.S. population</td>
<td>Higher than today</td>
<td>Higher than today</td>
</tr>
<tr>
<td>Environmental consciousness of the society in the U.S.</td>
<td>Higher than today</td>
<td>Higher than today</td>
</tr>
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</table>

Table 4: High and low values of uncertainties in Medford’s environment
<table>
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<tr>
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<th>DF1</th>
<th>DF2</th>
<th>DF3</th>
<th>DF4</th>
<th>DF5</th>
<th>DF6</th>
<th>DF7</th>
<th>DF8</th>
<th>DF9</th>
<th>DF10</th>
<th>DF11</th>
<th>DF12</th>
<th>DF13</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF1 Availability of healthcare workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF2 Availability of IT solutions for healthcare management</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF3 Climate-sensitivity of drugs and treatments</td>
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<td></td>
<td></td>
<td>-0.03</td>
<td>-0.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DF4 Complexity of US healthcare supply chain</td>
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<td>0.16</td>
<td>0.32</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF5 Consolidation within healthcare sector</td>
<td>0.57</td>
<td>0.10</td>
<td>0.29</td>
<td>0.37</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DF6 Cost pressure in the healthcare sector</td>
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<td>0.92</td>
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<tr>
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<td>0.41</td>
<td>-0.06</td>
<td>0.04</td>
<td>0.70</td>
<td>0.51</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DF8 Health-consciousness of average citizen</td>
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<td>-0.52</td>
<td>0.22</td>
<td>-0.13</td>
<td>-0.34</td>
<td>-0.25</td>
<td>-0.56</td>
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<tr>
<td>DF9 Location where majority of healthcare is provided</td>
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<td>0.67</td>
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<td>0.30</td>
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<td>0.63</td>
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<tr>
<td>DF10 Nature of reimbursement policies</td>
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<td>0.43</td>
<td>0.41</td>
<td>0.43</td>
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<td>0.39</td>
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<tr>
<td>DF11 Overall focus on drug security and safety</td>
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<td>-0.57</td>
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<td>-0.05</td>
<td>-0.15</td>
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<td>0.08</td>
<td>0.44</td>
<td>0.69</td>
<td>0.22</td>
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<td>0.32</td>
<td>0.68</td>
<td>-0.01</td>
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<td>DF13 Proportion of generic drugs in drugs consumed</td>
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<td>0.52</td>
<td>0.27</td>
<td>0.27</td>
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<td>-0.12</td>
<td>0.52</td>
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<td>0.28</td>
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<td>0.51</td>
<td>0.40</td>
<td>0.58</td>
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</table>

Table 5: Correlations between driving forces
<table>
<thead>
<tr>
<th>Driving forces</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
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<td>SCENARIO LOGIC (UNCERTAINTIES)</td>
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<td></td>
</tr>
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<td>DF4: Complexity of US healthcare supply chain</td>
<td>High</td>
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<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>DF7: Health of the overall U.S. economy</td>
<td>Weaker</td>
<td>Stronger</td>
<td>Weaker</td>
<td>Stronger</td>
</tr>
<tr>
<td>OTHER UNCERTAINTIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF1: Availability of healthcare workers</td>
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<td>Scarc</td>
<td>Abundant</td>
<td>Scarc</td>
</tr>
<tr>
<td>DF2: Availability of information for managing healthcare</td>
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<td><strong>Not much different than today</strong></td>
<td>Abundant</td>
<td>Abundant</td>
</tr>
<tr>
<td>DF3: Climate-sensitivity of drugs and treatments</td>
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<td>Temperature-sensitive drugs</td>
<td>Temperature-sensitive drugs</td>
<td>Temperature-insensitive drugs</td>
</tr>
<tr>
<td>DF5: Consolidation within healthcare sector</td>
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<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>DF6: Cost pressure in the healthcare sector</td>
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<td>High</td>
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<td>Low</td>
</tr>
<tr>
<td>DF8: Health-consciousness of average citizen</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>DF9: Number of locations where majority of healthcare is provided</td>
<td>Much higher than today</td>
<td><strong>Much higher than today</strong></td>
<td>Lower or about the same as today</td>
<td>Much higher than today</td>
</tr>
<tr>
<td>DF10: Nature of reimbursement policies</td>
<td>Outcome focused</td>
<td>Outcome focused</td>
<td>Treatment focused</td>
<td>Treatment focused</td>
</tr>
<tr>
<td>DF11: Overall focus on drug security and safety</td>
<td>High</td>
<td>High</td>
<td><strong>High</strong></td>
<td><strong>High</strong></td>
</tr>
<tr>
<td>DF12: Participation of government in the healthcare sector</td>
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<td>High</td>
<td><strong>High</strong></td>
<td>Low</td>
</tr>
<tr>
<td>DF13: Proportion of generic drugs in the volume of drugs consumed</td>
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<td>Much higher than today</td>
<td>Much higher than today</td>
<td>Not much different than today</td>
</tr>
<tr>
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<td>Much higher than today</td>
<td>Much higher than today</td>
<td>Not much different than today</td>
</tr>
<tr>
<td>TRENDS</td>
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<td></td>
</tr>
<tr>
<td>DF15: Average age of U.S. population</td>
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<td>higher than today</td>
<td>higher than today</td>
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<tr>
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<td>higher than today</td>
<td>higher than today</td>
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</tr>
</tbody>
</table>

Table 6: Final structure of Medford scenarios