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Key Quality Attributes for Computational and Sustainable Higher Education Strategy Implementation in Saudi Arabia

Saleh Alkhodhair [1], Ahmed Alsanad [1,*], Khaled Alghathbar [2] and Abdu Gumaei [1,*]

[1] Research Chair of Artificial Intelligence (RCAI), Department of Information Systems, College of Computer and Information Sciences, King Saud University, Riyadh 11543, Saudi Arabia; 434107522@student.ksu.edu.sa

[2] Information Systems Department, College of Computer and Information Sciences, King Saud University, Riyadh 11543, Saudi Arabia; kalghathbar@ksu.edu.sa

* Correspondence: aasanad@ksu.edu.sa (A.A.); abdugumaei@gmail.com (A.G.)

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Abstract: Higher education institutions (HEIs) in many developed and developing countries are facing big challenges in terms of quality in the face of growing global demand. Ensuring quality education is necessary to secure future prosperity and promote sustainable development. Hence; to ensure the success and sustainability of higher strategy; it is necessary for HEIs to improve the quality of strategy implementation processes and address the dynamic complexities of their attributes to identify areas for improvement. However; there are obvious issues associated with strategy implementation related to process modeling; automation; dynamic complexity; and cognitive limitations. This research is a step toward bridging the gap in adopting computational models in the higher education strategy implementation process to foster its automation and promote its sustainability. The aim of this research is to study the phenomenon of computational strategy implementation in the higher education domain using grounded theory to understand the criteria and quality attributes of the strategy implementation process and to generate a descriptive and explanatory model for strategy quality attributes (SQAs) of higher education; which entails the implementation of automated technology and computational models for more effective and sustainable strategy.

Keywords: sustainable strategy; higher education; grounded theory; information systems; strategic management

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1. Introduction

Within the current global economy, there have been major changes, making the world less sustainable and less secure [1]. Therefore, governments need to embark on sustainable development in major areas (such as education, healthcare, economy, social services, industrial sectors, national security, etc.) and undertake strategies that focus on building three forms of capital: human, physical, and natural [2]. Education is deemed to be the key enabler of a knowledge-based economy [3] and has become an "industry" that focuses on investing in human capital [4] with the support of information and communication technology to develop knowledgeable societies, promote sustainable development, and achieve economic growth [5,6].

In 2015, the global community adopted the 2030 Sustainable Development Goals (SDGs) [6]. It is a vision consist of 17 goals and 169 target to achieve a better and more sustainable future and to address the global challenges related to poverty, inequality, climate change, environmental degradation, peace and justice. The fourth goal of SDGs is "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all " including higher education to achieve the vision 2030 through

Education for Sustainable Development (ESD) [6]. Higher education is considered as a key player in the promotion of sustainable development [7]. It is seen as the core and final result of education around which the whole education system revolves [8]. Statistics from the Organization for Economic Co-operation and Development (OECD) show a remarkable increase in the rates of people entering the higher education system in all countries [9,10]. However, higher education institutions (HEIs) are facing big challenges in terms of quality in the face of growing global demand [8,11]. Ensuring quality education is necessary to secure future prosperity and promote sustainable development, as it has a significant contribution to many other sustainable goals [12].

In 2016, Saudi Arabia embarked on Vision 2030 as a sustainable development strategy to achieve economic diversity, secure future prosperity, and reduce reliance on oil [13]. In this vision, human capital is deemed to be the key enabler of sustainable development, and it makes efforts to expand the capabilities of future human capital and improve the quality of education and staff training [13]. For the last 10 years, Saudi Arabia has spent on average $53 billion annually for the development of the education sector [14]. In 2017, higher education in Saudi Arabia ranked 43rd on a global competitive index [5], and the statistics show that only 75% of adults with tertiary education were employed, compared to the OECD average of 83% [10]. In addition, an inadequately educated workforce becomes one of the most problematic factors in doing business [5]. Consequently, there have been repeated calls addressing the need to advance the quality of higher education in Saudi Arabia and align it with economic and labor market needs [5,15–18].

The strategic plan for higher education in Saudi Arabia has set the goal of aligning higher education outcomes with the labor market as one of the most important goals [13]. In this new strategy, HEIs play diversified roles to help different sectors, and are expected to engage locally and globally [13]. The recent statistics show a significant increase in the level of higher education [18], and indicate an expected increase in the attainment rate of higher education [9]. However, implementing a sustainable higher education strategy requires paying more attention to some major paradigm shifts that have taken place in the higher education domain, as well as in planning techniques and approaches [8]. Hence, it is important to understand the challenges facing the implementation of higher education strategy in terms of quality and sustainability. The decisions about implementing strategies that influence higher education, if they are based on inadequate information, could affect its sustainability. There is a growing need for additional strategies and management tools to address such challenges [19]. This research is a step toward more effective application of computational models and information system capabilities in higher education strategy implementation through a critical analysis of the quality attributes of the implementation process to promote its automation. Successful implementation of higher education strategy is significant in building human capital and a knowledge-based economy to promote sustainable development in Saudi Arabia. This research bridge the gap in adopting automation technology and computational models in strategy implementation and provide a blueprint for Information system and strategic researcher that help to identify a potential areas where adopting automation technology and computational models can have a significant contribution to strategy implementation of higher education in both academic and practical domain.

2. Background

Although strategy formulation is a critical and difficult task, implementing the formulated strategy is even more challenging and has many obstacles [20]. There are obvious issues associated with strategy implementation related to the process modeling approach, dynamic complexity, and cognitive limitations. However, it is clear from the available literature that little attention has been given to the field of strategy implementation [21,22].

Higher education institutes are surrounded by dynamic and changing environments, which requires continually reviewing their strategy and constantly accumulating, integrating, and updating their knowledge resource capabilities to achieve strategy objectives [23–26]. The cause of this issue may be rooted in the nature of the strategy implementation process, a series of actions and reactions over time [27] in a dynamic environment, which requires aligning and adapting the performance for the short term and long term [24]. The strategy needs timely responses to continuous changes in the lack of knowledge about the environment, which features complexity and uncertainty along with cognitive limitations of decision-makers [28]. Considering the complex and dynamic environment along with the cognitive limitations of strategists mentioned in bounded rationality [29] and misperceiving the interdependencies among multiple factors within the dynamic environment and multiloop feedback [30–33] will cause execution gaps and deviation from the intended strategy. Using the existing strategy models leads to a linear, static, and bounded point of view in terms of time horizon and systemic scope [34].

These challenges call for effective application of computational models, as they have been important vehicles to address significant organizational issues. Researchers in the field of computational organization theory (COT), as illustrated in Figure 1, study organizational phenomena and how to apply computational models to traditional organization theory to theorize about, describe, understand, and predict the behavior of organizations to overcome challenges [35]. Computational models help to explore the possibilities of what might be [36]. Yet, academic researchers have been slow to take advantage of computational methods in the strategy management field [37].

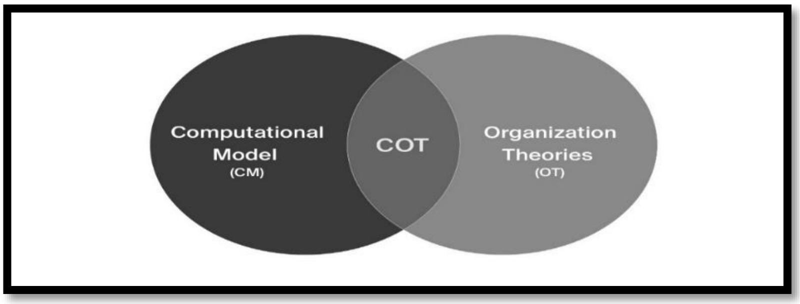

Figure 1. Computational organizational theory (COT).

In the literature of strategy management, little attention has been paid to the field of strategy implementation [21,22]. In addition, applying computational models and tools is still new in the field of strategy [38]. The current strategy models and frameworks mainly focus on and contribute to the analysis and formulation of strategies [39,40]. However, there are no commonly used, generally accepted models or frameworks in strategy implementation [39,41] and there has been little concern about this in the field [21,22]. Traditional approaches to strategy have been greatly criticized with respect to dynamic complexities [42,43], and most strategy frameworks are simplifying devices [44]. They are not capable of dealing with interdependent factors and interactions of multiple factors involved in strategy implementation [37]. Such interdependence and interaction produce nonlinearities and multiloop feedback [30].

Researchers have attempted to use automated technologies and apply computational models in the field of strategy implementation [45–49]. The use of an Internet-enabled multiagent prototype system for marketing strategy development, competitive strategies, and associated information system strategies was evaluated in [45]. In 2014, the business intelligence model (BIM) was introduced as an application for strategic business modeling and goal reasoning to effectively deal with dynamic characteristics and attain real-time strategy responses [46]. An automated model for effective strategy execution was developed in [48] to identify key variables of automation and linkages among the variables to have alignment among the systems to build a systemic mechanism to operationalize strategy execution processes. A proof of concept was introduced in [47] showing that the existing modeling language, integration definition for function modeling (IDEFM), has capabilities that can be applied to model strategy and automate its implementation process. The application of an algorithmic and computational model for strategic problem solving was illustrated in [38] that allows researchers to distinguish between different levels and kinds of adaptations to complexity, and to explore the fit between the canonical strategy problems a firm faces, its problem-solving procedures, and its architectural and procedural adaptations to complexity. The book *Real-Time Strategy and Business Intelligence: Digitizing Practices and Systems* [49] focuses on using business intelligence tools and algorithms to overcome the dynamic characteristics and attain real-time strategy response. However, the research in this area either focuses on the dynamic complexity of strategic decision-making and problem-solving or, on the other hand, linkages in the existing enterprise systems to be aligned with strategy implementation. There is a need for a comprehensive and holistic view of implementation challenges from the quality perspective to identify the quality attributes of automation prior to applying a computational model solution to the strategy implementation process. Although there is a need for higher education to improve the quality of the strategy implementation process and address the dynamic complexities of its attributes to identify areas for improvement [50] and obtain quality education to achieve sustainable development goals [11,12], the literature review implies that research on the topic is still scarce and little attention has been paid to quality attributes and criteria of the implementation process where the computational model can be applied to leverage its execution [21,22,38]. To bridge the gap in adopting automated technology and computational models in higher education strategy, information systems researchers need to critically analyze the quality attributes (QAs) of strategy implementation process automation to overcome the challenges involved and obtain sustainable strategy. The gap in applying computational models in higher education strategy is illustrated in Figure 2.

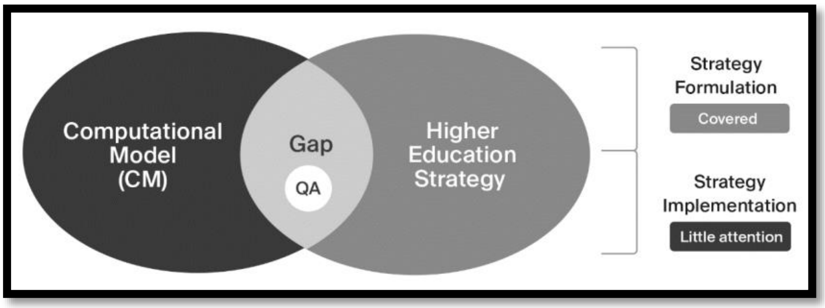

Figure 2. Research gap.

The successful implementation of sustainable higher education strategy in Saudi Arabia is facing a number of challenges and barriers. This research is intended to study the computational strategy implementation process of higher education to develop a descriptive and explanatory model and provide deeper and more critical quality attributes for the application of computational models in the implementation process to overcome issues related to its execution in the sophisticated and heterogeneous environment of the universities in Saudi Arabia, where they are managed by a central organization (Ministry of Education).

3. Methodology

In the literature of strategy management, little attention has been paid to the field of strategy implementation [21,22]. The literature is too descriptive and requires more research that provides information on the implementation process to help improve the quality of its outcomes [51]. The literature review implies that research in the topic is still scarce and little attention has been paid to the quality attributes and criteria of the strategy implementation process where the computational model can be applied to leverage its execution [21,22,38]. This research studies the phenomenon of strategy implementation and identifies its quality attributes to bridge the gap between the fields of strategy management and information systems in adopting automated technology. The research generates a descriptive and explanatory model for strategy implementation quality attributes in higher education that entail the implementation of automated technology. To identify the quality attributes, a constructivist research paradigm is applied to study the phenomenon using grounded theory. Grounded Theory Method (GTM) offers a set of a systematic guidelines and strategies to generate and form the foundation of a descriptive and explanatory model from data rather than formulaic prescriptions [52]. GTM is particularly suitable for research on topic that is limited prior research has been conducted [53–55] which is the case of this research. The major difference of GTM from other qualitative methodology is its specific approach of continuous interplay between data collection and analysis [56].

In information system researches, GTM has been applied frequently to study technological change and sociotechnical behavior in emerging research domains [57–59]. There has been more interest in studying information systems phenomena using grounded theory methodology [56] and the outcomes of such research are highly valued by the information systems community [60]. Applying grounded theory in the analysis and description of information systems phenomena has proved to be remarkably useful [61,62].

A literature review of analytic and confirmatory modes of research using grounded theory methodology, theoretical sampling, and theoretical integration was conducted to present a complete picture of the phenomenon. In this research, the guidelines outlined in [56] and [52] were followed.

3.1. Data Collection

One of the objectives of grounded theory in information systems research is to generate a descriptive and explanatory model [60], which is derived from data systematically elicited and analyzed [56]. It is an inductive method where the result is derived from data [63]. Therefore, all possible data sources in the Ministry of Education and universities of Saudi Arabia were considered and analyzed. Multiple information gathering methods were employed. The open-ended interview is the major method used in grounded theory. In this study, interviews of participants from varied backgrounds were carried out. The major criteria for selecting the study participants were the following: (a) participants should be involved in some higher education strategy process; (b) they should differ in terms of role, responsibilities, and background; (c) they should differ in terms of managerial reference (ministry and university (government and private)); and (d) they should be willing to share their experiences with the researchers. Diversity among participants in terms of roles, responsibilities, and institutes with strategy execution facilitated theoretical replication. In other words, it is reasonable to expect that there may be differences between sectors and universities, and in the various documents, strategic plans, and reports that provided the valuable additional information.

3.2. Data Analysis

This research uses the constant comparative method and theoretical sampling to analyze the data [64]. The constant comparative method establishes analytic distinctions during each phase of process analysis. Theoretical sampling looks for initial conditions that support the phenomenon and conditions that are not consistent with the initial categories.

The grounded theory method uses three levels of coding: open, focused, and theoretical. Open coding is the preliminary stage of coding, where the labels are assigned to parts of data and identify meaning. In this stage, researchers remain open to discovering results and theoretical options that can be derived from the data [52]. Open coding should be conducted without any preconceived ideas [65]. In open coding, researchers should stick to the data and focus on the action that can be derived from data rather than applying preconceived categories to the data. In this research, the focus is on coding for actions and what happens in the data to reduce individual judgments and avoid conceptual leaps. Line-by-line coding was applied to engage with data, discover each fragment, and define implicit meaning. Then, the most frequent and significant codes from the open coding phase were selected in order to synthesize, analyze, and conceptualize the large amount of data. This type of coding is called focused coding. It is an iterative process that aims to identify hidden patterns within the field to provide a deep understanding of the phenomenon and have a higher level of abstraction [66].

The conceptual categories that resulted from initial coding were used to refine the data in order to determine their usefulness in the analytical process [67]. Comparing categories with one another and with newly refined categories enables researchers to ensure their worth within the analytical process [52]. In this research, focused coding was applied to ensure the adequacy and conceptual strength of the initial coding, where new data were compared with initial codes and codes were compared with other codes to identify the most significant codes that make the phenomenon more clear and identify potential categories.

The third level is a sophisticated level that follows the codes that were selected during focused coding. Theoretical coding analyzes the focused codes and how they are related to each other [65]. Theoretical coding includes refining and clustering concepts into theoretical categories that characterize the aspects of the phenomenon [68]. Theoretical coding identifies the relationships between concepts [52]. The comparative process is the main process of this stage of the analysis, contrasting categories back to codes, and codes back to data, to ensure that the resulting model depicts the reality of the phenomenon. In this research, categories (strategy layers) were developed through continued comparative analysis until a saturation level was reached and it became clear that the issues and challenges of strategy implementation and associated quality attributes belonged to the right layer of implementation.

3.3. Model Scale-Up and Validation

Exploratory research was conducted to scale up the research results and ensure a rigorous association between challenges and identified attributes in the context of strategy implementation, and to demonstrate the influence of information system capabilities and automated technology on strategy implementation. It was stated in [52] that "a literature review provides a place to engage the ideas and research in the areas that your grounded theory addresses. It also serves as a way to evaluate your grasp of these areas." Thus, a focused literature review on strategy implementation quality attributes was merged and integrated into the research results, discussion, and analysis of the influence of information systems and computational models on strategy implementation.

The literature review was conducted using the EBSCO, Science Direct, ProQuest, and Google Scholar electronic databases. Search terms that were used independently or in combination were: strategy, execution, implementation, translating strategy into action, framework, adapt, and flexibility. In addition, this research applied a constructivist paradigm to study the phenomenon using grounded theory and case study, and to determine the scientific rigor of the study, the specific criteria of credibility, originality, resonance, and usefulness as mentioned in [52] were used to ensure research validity and quality.

4. Research Questions and Objectives

The fundamental understanding of strategy needs more research due to the largely descriptive focus of the research to date [21,22]. The strategy process literature is too descriptive and needs more research that provides information on the implementation process to improve outcomes [51]. It appears that the existing models in today's strategy implementation processes are insufficient to provide a significant solution for higher education strategy. Although there is a need to critically review and analyze the current level of strategy quality and identify areas for improvement [50], the literature review implies that research on the topic is still scarce and little attention has been paid to the quality attributes and criteria of the implementation process [21,22,38]. In order to apply computational models to overcome higher education strategy implementation issues and critically analyze the process, key quality attributes need to be identified and areas where automated technologies and computational modeling capabilities can be applied need to be defined in order to address and overcome challenges associated with these quality attributes to ensure the quality and sustainability of higher education strategy. This research is therefore intended to answer the following questions:

- What is the set of key quality attributes that entail implementation of computational modeling and automated technology for higher education strategy?

- How are these quality attributes interlinked and categorized?
- How is automation influencing the quality and sustainability of higher education strategy?

These led to the following research objective:

- To identify strategy quality attributes (SQAs) that entail the application of computational models and automated technology for more effective and sustainable higher education strategy.

5. Research Results

Strategy formulation is a challenging and difficult task for organizations, and implementing a formulated strategy is even more challenging [20]. This research presents a descriptive and explanatory model for strategy quality attributes (SQAs) in higher education using grounded theory, which entails implementing automated technology, as shown in Figure 3.

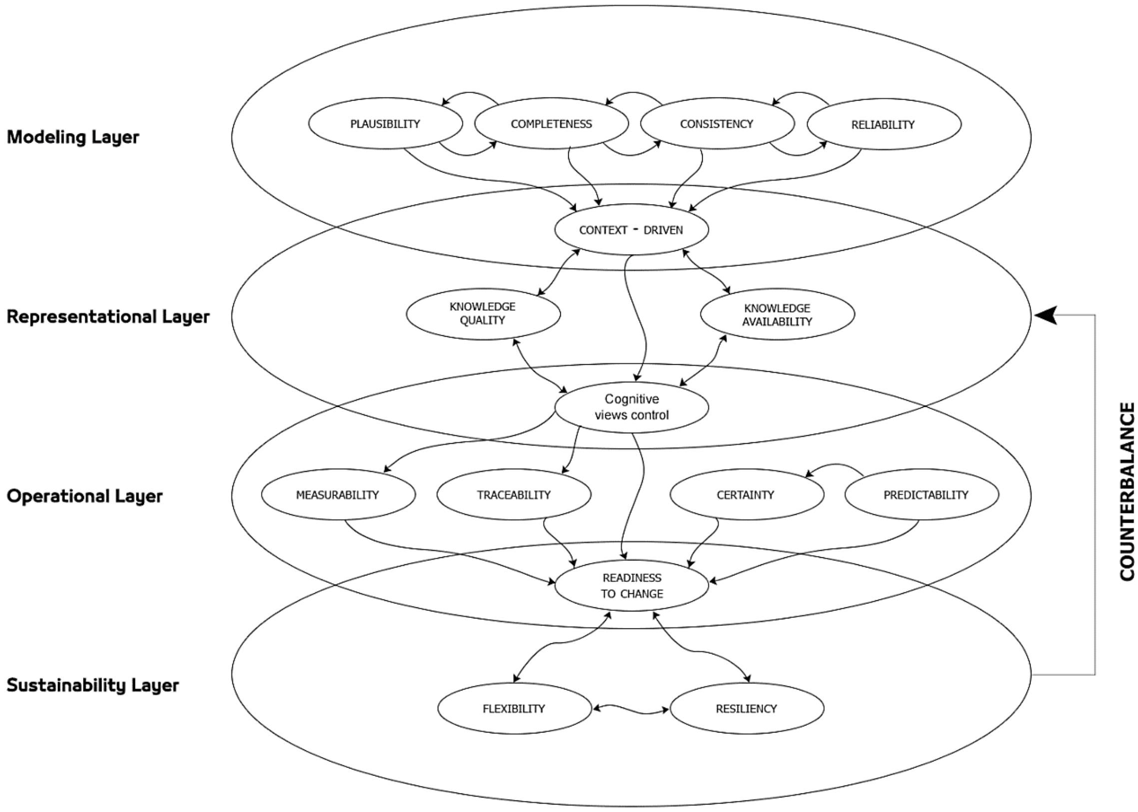

Figure 3. Strategy quality attributes model.

The model introduces SQAs with their relationships, categorized into four layers of implementation: modeling, representational, operational, and sustainability.

5.1. Modeling Layer

The first layer is the modeling layer, which assumes that all strategy aspects and components have been constructed and formulated and are ready for implementation. In this layer, the strategy should be reconstructed and modeled using a standard approach with a unified taxonomy in order to achieve four strategy execution quality attributes: consistency, completeness, plausibility, and reliability.

5.1.1. Consistency

The strategy implementation should be based on a unified and agreed taxonomy and semantics. Strategy implementation is a complicated process in which policies need to be enforced and strict and adherent standards should be complied with. The strategy needs to be executed in accordance with a consistent model and framework to provide consistent outcomes and resolution of critical decisions with contradictory processes and outcomes.

Implementation tactics need to be bounded with guidance and framed with clear specifications to be translated into an executable form. Effective guidance and framework ensure that the implementation process and its outcomes can be consistently defined, structured, presented, integrated, and governed. Higher education institutes need to have consistent definitions, policies, representations, and relationships in their strategies. At the same time, they should have consistent descriptions and understanding of the strategy execution process and outcomes.

5.1.2. Completeness

In order to achieve goals and objectives, higher education strategy should be fully implemented and all required processes and actions should be fully executed. In other words, completeness of the implementation and integrity of the strategy must be assured by applying an effective framework and robustly following a standard implementation approach, if any.

Each manager's perception and interpretation reflects his or her own cognitive bias [69,70], which drives strategic decision-making. Subjective interpretations or viewpoints lead to the emergence of different views in the implementation process [71]. Hence, strategists need to control and manage different viewpoints through a reliable and systematic standard approach to ensure common understanding and a unified interpretation of implementation outcomes. In addition, the standard approach should be able to define the relationships of implementation outcomes and how they are consistently integrated. Therefore, having common, related, and integrated outcomes enables strategists to verify the completeness of the implemented strategy against the intended goals and objectives. It is clear that the completeness attribute affects and is affected by the consistency attribute of strategy implementation.

5.1.3. Reliability

The strategy implementation process should be reliable to produce consistent and valid outcomes, which means that when the same process is performed in two different but consistent conditions, the same outcomes will be obtained. A highly reliable implementation process will produce accurate and consistent outcomes when it is performed in various higher education entities. The strategy process is full of different conceptualizations [72,73] and still too descriptive [51]. Therefore, to achieve a reliable process, strategists need to have a unified implementation model with unified semantics and syntax. In addition, having a reference model and a content model can consolidate different viewpoints and underpin the reliability of strategy implementation and produce consistent and valid outcomes to achieve the goals and objectives.

5.1.4. Plausibility

Strategy implementation involves processes and activities that transform strategic aspects into actionable components [74]. It also involves taking ideas, decisions, objectives, and other aspects of the strategy and transforming them into action [40]. Therefore, it is important for the strategy to be plausible so that the desired outcome is obtained. The strategy process is too descriptive and needs more research to improve its outcomes [51]. The organizational environment has complexity and uncertainty along with cognitive limitations of decision-makers [28]. Plausibility is one of the key quality attributes of the strategy to ensure that the process is reliable and implemented as intended to produce consistent outcomes. In plausible reasoning theory, plausible reasoning is driven by a premise and is based on common knowledge and perceptions [75]. Therefore, the strategy aspects should be encoded and described using a standard approach and unified modeling language that is plausible for all actors in higher education.

5.2. Representation Layer

In this layer, the quality attributes are related to knowledge, information, and artifacts that describe the higher education strategy. The inputs are from the previous layer (modeling) and bottom layer (operational). The quality attributes include knowledge availability, knowledge quality, context-driven, and control of cognitive views.

5.2.1. Context-Driven

Strategy context is affected by environmental attributes, organizational characteristics, and cognitive context [76]. The heterogeneity in strategy context is associated with differences in organizational context and actors' cognitive views [77], which cause deviation from the intended strategy. Strategy context has received limited attention in terms of cognitive views [78]. Strategy context should rely on configurational approaches to be represented considering organizational context, environment, and cognitive views [76,79] and incorporated according to the required characteristics and setting. Strategic processes are viewed as reflections of organizational context and the behaviors of strategic actors [80,81]. Limited attention to dynamics and variation of organizational contexts [77] calls for more attention to competitive theorizing and understanding of context-driven strategy implementation to maintain completeness, consistency, plausibility, and reliability of the implemented strategy.

5.2.2. Knowledge Quality and Availability

Knowledge is a key asset through which competitive advantage is gained and maintained [82]. The link between knowledge management and strategic management is well defined in academic research [83]. Strategic implementation is defined as "big strategies growing from little ideas" [84]. Strategy implementation is developed through unstructured and emergent processes that have been referred to in terms of human sense-making [85]. The knowledge involved in sense-making processes is tacit, not explicit [86]. As a result, it is not easy to tackle. Knowledge involved in the strategy implementation process includes expert knowledge [87], which means that when tacit knowledge can be made explicit, it should be represented as if-then rules [88], as cases [89], or as text.

In the strategic emergent process, knowledge is shared across all levels of the organization and actors [90], and knowledge will be incomplete and action faulty [91]. As a result, to achieve completeness, consistency, plausibility, and reliability of the implemented strategy, knowledge should be represented and managed in a way that ensures the quality and availability of strategy knowledge, which is built in a recursive participatory and evolutionary manner [85]. In addition, strategy knowledge should be bound by strategy context and represented in a way that ensures control of different viewpoints derived from sense-making processes at the micro level of strategy implementation.

5.2.3. Control of Cognitive Views

Tactical variation causes serious changes in the context of strategy during the execution process, as each university has its own setting and tactics. When these tactics are not clearly translated and instantiated, the context of strategy will not be executed as planned and the strategy will become emergent. The context is affected by the implementation process and how actors and managers view it and execute it [80,81] across different settings. This is due to cognitive views of the strategy where embedded actors [92] act, react, and interpret the strategy based on their background and perceptions [69,70], which steers the decision-making process. Cognitive perspectives in strategy implementation represent "an ongoing cycle of sense-giving by top managers, sense-making by lower echelons, and issue selling specifically by middle managers" [78]. Hence, the implementation process needs an approach to construct and instantiate the strategy to produce a desirable variety of perspectives. In addition, more investment is needed in the micro level of the strategy process to identify implementation diversification [93], where managers interact with the strategy's activities [94].

5.3. Operational Layer

The attributes involved in this layer describe the quality of the actual execution of higher education strategy. The inputs are from the previous layer where strategy knowledge is consumed, information is processed, and artifacts are manipulated. The attributes are traceability, measurability, predictability, and certainty.

5.3.1. Traceability

Existing strategy execution models do not provide rigorous tracking for the multidimensional impact of tactical variety. In strategy execution, continuous changes with a lack of knowledge about the higher education environment, which features dynamics, complexity, and uncertainty, transforms the strategy into an emergent one. The cognitive limitation of the actors would cause a fire-fighting situation, as multidimensional factors and influences will not be recognized. This dynamism produces nonlinearities, multidimensional impact, and feedback [31]. Conventional management approaches cannot effectively model and analyze such dynamic impact [33,95,96] specifically in real time. They are not capable of dealing with multiple interdependent activities involved in strategy implementation [37]. More focus on micro-level analysis in the implementation process is needed in different contexts [77]. Therefore, traceability is an essential quality attribute for successful implementation of higher education strategy, which requires the application of advanced models, tools, and technology.

5.3.2. Measurability

An effective modeling approach is needed to translate the vision into executable projects and operation tasks at all levels to reformulate the strategy and reconfigure the structure considering its culture, and then to systematically measure the performance toward the goal [97]. Strategy interacts with the dynamic environment in which the organization should align its performance for the short term and long term [24,98]. In order to implement the strategy, effective performance measures need to be robustly applied; as stated by Osborne and Gaebler: "What gets measured gets done" [99]. Performance measurement aims to support management activities, enhance the decision-making process, and enhance the implementation performance in order to obtain the desired outcomes [100].

Measurable implementation processes help strategists to know the current status; as Osborne and Gaebler state, "If you don't measure results, you can't tell success from failure" [99]. In addition, a measurable strategy can motivate decision-makers to take timely corrective action; as also stated by Osborne and Gaebler, "If you can't recognize failure, you can't correct it" [99]. Thus, measurability is also an essential quality to determine the current status of the higher education strategy and enhance its performance toward goals and objectives.

5.3.3. Predictability

Strategy implementation features complexity and uncertainty along with cognitive limitations of the organization's decision-makers [28]. As per [34], scholars are becoming more interested in the dynamic characteristics of the strategy process. Accumulation and depletion of resources occur constantly and simultaneously throughout an organization's lifetime [34]. Growth and enhancement of resource performance depends on the level of other resources in the organization, whether in the internal or external environment [101]. These interdependencies in organizational resources cannot be tackled unless all gains and losses of the resources have been identified for the entire history of the organization [102]. One of the fallacies of strategic planning is that prediction is possible when the strategy is being formulated [84]. Strategists should stay on the prediction course during the implementation [84]. Therefore, predictability is one of the key quality attributes to ensure successful implementation of higher education strategy.

5.3.4. Certainty

Strategy is surrounded by dynamic and changing environments [23–26], which cause uncertainty about its implementation. In an organization facing strategic change, a highly disruptive and unpredictable environment [103] will lead to organizational collapse [104]. There are three major types of uncertainty, risk, structural, and unknowable, and the strategic responses are, respectively, forecasting, scenario-based planning, and skillful reaction [104]. Obviously, the more the strategy is predictable, the higher the level of certainty is increased. Therefore, to ensure successful implementation, it is important to address uncertainty and increase the level of predictability for higher education strategy.

5.4. Sustainability Layer

This layer is related to the sustainability attributes for strategy implementation and responses to the changing environment. Constant changes in the implementation process require speedy responsiveness and adaptability. However, the necessity for higher education institutes (HEIs) to grow and compete in a rapidly changing environment slows their ability to be agile and have timely responses to market changes. Therefore, the strategy implementation process needs to be flexible, resilient, and ready for change.

5.4.1. Readiness for Change

A rapidly changing environment increases managers' concerns that their strategy implementation process needs to be proactive in order to adapt to continuous change [105,106]. Changes are dynamic and often occur simultaneously and cannot be easily predicted. Change is inevitable and it will come and significantly affect the higher education strategy. The key success of the strategy implementation is to perceive the need for change and then respond to it. The change should be perceived, implemented, and then tested [107]. Readiness for change can be achieved by controlling the cognitive views of actors and continuously monitoring the strategy status (measuring and tracking). In addition, predicting the future and measuring uncertainty can increase the level of readiness for change. Thus, readiness for change is an important quality attribute for higher education strategy implementation. However, it requires a flexible and resilient implementation to respond and adapt to change when it occurs.

5.4.2. Flexibility

Higher education institutes' need for flexibility in strategy implementation derives from concerns about future uncertainty [108]. Strategic flexibility is the capability to act in and react to a changing environment and create or maintain competitive advantage [109,110]. HEIs need flexibility to respond to a changing environment in order for actors to thrive in such an environment [111,112]. Strategic flexibility allows them to respond to changes [113]. Strategic flexibility is described in [114] as the "capability to identify major changes in the external environment, quickly commit resources to new courses of action in response to those changes, and recognize and act promptly when it is time to halt or reverse existing resource commitments" [114]. The authors delineated three stages of the process: attention, assessment, and action [114]. This requires flexibility and continuous analysis of current strategic actions, structure, and culture and other aspect of the strategy [115]. Flexibility can increase financial performance [113,116], ensure sustainability [117], and reduce uncertainty [118].

5.4.3. Resilience

Resilience is the ability to absorb change [119] and return to balance after a temporary disruption [120]. The environment surrounding higher education institutes increasingly challenges them by posing different threats in various forms, both inside and outside. Natural disasters, pandemic diseases, terrorist attacks, economic recessions, equipment failure, and human errors are some examples that help to understand how different events can undermine stability and security [120]. Moreover, higher education institutes exist and compete in a world that is increasingly interconnected both socially and technologically. Challenges occasionally appear in the form of minimal and apparently insignificant uncertainties and offsets, but a small event can create the so-called butterfly effect in a wide interconnected network. Consequently, currently it is always more difficult to be an independent entity and resist or try to resist shocks, impacts, and disasters while maintaining a competitive position [121].

The strategy should be resilient and elastic to adapt to the impact of continuous changes and deal with dynamics, complexity, uncertainty, and offsets to achieve the intended goals and objectives and to avoid being transformed to an emergent strategy.

6. Discussion

This research studied the challenges of strategy implementation and identified key quality attributes that entail the implementation of automated technology. The research used grounded theory methodology to conceptualize the qualitative data obtained from the Ministry of Education in Saudi Arabia, which helped in identifying these attributes. The purpose of identifying strategy quality attributes (SQAs) is to determine the areas in which the capabilities of information systems and computational models can be applied to promote the quality and sustainability of higher education strategy and overcome the challenges involved. It is difficult to cover all aspects of the proposed model. Thus, this section discusses main aspects of the model.

6.1. Modeling Layer

When a strategy is formulated, the research results imply that it is necessary to check it against certain quality attributes to ensure the success of its implementation for the long term. First, the strategy should be consistent, with the different aspects built based on a unified reference model. Strategy implementation is a complicated process in which policies need to be enforced and strict and adherent standards should be complied with. Strategy implementation is a complicated process that needs to be executed in accordance with a consistent model and framework to provide consistent outcomes and resolution for critical decisions with contradictory processes and outcomes. To ensure consistency, strategists ought to build a unified reference model and language, a consistent structure, and policies and representation to adhere to the strategy's context at the micro level of higher education institutes where the implementation take place in functional departments. Each functional department has its own setup and viewpoints, which can affect the consistency of the implementation process. Strategy implementation outcomes need to be integrated and adherent in consistent patterns across the functional departments to meet the goals and objectives.

The second attribute in the modeling layer is completeness, which affects and is affected by consistency. There should be complete and consistent building blocks that cover all parts of the higher education strategy. These building blocks need to be built with a systematic approach to ensure that their implementation outcome is consistently integrated. Building a unified reference model and language for higher education strategy enables strategists to verify the completeness and consistency of the implementation process.

As the research results indicate, the strategy process is full of different conceptualizations and is too descriptive. Therefore, consistent building blocks are not enough for implementation success. The implementation process should be reliable; when the same process is performed in two different but consistent conditions, the same outcomes will be obtained. In addition, the strategy also needs to be plausible for all actors who are involved in its implementation across all higher education entities.

The quality attributes in the modeling layer represent the context of higher education strategy where whole activities are extended from its essence. The results of this research indicate that the strategy context can be considered as the mindset of the implementation model, which is formed by the context and cognitive views based on the available knowledge for strategists and actors. The context should be governed through a systematic approach of controlling cognitive views and readiness for change to avoid deviating from the intended strategy. The strategy context is a reflection of the behavior of actors in the implementation process. A variety of cognitive views of actors is an important aspect of the implementation process that needs to be carefully addressed. Limited attention to these aspects and pattern variation in different organizational contexts can affect the context-driven attributes of the implementation process and cause a deficiency in attributes of strategic layers (completeness, consistency, plausibility, and reliability) through variation in the implementation process at the micro level. To achieve completeness, consistency, plausibility, and reliability of the implemented strategy, cumulative knowledge needs to be represented and managed effectively to ensure the quality and availability of knowledge that is developed in a recursive, interactive, and evolutionary manner. In addition, strategy knowledge should be bounded by strategy context and represented in a way that ensures control of the variety of viewpoints derived from the sense-making process at the micro level of implementation.

Studies in the literature analyzed the concepts of actor's cognition and control of variety. Approaches to cognitive actors were defined in [122] with a differentiation between hard, objective, and quantitative information processing, and in [123] they were seen as soft, subjective, and qualitative sense-making approaches. The research in the field has led to a concept of cognitive mapping [124], and qualitative methodologies such as ethnography and discourse analysis [125].

To address these attributes and associated challenges in this layer, higher education institutes should adopt a unified modeling language, reconstruct and model the strategy using a standard approach with a unified taxonomy to automate the implementation process, and have a context-driven strategy with control of cognitive variation.

6.2. Representation Layer

In the representation layer, control of cognitive views is a key quality attribute that links the knowledge of strategy actors to the actual operation in the implementation journey. In this layer, the actions of actors and the decision-making process should be based on reliable knowledge that is available and shared across higher education institutes. This knowledge should be represented in a way that is understandable to all actors when it is needed, to ensure the implementation of the right patterns of strategy. Not addressing the variety of actors' cognitive views in strategy implementation will impact the context and therefore lead to implementation patterns varying from intended goals and objectives. Strategists need to carefully represent the strategy context based on reliable knowledge through a systematic approach and adopt a mechanism as in other fields, such as knowledge management and governance frameworks, applying associated information systems and computational models to strategy knowledge and actors' cognition representation to ensure a context-driven implementation process.

6.3. Operational Layer

The actual implementation of higher education strategy occurs at the operational level. In this layer, the strategy is translated into executable projects and operation tasks to reformulate it, reconfigure the structure considering its culture, and then systematically measuring the performance toward its goal [97]. Control of cognitive views plays a prominent role in the operation level of implementation to govern the translation of represented strategy into executable projects and operation tasks at the micro level. Thus, actions and decisions of strategy actors need to be measurable and traceable. Higher education institutes are surrounded by dynamic and changing environments, which requires them to continually review their strategy to constantly accumulate, integrate, and update their knowledge resource capabilities in order to achieve strategy objectives [23–26]. Failing to realize that any change to the strategy requires a change in the operation level is the biggest blind spot of strategic management [97]. Strategy implementation should not be considered as a static process. One of the implications of strategy implementation is related to the need for tracking and timely responses to continuous changes while considering the lack of knowledge about the environment, which features complexity and uncertainty along with cognitive limitations of decision-makers [28]. As the research results indicate, conventional management approaches cannot effectively model and analyze the impact of such dynamics specifically in real time. They are not capable of dealing with multiple interdependent activities involved in strategy implementation. Therefore, traceability is considered an essential quality attribute for successful implementation of higher education strategy, which requires the application of an advanced model, tools, and technology.

Information systems researchers should provide advanced solutions using computational models to address these quality attributes and effectively translate the strategy building blocks into actionable tactics at the micro level to ensure the proper operation management of the strategy implementation process.

6.4. Sustainability Layer

In the proposed model, this layer consists of three attributes that promote the sustainability of higher education strategy. The resiliency attribute can be considered as an adaptation that is defined as the ability to absorb change [119] and return to balance after temporary disruption [120]. The resiliency and flexibility attributes make up the agility capability of strategy implementation. One prominent value of agility is the capability of handling adaptation to chaos and self-organizing to contribute to the higher education strategy implementation process by counterbalancing sustainability and representation. This part of the model needs further research in the field of computational modeling, such as complex adaptive systems and their influence on optimizing strategy implementation.

Reviewing the linkage between the four layers of the model shows that there are three connector attributes: context-driven, control of cognitive views, and readiness for change. These attributes and their relationships are deemed to be the backbone of sustainability of the higher education strategy implementation process.

The context-driven attribute is among the attributes of the modeling layer, and it affects and is affected by the attributes of the presentational layer. The context of strategy is transformed into executable form through actors' cognition, where control of cognitive views should take place to control the variety of viewpoints. These viewpoints depend on the knowledge that comes from the strategy context, which in turn needs to remain and be bounded through controlling attributes in the operational layer: measurability, traceability, certainty, and predictability.

The strategy actors are cognitive workers. They interpret data and information, understand and interact with the operational environment, analyze the situation, and take action based on the available knowledge. Their decisions not only depend on explicit knowledge, but also on their experience, background, relationships, and emotions. They carry out and make sense of the processes and work items that are under their responsibility and evaluate their decisions based on their viewpoint of the strategy context. Thus, to ensure sustainable higher education strategy, the cognitive workers' actions and decisions should be governed and controlled through measurable and traceable processes, along with alignment with certain and predictable events and outcomes. This control of cognitive variety leads to the third connector of the strategy implementation backbone, readiness for change.

However, as the strategy implementation process has not been well addressed in the literature [22], computational models and information system capabilities have not been effectively utilized in designing and modeling the process and providing a common language with computer-aided tools to leverage its execution [37,38,126].

6.5. Influence of Automated Technologies on Quality and Sustainability of Higher Education Strategy

The proposed model identifies quality attributes and associated challenges in strategy implementation through the models' layers in the sense of quality. These challenges are mainly related to process modeling, dynamic complexity, and cognitive limitations. Traditional approaches to strategy have been greatly criticized with respect to dynamic complexities [30,42]. They are not capable of dealing with the interdependencies and interactions of multiple factors involved in strategy implementation [37]. Considering the complex and dynamic environment along with the cognitive limitations of the strategists mentioned in bounded rationality [29], and misperceiving the interdependencies between multiple factors within the dynamic environment and multiloop feedback [30–33], will create an execution gap and deviation from the intended strategy. Using the existing strategy models will produce a linear, static, and bounded point of view in terms of time horizon and systemic scope [34]. In addition, the current strategy models and frameworks mainly focus on and contribute to the analysis and formulation of the strategy [39,40], and there is no commonly used framework for modeling strategy implementation [41]. These challenges call for the effective application of computational models and automated technologies, as they have been important vehicles for addressing significant organizational issues. The field of information systems can potentially provide a systematic way of modeling, designing, and visualizing different strategic concepts, as it has a rich body of knowledge to model concepts, ontology, and artifacts [126,127]. The computational models of information systems can provide a new perspective and a set of conceptual tools, as they have the capability to deal with the dynamic complexity of interdependencies among multiple factors and variables and accumulated cause and effect feedback [30–33]. Thus, the research results suggest that applying a computational model and automated technologies can overcome the key challenges associated with the quality attributes of higher education strategy implementation and help HEIs to achieve the desired level of quality to leverage strategy implementation and promote its sustainability.

To address the quality attributes in the modeling layer, the computational model and automated technologies can make a great contribution to adopting a unified modeling language and building a standard approach with a unified taxonomy to automate the strategy implementation process and have a context-driven strategy with control of cognitive variety as it has done in the field of business processes management (BPM). Researchers have explored the opportunity to formalize models in business process management, an established field in information systems research, as there is a need for a modeling language for business processes that is formal enough and understandable by end users, not just by domain experts [128], which can transform them into a form that is executable by computer engines. Information systems have constructed effective modeling languages that have been successfully executed in various tools and engines, such as Coloured Petri nets [129,130], Business Process Execution Language (BPEL) [131], Integration Definition for Function Modeling (IDEF0) [132], Business Process Model and Notation (BPMN) [128], and System Modeling Language (SysML) [133].

In the representation layer, computational models and automated technologies can help strategists to represent strategy context based on reliable knowledge through systematic approaches and adopt a mechanism as in other fields, such as knowledge management and governance frameworks, with associated information system and computational models of strategy knowledge and actors' cognition representation to ensure that the implementation process is context-driven and has control of cognition.

In order to implement the strategy in the operational layer, effective tracking and performance measurement systems need to be robustly applied to know the current status of the higher education strategy and motivate decision-makers to take timely corrective action. The dynamics of strategy implementation and the changing environment cause uncertainty in the implementation, which lead to strategy collapse. In addition, in order to have more in-depth analysis of the dynamic interdependencies and interactions of quality attributes and associated challenges at the micro level of strategy implementation, the dynamic relationships of quality attributes should be modeled using system dynamics to tackle the complexity of the phenomenon and address the interdependent relationships and interactions of multiple factors and challenges.

At the sustainability layer, applying agent-based and complex network-based models [134] to model conditional action patterns in strategy implementation [135] will contribute to the field and overcome challenges associated with resiliency and flexibility attributes such as adaptation, dynamism, and complexity.

However, the influence of automated technologies on quality attributes is not limited to what has been mentioned, as the application of computational models and tools in the field of strategy needs more research [38]. Therefore, the proposed model supports what was suggested in [126], that the information system and strategic researchers together should investigate more strategy notions and the use of technology in the process of crafting strategic business concepts [126]. This research claims that the field of information systems is well equipped to make substantial inroads in promoting the quality and sustainability of higher education strategy, addressing the challenges involved, and optimizing the outcome.

7. Contributions of this Study

As a step toward bridging the gap between the fields of strategy implementation and information systems in adopting automated technology in strategy implementation, this research generates a descriptive and explanatory model for strategy quality attributes in higher education using grounded theory, which entails the implementation of automated technology. The research results contribute to both the information systems and strategy fields. The strategy quality attributes model helps higher education institutes (HEIs) to identify the challenges involved in strategy implementation through its implementation layers and their relationships in the sense of quality and sustainability, which can be interpreted and understood in business and IT. Strategy implementation is a series of actions and reactions over time [27], so predefined quality attributes in each layer of implementation provide comprehensive insight into how to obtain sustainability in higher education strategy implementation and overcome challenges associated with the process using the capabilities of information systems and computational models.

Strategy is translated and interpreted across different levels and divisions in higher education institutes. Hence, the strategy context changes and cannot be clearly represented and implemented as planned. The heterogeneity in the strategy context is associated with differences in higher education institutes' contexts and settings, and actors' cognitive views, which is the main cause of the implementation gap and the deviation from intended strategy. A new management framework is required to combine and control changes in different management and operational systems [136]. The proposed model provides a clear connection between modeling and operational layers, as failing to realize that any change to the strategy requires a change in the operational level is the biggest blind spot of strategic management [97]. In the proposed model, achieving connected, context-driven, tactical variety and readiness for change quality attributes, implementation layers and all other quality attributes can fill the gap between strategy and operation and ensure successful implementation of intended goals and objectives. In addition, iterative cycles and counterbalancing provide the capability to optimize the implementation over time through the sustainability layer, which enables the agility and sustainability of the implementation. The lack of such an exercise may lead to undesired performance despite the use of advanced performance and control management tools.

The research findings in terms of strategy modeling identify the need for unified modeling languages for strategy implementation. To achieve quality attributes in the modeling layer and consequently in other layers, implementation needs to be modeled using a standard approach with a unified taxonomy in order to have consistent, complete, plausible, and reliable strategy. However, there is no agreed-upon, generally accepted, and dominant framework in strategy implementation [39,41]. To fill this gap, the research results suggest that information systems and computational modeling capabilities should provide a systematic approach for strategists to formalize the strategy implementation process and assist in modeling, representation, and visualizing different strategic concepts and notations. The capabilities of computational modeling can also provide algorithms for the implementation process that can translate these models to a form that is executable by various computer engines.

This research contributes to the fields of both information systems and strategy management by introducing a model of key quality attributes for sustainable higher education strategy implementation, categorizes them into four layers of execution, and determines their interrelationships. The study also demonstrates the challenges associated with these attributes, which entail the implementation of automated technology. The model provides a blueprint for information systems that can help to identify potential areas where information system capabilities can make a significant contribution to strategy implementation of higher education in both academic and practical domains.

8. Limitations and Suggestions for Future Research

It is difficult to make a universal model for key quality attributes of strategy implementation that entails automated technology and ensures sustainability. However, this study has attempted to synergize and integrate multiple research methods to increase the significance of the findings. Key quality attributes are contextual in higher education strategy, and validating the study's findings would therefore require extended research in different contexts and settings. The research uses grounded theory to identify the SQA model, and further quantitative research would be advisable to evaluate the research results. In addition, since the research result is a conceptual model, future studies may extend the body of knowledge by empirically applying information systems and computational modeling, which may provide insights for this study.

The limitations of this research suggest two streams of future research. The first stream is related to the proposed SQA model, where further quantitative research is advisable to evaluate the results, and extended research is also possible in different contexts and settings. In addition, identifying key quality attributes for strategy in the early stage of implementation would help strategists and their teams to clarify and understand the required processes and decisions to proactively deal with challenges associated with quality attributes for the context under study.

The second stream is related to solutions that can be provided to overcome challenges involved in obtaining strategy quality attributes. An executable framework for the strategy implementation process using information systems design theory can contribute to the body of knowledge of information systems and strategy implementation and provide insight into how to successfully obtain strategy quality attributes. Moreover, this research explains the need for a unified modeling language for strategy implementation. Thus, advanced research is required to develop a formal modeling language for the strategy implementation process with unified syntax and semantics. In addition, the SQA model illustrates the importance of agility, which comes from the resiliency and flexibility quality attributes and the significant counterbalance between sustainability and representation layers, and how the computational model can be applied to adopt a strategy with emerging changes to ensure sustainability. Therefore, applied sciences research is significant to provide an application of information systems and computational model capabilities in the context of the agility of strategy implementation.

9. Conclusions

Obtaining a sustainable higher education strategy requires greater attention to some major paradigm shifts in the higher education domain, as well as in the planning techniques and approaches [8]. Higher education plays a prominent role in the promotion of sustainable development [7]. It is the core of education, around which the whole education system revolves [8]. Globally, HEIs are facing challenges in terms of quality [8,11]. Ensuring quality education is necessary to secure future prosperity and promote sustainable development [12]. This research studied the challenges facing the implementation of higher education strategy in Saudi Arabia in terms of quality and sustainability in response to repeated calls addressing the need to advance the quality of higher education in the country and align it with economic and labor market needs [5,15–18]. However, decisions about implementing strategy that influence higher education, if they are not based on adequate information and effective tools, could affect its sustainability and many other sustainability goals.

This research is a step toward a more effective application of computational models and information systems capabilities in higher education strategy implementation through a critical analysis of the quality attributes of the implementation process in order to promote its automation and overcome the challenges. Successful implementation of higher education strategy is significant in building human capital and a knowledge-based economy to promote sustainable development in Saudi Arabia.

The study of the computational strategy implementation process provides a new understanding of how to adopt automated technology and computational models in higher education strategy to obtain its sustainability. The research generates a descriptive and explanatory model for deeper and more critical quality attributes to provide a comprehensive and holistic view of challenges facing higher education strategy implementation in the sense of quality to identify areas for improvement prior to applying a computational model solution to the implementation process. The introduced strategy quality attributes model identifies strategy implementation quality attributes, categorizes them into specific categories, and determines their interrelationships through implementation layers: modeling, representational, operational, and sustainability. The model is intended to be a blueprint for information systems researchers to identify potential areas where information systems capabilities can make a significant contribution to higher education strategy implementation.

Applying automated technologies and computational models can overcome challenges associated with quality attributes and ensure the quality and sustainability of higher education strategy. A preliminary analysis of the proposed model shows the potential influence of automated technologies and computational models on the quality attributes as follows:

- In the modeling layer, HEIs need to adopt a unified modeling language and build a standard approach with a unified taxonomy to automate the strategy implementation process and have a context-driven strategy with control of cognitive variety.
- In the representation layer, computational models and automated technologies can help strategists to represent strategy context based on reliable knowledge through a systematic approach and adopt a mechanism for knowledge management governance frameworks and actors' cognition representation to ensure that the implementation process is context-driven and has cognitive control.
- In the operational layer, advanced computational modeling of system dynamics needs to be robustly applied to tackle the dynamic complexity of the strategy implementation process, determine the current and future status of higher education strategy, motivate decision-makers to take timely corrective action, and control the cognitive variety at the micro level of implementation.
- In the sustainability layer, agent-based and complex network-based models can be applied to model conditional action patterns in strategy implementation and overcome the challenges associated with resiliency and flexibility such as adaptation, dynamism, and complexity.

However, the influence of automated technologies on quality attributes is not limited to the above, as applying computational models and tools in the field of strategy needs more research [38]. Therefore, information systems and strategic researchers together should investigate more strategy notions and the use of automated technologies in the process of crafting higher education strategy.

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