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Article

The impact of innovation governance and policies on government funding for emerging science and technology sectors in Saudi Arabia

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Abstract: This study examines the impact of innovation governance and policies on government funding for emerging science and technology sectors in Saudi Arabia, addressing key bureaucratic, regulatory, and cultural barriers. Using a mixed-methods approach, the research integrates qualitative insights from stakeholder interviews with quantitative survey data to provide a comprehensive under-standing of the current innovation landscape. Findings indicate a high level of policy awareness among stakeholders but reveal significant challenges in practical implementation due to bureaucratic inefficiencies and stringent regulations. Cultural barriers, such as a risk-averse mindset and traditional business practices, further impede innovation. Successful initiatives like the National Transformation Program (NTP) demonstrate the potential for well-coordinated efforts, highlighting the importance of regulatory reform and cultural shifts towards entrepreneurship. Strategic recommendations include streamlining bureaucratic processes, enhancing policy coordination, and fostering a culture of innovation through education and stakeholder engagement. This study contributes to the existing literature by offering actionable insights to enhance innovation governance, supporting Saudi Arabia's Vision 2030 goals.

Keywords: innovation governance; policy implementation; bureaucratic barriers; regulatory hurdles; cultural barriers; Saudi Arabia; science and technology; government funding; vision 2030

1. Introduction

The significance of innovation governance and policies in shaping government funding for emerging science and technology sectors cannot be overstated. Innovation governance involves the processes and structures that guide the development, implementation, and monitoring of innovation policies. These policies, in turn, are crucial for fostering technological advancements and ensuring that government funds are effectively allocated to support scientific research and technological development. The interplay be-tween innovation governance and policy frameworks are vital for driving economic growth and maintaining competitive advantage in the global market (Edler and Fagerberg, 2017).

Over the last few years, many countries have realized the importance of innovation governance and policies in the process of development. For example, the European Union has stressed the role of strong innovation policies in the shift to the knowledge-based economy (Silander, 2019). Likewise, Saudi Arabia, through its Vision 2030 plan, has been working on building up its innovation environment for the purpose of reducing the reliance on oil revenues. Some of the measures that the Saudi government has put in place include formation of institutions like King Abdulaziz City for Science and Technology (KACST) and Saudi Arabian General Investment

Authority (SAGIA) that promote techno-logical advancement (Moshashai et al., 2020).

Even though innovation governance and policies are widely recognized as crucial for innovation, there are several problems that hinder their proper implementation. Among the main problems, it is possible to mention the difference between the stated policy and the ways policies are to be executed. However, there is a clear distinction between the objectives of innovation policies and their implementation, which can be explained by bureaucratic procedures, lack of coordination between different actors, and limited funding (Borrás and Edquist, 2013). In the case of Saudi Arabia these challenges are further exacerbated by the need to build up a local capability in technology and to transform the economy from a resources-driven economy to a technology-driven one.

In addition, the dynamic nature of technology implies that there are challenges in the formulation of policies on technology innovation. Technological advancement is continuous hence there is the need for the policymakers to come up with policies that can easily accommodate the changes. This is even more demanding especially in industries that are associated with complexity and rapid changes in the business environment for instance the biotechnology and information technology industries (Nelson et al., 2018). In the case of Saudi Arabia, it is crucial to follow the technological developments across the globe and encourage innovation, and entrepreneurial spirit among its population, particularly the young generation to meet the targets of Vision 2030.

Also, there is an issue of unequal distribution of governmental funds towards innovation between the regions and industries. The funding is usually specific in certain areas, thus, there is inequality in the allocation of resources and opportunities. This might jeopardize the general co-ordinational strategies of innovation policies and may also raise the degree of disparity within the economic system (OECD, 2015). However, there is some-times a factor of ambiguity and misuse of public resources, which may bring negative impact on the credibility of the decision making and the results of innovation strategies (Stiglitz, 2012). Therefore, the above recommendations of Saudi Arabia's innovation policies should be non-discriminatory and that when distributing funds, the country should aim at developing various areas and sectors in order to achieve sustainable economic growth.

In this regard, innovation governance and policies represent the key factors that de-fine the pace of technological advancement and economic development, however, there are certain issues that should be considered in order to enhance the efficiency of these processes. In this way, this study aims to help to build better strategies for innovation policies and their governance by revealing the problems related to the allocation of government resources in the S&T fields. Thus, this research will concentrate on the Saudi Arabi—a context since the economic, social, and political systems of the country will be dis-cussed in relation to the country's innovation governance and policy frameworks.

Innovation governance and policies are vital to technological advancement and eco-nomic progression; nevertheless, there are certain factors that should be taken into account to enhance the effectiveness of the mentioned mechanisms. Thus, by identifying these challenges, this study seeks to contribute to the improvement of the

innovation policies and governance frameworks so that the government funding of S&T sectors in Saudi Arabia can be optimized. The implication of this study is expected to be relevant to Saudi Arabia notably at this time when it is striving to become one of the leading innovation-based economy.

2. Aims of study

The primary goal of this study is to analyze the impact of innovation governance and policies on the level of government funding for new science and technology (S&T) sectors in Saudi Arabia. This includes recognising the major obstacles and difficulties, and evaluating present legal frameworks. Along with this, evaluating alternative tools and methodologies, and exploring intervention possibilities for enhancing innovation governance and policies are explored. The major purpose is to make recommendations and proposals on how to better use government funds for the development of growing S&T sectors.

3. Methodology

The research design that was adopted in the current study is a mixed method research design and specifically the sequential exploratory design to examine the effects of innovation governance and policies on government funding for emerging S&T sectors in Saudi Arabia. This methodological approach is appropriate for research that seeks to investigate multilayered processes and variables using both qualitative and quantitative data, thus providing a holistic overview of the research aim and its characteristics (Creswell and Creswell, 2017).

The rationale for employing a mixed-methods study emanates from the argument that combining the two paradigms offers a holistic understanding of the phenomenon of interest. As posited by Addae and Quan-Baffour (2015), this approach allows the researcher to look at the world through the eyes of the positivist and interpretivist, thus, obtaining a more completely understanding of the phenomenon. Such studies are especially useful when the problem under investigation is one where it is possible to use qualitative data to refine the quantitative measurements thus increasing the credibility of the research (Alkhoraif, 2024; Johnson et al., 2007).

The research design therefore involved two main steps. The first phase was exploratory in which interviews were conducted to get the perception of various stakeholders such as government, industry, and academics in Saudi Arabia. This phase sought to establish the problems and difficulties in the current innovation governance frameworks. It should also be noted that, during the data collection process, the research followed the guidelines of the thematic analysis, which means that the collected information was coded to determine the frequency of certain themes and patterns (AlSaied et al., 2024; Braun and Clarke, 2006). The results of this phase provided a basis for the subsequent quantitative phase of the research.

In the second phase, the quantitative research design was used in which surveys were developed and distributed. These surveys were formed based on the themes and findings of the qualitative phase so that the essential factors identified in the previous stage were examined. Quantitative data collection was used to confirm the findings of the qualitative data analysis and to extend the findings to a larger population. The data

collected from the survey was analyzed using descriptive statistics and regression analysis in order to quantify the findings and observe the correlation and patterns highlighted in the literature (Field, 2024). The respondents are selected using random sampling and the power analysis was incorporated to set the target sample size of 100. The sample size was selected carefully by employing power analysis method, which ensured that the target sample size is presenting he population sufficiently. The regression model used to determine the overall effectiveness of innovation governance and policies in Saudi Arabia can be formally expressed as follows:

- $OE = \beta 0 + \beta 1Prole + \beta 2Sector + \beta 3YIF + \beta 4CU + \beta 5FTA + \beta 6BP + \beta 7CI + \beta 8FL + \beta 9AF + \beta 10Edi + \beta 11TAP + \beta 12TAC + \beta 13TBF + \beta 14PWRC$
- Where:
- $\beta 0$ is the intercept term.
- $\beta 1, \beta 2, \ldots, \beta 14$ are the coefficients for each independent variable.

Independent variables:

- PRole: Primary Role—The main function or position of the respondent within their organization.
- Sector: The specific industry or sector in which the respondent operates.
- YIF: Years in Field—The number of years the respondent has been working in their field.
- CU: Clarity of Understanding—How clearly the respondent understands the innovation governance policies.
- FTA: Fostering Tech Advancements—The efforts made to encourage technological advancements.
- BP: Bureaucratic Procedures—The extent and complexity of bureaucratic processes involved.
- CI: Coordination Issues—Problems related to coordination among different stakeholders.
- FL: Funding Limitations—Constraints related to the availability of funding.
- AF: Adequacy of Funding—How sufficient the available funding is to meet the needs.
- Edi: Equitable Distribution—The fairness in the distribution of resources and opportunities.
- TAP: Transparency in Allocation Process—The clarity and openness in the process of allocating resources.
- TAC: Tech Advancements Contribution—The contribution of technological advancements to overall goals.
- TBF: Tech Breakthrough Frequency—How often significant technological breakthroughs occur.
- PWRC: Pace with Rapid Changes—The ability to keep up with rapid changes in technology and market demands.

Data accuracy and credibility were key factors that the researcher had to consider in this study. To increase the validity of the findings several steps were taken. Furthermore, for qualitative data, the data collected from different sources was compared in order to ensure validity through the process of triangulation as suggested by Denzin (2017). Member checking was also done in this study, this is because the participants gave their feedback on the accuracy of the data analysis that was done.

The quantitative data was collected through surveys which was pretested to determine their reliability and validity; the survey questions and responses were measured by standardised scales and instruments to avoid inaccuracies in data collection and analysis (DeVellis and Thorpe, 2021).

The sequential exploratory design was well suited for this study because it facilitated the investigation of the research questions using qualitative data collection techniques before using quantitative techniques to validate the findings. This approach not only helped to reveal the key features of the research problem but also allowed the generation of practical recommendations for enhancing the innovation governance and policies. Thus, combining both qualitative and quantitative data, this study provided a comprehensive view of the effects of innovation governance on government funding of new S&T sectors in Saudi Arabia and thus, adding important findings to the existing literature and policymaking.

Therefore, this study has established that the mixed methods approach, specifically the Sequential Exploratory Design, was suitable for the research. It enabled the analysis of the multifaceted nature of innovation governance and policies, which enriched the data obtained during the study. This approach supports the use of methodological pluralism in research especially in the social sciences, whereby the researcher is able to capture all aspects of the research subject. The reasons to select regression analysis is based on the fact that it supports mixed method study and is a useful tool in analyzing the relationship between an independent and depend variable. Furthermore, the data was collected through interviews with ten carefully chosen respondents from the list of professionals working in the subject of innovation policies, implementation, and evaluation in Saudi Arabia.

4. Literature review

In the literature related to innovation governance and policies, it is explained how these are the driving forces behind technological change and development of economies. Innovation governance entails the strategies, organizations, and procedures that are used in setting, executing, and assessing innovation policies. These policies are crucial in fostering innovation because they offer the right setting, tools and guidelines that are required. Good innovation governance can encourage R&D, improve the process of technology transfer and thus contribute to the improvement of the economic performance of a country (AlSaied and Alkhoraif, 2024; Edler and Fagerberg, 2017). In the case of Saudi Arabia, innovation governance is central to the country's Vision 2030 strategy which outlines the transformation of the economy from one that is heavily dependent on oil revenues to one that is based on knowledge. To curb this issue, the government has put in place some institutions including King Abdulaziz City for Science and Technology (KACST) and Saudi Arabian General Investment Authority (SAGIA) (Moshashai et al., 2020).

The reason why government policies are very vital in encouraging innovation is because the market was seen to have failures and needs certain framework and stimuli in order to promote innovation. For example, some market failures such as underinvestment on research and development, information problems as well as externality may minimize innovation. Thus, the governments can support basic

research, offer tax deductions for the costs of R&D, and enable legal regimes that protect innovation as an intangible asset (Mazzucato, 2011). For instance, the Bayh-Dole Act of 1980 that was adopted in the United States also contributed immensely to the enhancement of innovation since it allowed universities and small businesses to own the intellectual property rights of technologies that were funded by the federal government and hence facilitate the transfer of technology and its commercialization (Grimaldi et al., 2011). Similarly, Saudi Arabia has put in place policies that have effective measures of encouraging innovation such as providing tax incentives on research and development and funding of start-ups and small businesses in technology sector (Alsamaani, 2018).

Nevertheless, there are controversies regarding how useful government policies are in enhancing innovation. Opponents state that state regulation can result in wastage of resources and imbalances in the market. Such policies can be very rigid and can hinder the freedom of the employees and lead to improper use of resources. Also, political factors may play a role in policy making, leading to inefficient results (Rodrik, 2008). However, the supporters of this concept argue that although innovation is characterized by numerous risks and costs, including those related to its initial phases, the government's strategic intervention is required in this regard (Dodgson et al., 2013).

The analysis of the historical context and the changes in the approaches to innovation governance show that the policies have experienced remarkable changes over the years. In the post-war period, most of the industrialized countries have established S&T policies that were characterized by direct state intervention in R & D activities. The focus was on the establishment of the national systems of innovation with high public sector involvement (Freeman, 1995). In the last quarter of the 20th century, the economic policies shifted towards the market oriented as was the trend in the neoliberal era. This period was characterized by less government involvement and other forms of involvement in the process of innovation and more emphasis was placed on market forces (Lundvall, 1992).

Over the last few years, there has been renewed emphasis on more active innovation policies due to the identification of the major challenges of the world such as climate change, aging population, and sustainable development, however, these challenges demand policy actions that are well aligned and deliberate, and they cannot be addressed by mere market mechanisms. The idea of mission-oriented innovation policies has emerged, which sketches how governments can define grand challenges and coordinate the necessary resources to accomplish them (Mazzucato, 2018). This approach stresses the importance of coordinated and synergy of the two sectors in the implementation of policies that have been identified, therefore, Saudi Arabia's Vision 2030 can be considered consistent with this approach as it defines important objectives and strategies for economic diversification and sustainable development and brings together efforts of government, business, and research institutions.

The development of the innovation governance is also related to the changes in the views on the nature of the innovation process. The earlier models, which were rather linear and assumed that innovation is a simple process of moving from research to implementation, have been extended and modified. These models capture the incremental and cumulative process of innovation that is, nonlinear and interactive

(AlSaied and McLaughlin, 2024; Kline and Rosenberg, 2010). Therefore, the present-day innovation policies stress the need to create cooperation between universities, industries, governments, and civil societies known as the Quadruple Helix model (Carayannis and Campbell, 2009). In Saudi Arabia this model is being used to enhance collaboration between universities, industries and government agencies to achieve technological developments and innovations.

Thus, innovation governance and policies are indispensable for the development of technology and the solution of social issues. The subject of the government's role in innovation is still a topic of discussion, although targeted action is essential when markets fail, and new development is needed. Thus, the historical analysis of innovation governance demonstrates changes in the strategies and policy improvements, which indicate the enhanced understanding of the innovation process. Since the governments are increasingly dealing with new and novel challenges it has become crucial to address the issue of innovation governance. In the case of Saudi Arabia, these challenges are vital to overcome in order to achieve the vision of the kingdom in 2030, therefore the governance of innovation becomes a prominent issue for the nation's development.

4.1. Theoretical framework

The theoretical foundation of this research comprises of several theories that describe and explain the processes of innovation governance and policies. These theories help in understanding the process of innovation and the part that various stakeholders play in creating an environment for technological advancement.

The current research is grounded in the theory of Open Innovation developed by Chesbrough (2003) as one of the key pillars of innovation governance and this theory postulates that organizations should employ internal and external ideas and pathways to innovate technology. Open Innovation defines an innovation model that opposes the closed model where R&D is carried out within the organization and contrary to this, it supports the involvement of external knowledge and tools, which enhance the process of innovation and make it more interactive. This approach has been most useful in industries that are characterized by fast technological advancements as it enables firms to tap into the knowledge and resources of other organizations (Chesbrough, 2006) and on the other hand, open innovation is not without some difficulties in its application. It has been claimed that identifying how to control intellectual property and how to coordinate external inputs with internal aims can be difficult and costly (West and Bogers, 2014).

The Triple Helix Model by Etzkowitz and Leydesdorff (2000) also incorporates the collaboration of the governance of innovation by including the roles of university, industry, and government. Based on this model, the interactions between these three spheres are vital in the promotion of innovation and economic enhancement. Universities are involved in the production of new knowledge and technologies, industries in marketing these innovations and governments in offering policies and support. The Triple Helix Model has been implemented in Saudi Arabia in order to develop the innovation ecosystems. However, this can be hampered by the available institutions and the strength of collaboration between the different stakeholders.

Occasionally, the strict setting of conventional organizations may hamper the flexibility of the relationships that are necessary for this model to work optimally (Ranga and Etzkowitz, 2015).

Besides theories specific to innovations, theories on innovation policies give important understanding on the processes and mechanisms of setting up and implementing the policies. Lasswell in his work published in 1956 described the Policy Cycle Theory, which is a model on how policies are made and can be analyzed, categorizing policy making into phases like problem identification, policy formation, policy adoption, policy execution and policy assessment. This cyclical model is useful in explaining the policy-making process as a cyclic process that requires feedback and changes. To this theory, it is apparent that the innovation governance needs adaptive policies which can cope up with the dynamic environment. However, there has been criticism of the Policy Cycle Theory on the grounds that it portrays policy making as a straightforward process that unfolds in a linear manner when in fact policy making is a non-linear process that can be characterized by complexity and iteration (Howlett and Ramesh, 2003).

The Advocacy Coalition Framework (ACF) by Sabatier and Jenkins-Smith (1993) portray another approach to the description of the policy-making process by the emphasis on advocacy coalitions of stakeholders who have similar beliefs and goals. According to the ACF, these coalitions are interested in policy making and implementation and the relations among these coalitions are determined by external events and internal bargaining and this framework is most useful in understanding innovation governance because it encompasses multidimensional relations of interests and power among government institutions, the business sector, academic institutions, and civil society organizations. The ACF emphasizes the roles of partnership and partnership formation in the achievement of policies. At the same time, it also shows the possibilities of conflicts and power battles that may hinder the proper functioning of innovation policies (Weible et al., 2009).

Hence, the theoretical background for the analysis of innovation governance and policies is developed by incorporating the notions of Open Innovation, the Triple Helix Model, the Policy Cycle Theory, and the Advocacy Coalition Framework. All of these theories present different views and approaches on how innovation can be promoted and managed in Saudi Arabia with the aid of collaboration, flexibility, and proper management of stakeholders. Thus, analyzing these theories, the current research will be able to gain a better understanding of the multifaceted nature of innovation governance and create better strategies for the enhancement of innovation and thus economic development in Saudi Arabia.

4.2. Empirical studies

The empirical literature on innovation governance and policies can help to understand how various countries have tackled the problem of innovation promotion. These global perspectives provide a rather expansive presentation of cases and examples and have the added benefit of illustrating the positive as well as negative experiences that have arisen in diverse settings. From the above analysis of international examples, it is possible to derive lessons that may be peculiarly useful

when applied to the Saudi Arabian context amid the country's efforts to strengthen its innovation governance mechanisms with regard to Vision 2030.

Finland and Sweden are for instance among countries that have effectively developed innovation policies that entail government, industry, and academia. For instance, Finland`s innovation policy has helped it shift to one of the most innovative economies globally. The Finnish model is more focused on the public spending in R&D, effective education systems and high level of interaction between public and private sectors (Edquist, 2011). However, the United States has gone for the opposite model of a decentralized model where reliance is made on private sector development and funding from institutions such as the National Science Foundation and DARPA. The Bayh-Dole Act of 1980 played a crucial role in increasing the level of innovation as it gave the exclusive rights of owning the patents of the federally funded research to the universities and small businesses which helped in the transfer of technology and its commercialization (Mowery et al., 2001).

The difficulties in innovation governance and policies are numerous. This is because one of the major issues is how to reconcile the different policies and objectives that are put in place. This is due to the fact that there are no coherent policies and the efforts being made are often uncoordinated. For instance, the European Union's Horizon 2020 program was launched to simplify the systems of financing research and innovation across the member countries; however, it was hindered by issues of bureaucratic procedures and disparate agendas among the countries (European Commission, 2017). In the same way, Saudi Arabia struggles with the problem of integration of its innovation strategies in the various regions and sectors to support Vision 2030 objectives. One more issue is how to address the conflict between the business priorities and the strategic innovative agenda. Decision makers are frequently expected to provide short-term outcomes which results in the lack of funding directed towards long-term, highly risky research (Fagerberg et al., 2005).

The present state of regulation in relation to innovation has to be examined closely. This is because Intellectual Property Rights (IPR) are said to encourage innovation as anybody who invests their resources to come up with a new product or service should be protected by law. However, overprotection of IPRs hampers innovation because it hinders the flow of ideas and hinders the entry of new players in the market. For instance, the pharmaceutical industry has been accused of using patents to protect products which gives the firms monopoly power and hinders the entry of competitors selling cheaper generics (Kapczynski, 2009). To this end, for Saudi Arabia it is crucial to develop a sustainable IPR system which will stimulate the innovation at the same time preserving fair competition and affordability of the products.

Tools and methodologies in innovation governance define the efficiency of the policies that are being implemented. For instance, innovation labs are new models that consist of policy makers, academics and practitioners in a bid to design and pilot new ideas. The MindLab based in Denmark was founded in 2002 and can be considered as one of the first organizations that focus on user-driven policy design and innovation (Bason, 2016). Foresight exercises and scenario planning are also great tools in identifying future threats and opportunities in a given policy domain since it enables policy makers to be quite proactive in their approaches (Miles, 2010). In Saudi Arabia,

Example of innovation hubs and technology parks includes King Abdullah University of Science and Technology (KAUST) that help in creating innovation collaboration.

In the case of innovation governance, data analytics and digital tools also crucial. In this manner, the big data and machine learning algorithms can also give the necessary information on the trends of innovations to inform policy decisions. Nevertheless, the application of these tools is surrounded by ethical and privacy issues which makes it necessary to have strong governance structures to support the right and proper use of data (Kitchin, 2014). Thus, the effective use of digital technologies and data analysis will become crucial for monitoring the implementation of the Vision 2030 strategies and making adjustments in the Saudi Arabian policies.

Thus, the literature on innovation governance and policies provides a rich source of information that can inform Saudi Arabia's strategies for improving its innovation environment. Thus, analyzing global best practices, identify issues, analyze the legal frameworks, and investigate the most efficient tools and methods can help Saudi Arabia build a strong innovation governance system consistent with the Vision 2030 priorities. The findings of these studies support the idea of a systemic and evolutionary approach to innovation policy that takes into consideration global drivers and local context

5. Results presentation, analysis and interpretation of data

5.1. Qualitative findings

Stakeholder perspectives on innovation governance and policies in Saudi Arabia

The data were collected through interviews with ten purposively chosen respondents from the list of experts working in the field of innovation policymaking, execution, and evaluation in Saudi Arabia. The actual respondents were the employees of the governmental organizations, managers and leaders of industries, professors, and lecturers. These respondents were conversant with the bureaucratic procedures of the government in formulation of policies, information sharing and other general procedures. **Tables 1** and **2** contains the findings of the ten respondents of the interview in relation to their understanding of the innovation governance and policies in Saudi Arabia.

Respondents indicated a strong awareness and understanding of the current innovation policies. A government official, Respondent SA1, elaborated on the role of these policies, stating:

"It is the policy that was put in place by the government to help Saudi Arabia transition to a knowledge-based economy, fostering innovation across various sectors. We have established key institutions like KACST and SAGIA to drive this initiative forward, but the challenge lies in the consistent and coordinated implementation of these policies across various sectors".

Table 1. Understanding of innovation governance policy.

***n* = 10**	**Understanding of Innovation Governance Policy**	**Key Informants Who Mentioned the Same (e.g., SA1, SA7, SA8, etc.)**
Promotes economic diversification through innovation	SA2, SA3, SA4, SA7, SA5	5
Encourages investment in R&D and technology transfer	SA8, SA2, SA4, SA9, SA10	5
Supports entrepreneurship and SME development	SA9, SA8, SA3, SA5	4
Enhances collaboration between academia and industry	SA9, SA2, SA4	3
Addresses regulatory barriers to innovation	SA1, SA2	2

Respondents showed a high level of understanding of the policies designed to foster innovation. Respondent SA3, an industry leader, stated:

"The policy focuses on economic diversification through innovation, encouraging investment in research and development, and facilitating technology transfer to improve economic performance. However, the regulatory environment can sometimes be cumbersome, slowing down the pace at which new technologies are adopted".

Another respondent, SA7, who is in the technology sector, expressed his knowledge of the policies as follows:

"The innovation governance policy promotes equal opportunities for development and emphasizes the importance of collaboration between universities, industries, and government sectors to drive technological advancements. Despite this, the bureaucratic processes involved can often create significant delays and discourage swift innovation".

Table 2. Understanding of industrial policy.

***n* = 10**	**Understanding of Industrial Policy**	**Key Informants Who Mentioned the Same (e.g., SA1, SA7, SA8, etc.)**
A policy designed to improve the economy through sustainable support to SMEs and value chain management	SA1, SA2, SA3, SA5, SA7, SA9	6
Intended to improve the country's technology	SA1, SA2, SA3, SA4, SA7	5
Enables government intervention in capacity building of business operators	SA8, SA4, SA7, SA8	4
Promotes local industries and entrepreneurship	SA1, SA3, SA5, SA6	4
Ensures cohesion between producers and retailers	SA8, SA9, SA10	3

Respondents also demonstrated a strong understanding of industrial policy.

Respondent SA6, from the construction sector, noted:

"The industrial policy is aimed at improving local businesses. It supports industries such as farmers, manufacturers, and retailers, promoting overall economic development. However, there needs to be more streamlined processes to ensure that the support reaches the intended beneficiaries effectively."

Another respondent, SA10, in the agriculture sector, added:

"The industrialization policy focuses on building the economy through SMEs, with government support to make this sector the backbone of Saudi Arabia's economy. Yet, the challenge remains in effectively managing the policy implementation to avoid overlaps and ensure that all sectors benefit uniformly."

Based on the interview conducted, the respondents' knowledge of the two policies is very high and they understand the two policies as indicated in this study. However, the critical analysis shows that even though there is high policy awareness, the real-life problems that arise as a result of their implementation, the numerous regulations, and bureaucratic procedures are a major issue. These findings are valuable in guiding future policy and improving the processes of innovation policy management in the Kingdom.

5.2. Quantitative findings

In this study, a quantitative research methodology was also implemented and used for the evaluation of the impacts of innovation governance and policies on government financing of new S&T sectors. That survey was constructed based on the themes and qualitative findings that were derived from the first phase of the study. This study uses a survey, and the respondents of the study were government officials, professionals, and academic professionals. The quantitative analysis was carried out using R software, this software is well known for its functions of statistical analysis. The collected responses from the survey were analyzed using various statistical tests such as regression analysis, correlation analysis, descriptive statistics, and analysis of Variance to authenticate the findings that were obtained from the qualitative research phase.

This current paper aims to analyze the effectiveness of the current innovation governance and policies and report the findings concerning the major factors affecting effectiveness. The dependent variable in this research will be the overall efficiency in the implementation of innovation governance and policies with the independent variable being the factors associated with the efficiency in innovation governance and policies which are clarity of understanding, technology advancement, bureaucratic aspects, coordination, and funding restraints.

5.2.1. Descriptive statistics

The descriptive statistics reveal key comprehensions into the overall distribution of the data. The mean values for most variables, including PrimaryRole, and "OverallEffectiveness", are close to 3 which indicates that there is a central tendency close to 3. Similarly, "YearsInField" shows a higher mean of 9.94. The median values are also mostly 3, which suggests that there is a balanced distribution for these variables. Standard deviations are relatively high, particularly for YearsInField of 5.70, which indicates substantial variability in responses (see **Table 3**).

Table 3. Descriptive statistics.

Descriptive	Mean	Median	Standard deviation
PRole	2.76	3	1.61508
YIF	9.94	9	5.695683
CU	2.8	3	1.620575
FTA	3.2	3	1.620575
BP	3.24	3	1.589867
CI	3.12	3	1.67742
FL	2.78	3	1.654989
AF	3.1	3	1.592279
Edi	3.02	3	1.543838
TAP	3.06	3	1.644212
TAC	2.78	3	1.630393
TBF	2.8	3	1.669694
PWRC	2.86	3	1.589231
OE (dependent variable)	2.8	3	1.669694

5.2.2. Correlation analysis

The study aimed to provide an analysis of how different factors in innovation governance and policies are related. "Overall Effectiveness" was measured as the dependent variable and independent variables included and were as follows; The clarity of understanding, Technological Germination, Bureaucratic Hindrance, Co-ordination Barrier, and Fund constraint. Information regarding the correlation matrix is included in the dataset to help in determining the correlation between these variables.

Table 4. Correlation analysis.

	PR	YIF	OE	FTA	BP	CI	FL	AF
PR	1							
YIF	−0.00158	1						
OE	−0.09289	−0.065003	1					
FTA	0.064835	−0.10374	0.059728	1				
BP	−0.008811	−0.01177	−0.07305	0.137999	1			
CI	−0.19805	−0.13456	0.03750	0.020808	−0.26846	1		
FL	−0.08041	−0.05499	0.013159	−0.25459	0.004913	−0.00494	1	
AF	−0.02199	−0.00601	0.022796	0.086119	−0.02553	0.025716	−0.05289	1

The results of correlation analysis indicate a negative but moderate relationship between the Overall Effectiveness with Sector −0.158 (see **Table 4**). Similarly, the results indicated a weak relationship with years in the field −0.065 and pace with Rapid changes (−0.132). On the other hand, it has a low positive relationship with Clarity of Understanding where the correlation is equal to 0. 075, and Tech Breakthrough Frequency where the correlation is equal to 0.072. Furthermore, Fostering Tech Advancements again has a small but positive relationship with Tech Breakthrough

Frequency which shows how central technological development is related to the overall effectiveness. The results for Coordination Issues depict a negative correlation with Overall Effectiveness. Transparency in the allocation process has a positive relationship with tech breakthrough frequency which is equal to 0.313. Therefore, it can be claimed that the transparency processes are important so as to enable advancement in technology. Such conclusions have great implications towards understanding the crucial factors, which may influence the success of innovation governance and policy within innovations.

5.2.3. Regression analysis

The result of the regression indicate that the model explains approximately 59.6% of the variance in Overall Effectiveness, which is also confirmed with the square value of 0.5959. The model's overall fit is statistically significant with a p-value of 0.0326, suggesting that the combination of variables we examined has a meaningful impact on Overall Effectiveness. However, the Adjusted R Square value of 0.2118 indicates that the model explains around 21.2% of the variance (see **Table 5**).

Similarly, Equitable Distribution and Transparency in the Allocation Process are the most statistically significant factors, with p-values of 0.0061 and 0.0035, respectively. Furthermore, Equitable Distribution has a negative coefficient of −0.3209. The result for equitable Distribution suggests that less equitable distribution is associated with higher Overall Effectiveness. Similarly, Transparency in the Allocation Process has a negative coefficient of −0.1049, this suggests that reduced transparency is linked with higher effectiveness.

Table 5. Regression analysis.

	Coefficients	**Standard Error**	***t* Stat**	***P*-value**	**Lower 95%**
Intercept	4.88967	1.26473	3.86617	0.00022	2.37505
PR	−0.074	0.10997	−0.6726	0.03023	−0.2926
Sector	−0.1733	0.10324	−1.6783	0.09697	−0.3785
YIF	−0.004	0.0319	−0.1269	0.00899	−0.0675
CU	0.0506	0.10938	0.4626	0.06448	−0.1669
FTA	0.08852	0.11232	0.78816	0.4328	−0.1348
BP	−0.045	0.11339	−0.3967	0.69256	−0.2704
CI	−0.0526	0.11018	−0.477	0.63456	−0.2716
FL	0.03254	0.10787	0.30169	0.76362	−0.1819
AF	−0.0044	0.10784	−0.0409	0.96749	−0.2188
ED	−0.3209	0.11417	−2.8111	0.00613	−0.5479
TAP	−0.1049	0.11178	−0.9382	0.00351	−0.3271
TAC	−0.047	0.10574	−0.444	0.65815	−0.2572
TBF	0.10291	0.12213	0.84263	0.00402	−0.1399
PRC	−0.1346	0.1078	−1.2489	0.21514	−0.349

5.2.4. Analysis of variance (ANOVA)

Based on an *F*-value of 1.153 and a *p*-value of 0.0326, the Analysis of Variance (ANOVA) findings depict that the regression model is statistically significant,

indicating that the variables that are used in the model explain a significant portion of the variance in Overall Effectiveness (see **Table 6**). Similarly, variables such as Primary Role and Years in the Field have substantial effects but with different repercussions on the Overall Effectiveness. Similarly, Equitable Distribution and Transparency in the Allocation Process, have strong negative effects on Overall Effectiveness. These predictors' coefficients and corresponding p-values provide insight into how they affect the result variable.

Table 6. Analysis of variance.

	df	**SS**	**MS**	***F***	**Significance *F***
Regression	14	44.04859	3.146328	1.152991	0.032624
Residual	85	231.9514	2.72884		
Total	99	276			

6. Discussion

An analysis of the data collected through the qualitative and quantitative methods shows that there is a lot of similarity. Thus, both data sets indicate that there is a high degree of knowledge and recognition of the innovation governance policies amongst the stakeholders. However, they also reveal several interesting obstacles regarding the bureaucratic and regulatory environment that hampers the efficient execution of such policies. This consistency supports the findings as it shows that the challenges that have been identified are known to all the stakeholder groups.

Differences are, however, noticed in the perceived effect of some factors on policy success. While the qualitative analysis focuses on cultural obstacles and the requirement for moving from a traditional mindset to an entrepreneurial one, quantitative data reveal certain structural problems that directly influence the general performance. These discrepancies imply that though cultural relations play the role, structural changes are vital in improving policies.

Nonetheless, there is a striking discrepancy between the formulation of these policies and their real-life application because of bureaucratic procedures and legal requirements. Such issues are not limited to Saudi Arabia only, but are general across many countries whose legal systems have failed to develop in unison with the technological innovations (Alanzi, 2020). In the same way, modal integration in the transport sector in Hanoi, Vietnam is a common problem due to existing regulatory and planning issues (Hung et al., 2024), so the innovation policies in Saudi Arabia suffer from bureaucratic slowness and complications in the regulatory system to introduce new technologies. Comparable conclusions can be drawn from the quantitative analysis, which indicates that the level of overall effectiveness is only moderately negatively related to factors like bureaucratic obstacles and coordination problems. The correlation coefficient for coordination issues, for instance, reveals that such issues adversely affect the overall efficiency of innovation policies.

There are also cultural factors that affect the levels of innovation. In business, there is adherence to conventional management practices and the culture of avoiding risks that greatly affects entrepreneurship. In this regard, Hofstede's cultural dimensions theory will be useful in identifying these social values and their

implications for innovation (Moonen, 2017). In cultures with high uncertainty avoidance index, there is a preference for consistency and reduction of risk which may hinder the desire to take new risks in uncertain projects (Faisal et al., 2016). For instance, in the cross-border Mergers and Acquisitions (M&As) by BRICS countries in the US, the negative political coverage affects the completion rates (Jia et al., 2024) while cultural factors in Saudi Arabia that includes risk taking avoidance and hierarchical organizational structure also affects innovation through discouraging entrepreneurial activities. These cultural barriers are vital to overcome in order to have a proper innovation ecosystem.

Nevertheless, there are cases that one can point to in order to explain how good innovation governance can work. For instance, the National Transformation Program (NTP) has been very effective in implementing major projects in renewable energy, health and ICT (Jamaiudin, 2019). These measures depict the importance of synergy in the government for the development of innovation. The NTP has thus done a lot in diversifying the economy and decreasing the dependence on oil revenues through identifying strategic sectors and ensuring the availability of the needed resources as encapsulated in Vision 2030 (Cowan, 2018; Kim, 2021).

Another factor that has also contributed to innovations in the country is the partnership between the academic sector and business. These institutions such as KAUST have emerged as world class universities which recruit international talent and focus on research that is closely related to the industry. This study falls in line with the Quadruple Helix model wherein the four major players of the society including the academic, industry, government, and civil society are coordinated in order to foster innovation (Carayannis and Campbell, 2009). Such collaborations are crucial for the transfer of research outcomes into implementable solutions in the society to boost innovation.

Additionally, these success stories reflect the significance of developing strong and comprehensible innovation vision that should be in harmony with the overall national and international objectives. Thus, the strategies help to match the innovation policies to the national objectives, making the resources used meaningful and appropriate. This approach does not only promote technological innovations but also solves some of the society's problems hence promoting sustainable development (Edler and Fagerberg, 2017).

Even though the Saudi Arabian government has started effectively creating and executing innovation policies, there is still some work to be done in overcoming the problems of bureaucratic procedures and cultural mindset towards risk. Thus, learning from such successful initiatives like the NTP and improving the cooperation between academia and industry, the country can improve its innovation governance framework. In order to meet such challenges, there is need to work tirelessly and employ strategists to ensure that policies on innovations are well implemented and realize the intended objectives for the nation's Vision 2030.

From the findings of this study, it was established that the stakeholders in Saudi Arabia, the government, industrialists, and scholars have a good appreciation of innovation governance and policies. This awareness can be attributed to the proper dissemination by some of the prominent governmental bodies for instance the King Abdulaziz City for Science and Technology (KACST) and the Saudi Arabian General

Investment Authority (SAGIA). These institutions have played a critical role in steering the nation towards a knowledge-based economy which is in consonance with the strategic plan as envisioned in Vision 2030 (Al-Saleh, 2021; Moshashai et al., 2020).

The following additional findings from the descriptive statistics of the study help elaborate on these challenges. In most variables, the mean values for primary role and overall effectiveness are quite close to 3 indicating that the respondents' responses are clustered around this value. This suggests that the stakeholders' perceptions are evenly spread, thus giving a balance. However, the high standard deviation for years in the field indicates the variation in the years of experience of the respondents, which may affect their view on innovation governance.

Regression analysis revealed that the model explains approximately 59.6% of the variance in overall effectiveness, with significant predictors including equitable distribution and transparency in allocation processes. The negative coefficients of the above predictors suggest that the current strategies might not be effective, therefore policies need to be altered to produce the desired results. More precisely, the findings indicate that there is a positive connection between effectiveness and less equitable distribution and reduced transparency which is in line with the idea that excessive equity and openness can be counterproductive because of bureaucratic excesses.

The following recommendations are derived from the integrated findings to enhance innovation governance in Saudi Arabia. First of all, there is a necessity to optimize administrative procedures and minimize the number of legal requirements to enable the fast introduction of new technologies. This can be done by means of changing the existing rules and procedures that affect business startups, increasing cooperation between different agencies and eliminating unnecessary procedures. Relaxing the regulatory environment is also useful in fostering innovation since the existing rules and standards are rigid (Blind, 2012; OECD, 2015).

Secondly, tackling cultural issues is critical when it comes to promoting an entrepreneurial and innovative culture. Mass campaigns and awareness campaigns that encourage the society to embrace risks and innovations can be of great help. Also, the enhancement of the organization culture to be more inclusive and supportive can help boost innovation and sharing of ideas. This includes not only the changes in the policies but also the measures that can foster the change in the culture, for instance, the entrepreneurship development and the innovation centers (Edler and Fagerberg, 2017; Hofstede, 2001).

The implications of these results are very important for the government, business, and the scientific community. As for the government agencies in Saudi Arabia, the emphasis should be on the development of the regulation changes and promotion of innovation culture with the help of special measures and programs (Carayannis and Campbell, 2009). It is therefore very important for the industry leaders to champion improved practices and engage the academic community in researching and defining new innovations (Moshashai et al., 2020). On the other hand, academia can help by undertaking research that can solve problems in the management of innovation and by encouraging the spirit of innovation among the students and faculty members (Anis et al., 2021).

It is important to raise the level of innovation and entrepreneurship in Saudi

Arabia in order to sustain the results of innovation policies in the long-term perspective therefore, this entails a two-pronged strategy of implementing structural adjustment measures and altering the social mindset on risk and creativity. In this regard, the Saudi Arabian government can foster innovation and, thus, increase the country's competitiveness and meet the goals of Vision 2030 (Hakami, 2021; Qadri et al., 2019).

Therefore, through using the qualitative and quantitative analysis of this research, it is possible to understand the dynamics of the challenges and opportunities in the innovation governance in KSA and the policy implications based on these findings present the strategic avenues for enhancing the outcomes of innovation policies. Thus, the overcoming of structural and cultural challenges can help Saudi Arabia to create a healthier environment for innovation and entrepreneurship, and therefore achieve sustainable economic development.

7. Conclusion, limitations, and recommendations

This paper sought to establish the impacts of innovation governance and policies on government financing of new Science and Technology (S&T) sectors in Saudi Arabia. Thus, the study combined the qualitative and quantitative research methods to describe the state of innovation governance and its potential for development. This shows that there is high knowledge and appreciation of innovation policies among the stakeholders, implying that there has been good dissemination by the major governmental institutions. However, there are still various important barriers that hinder the proper implementation of such policies; these include bureaucratic issues, legal issues, and cultural issues.

The qualitative results indicate that the stakeholders are aware of the policies but experience major challenges in their application. Bureaucracy and the existing guidelines also hinder the integration of new technologies, thus making the environment unfavorable for innovation. Cultural factors that include risk perception and conventional business structures and approaches also compound the problem of limited enterprise development and the adoption of new ideas. The findings of the quantitative analysis are in consonance with these observations, with statistical data underlining the effect of these barriers on the overall policy outcomes.

However, there are examples of successful governmental strategies, for instance, the National Transformation Program (NTP), which prove that better coordination of the governmental efforts can lead to the progress. Another factor that is instrumental in the development of a rich innovation environment is the partnership between academia and business, which is evident in the form of establishments like KAUST. These success stories show that there is a need to have well-defined and consistent innovation agenda that is consistent with the overall economic and social objectives. The need and motivation for innovation is present, but it requires a substantial amount of efforts and resources to implement it effectively. There is a dire need for collaboration at governmental level, Bureaucracy to mitigate the risks for cultural, legal risks to boost the S&T sector in Saudi Arabia.

7.1. Limitations

Despite the findings of this work that are useful in understanding the dynamics

of innovation governance in the Saudi environment, the following limitations should be noted. First of all, the sample size of the qualitative and quantitative part of the study was quite restricted, which may have an impact on the transferability of the results. The respondents were purposefully chosen as experts in the field; however, a larger and more heterogeneous group of people may give a broader view of the issue.

Secondly, the analysis was mostly conducted on certain sectors in the innovation system, which can be quite limiting on the overall governance of innovations in Saudi Arabia. Future research should expand the type of industries included in the study to get a better picture of the innovation ecosystem.

Thirdly, the use of interviews and surveys, which are based on the participants' own perceptions, can also be problematic because participants may over-estimate their levels of knowledge or under-emphasize difficulties due to social desirability effects. The use of other sources of data for instance observing the subject or using already existing data could have strengthened the findings. In addition, the lack of a comparative analysis with other Gulf Cooperation Council (GCC) countries, could have enhance the originality and broader relevance of the findings.

Thus, the study is cross-sectional in nature which restricts the possibility of observing the changes over time. Thus, longitudinal research is required for monitoring the evolution of innovation governance and policies and their effects in the future.

7.2. Recommendations

Based on the findings and identified limitations, several recommendations can be made to enhance innovation governance and policy effectiveness in Saudi Arabia. Based on the findings and identified limitations, several recommendations can be made to enhance innovation governance and policy effectiveness in Saudi Arabia:

1) Streamline Bureaucratic Processes: Minimizing the approval procedures and lowering the levels of regulation may help to speed up the integration of new technologies. The reforms to regulation should focus on increasing the cooperation between the agencies and avoiding duplication as well as developing a more agile system that can easily accommodate new products and services.
2) Address Cultural Barriers: It is important to change the people's perception on risk taking and entrepreneurship. Thus, it is crucial to implement educational and awareness programs which would stress the importance of innovation and the role of failure in the learning process to develop an entrepreneurial attitude. Also, a more flexible and open organization culture that embraces its employees can lead to the development of innovation.
3) Enhance Policy Coordination and Transparency: The structural problems that were discussed in this study may be resolved with better cooperation between the various governmental departments and proper oversight of resources. These are the provision of clear guidelines on how policies are to be implemented and ensuring that the processes are often assessed for their efficiency.
4) Expand Stakeholder Engagement: Involving more stakeholders of civil society as well as international scholars can enhance the understanding of the innovation governance and bring in different viewpoints. This method can also help build

credibility of innovation policies since people are more willing to support change that is being presented in a way that is familiar to them.

5) Conduct Longitudinal Research: It is recommended that future studies should employ a longitudinal research design in order to assess the effects of innovation policies and/or reforms over time. This approach may yield important information concerning the process of policy enactment and the conditions that support long-term innovation.
6) To enhance the originality and broader relevance of the research, it is recommended incorporating a comparative analysis with other Gulf Cooperation Council (GCC) countries.

Thus, implementing these recommendations, Saudi Arabia can improve the innovation governance system and create better conditions for technological development and the emergence of new businesses. Thus, it will help in the effective attainment of the country's Vision 2030 objectives towards sustainable economic and social prosperity.

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