

## THE ENHANCEMENT FACTORS OF MINING COMPLEXES IN RIYADH SAUDI ARABIA

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### Abstract

The research aim is to enable the mining sector to achieve sustainable development for Vision 2030, by reducing the number of scattered licenses outside of mining complexes, to assist the Ministry of Industrial and Mineral Resources to facilitate an attractive investment environment. Utilizing the Plan, Do, Study, Act (PDSA) methodology helped to optimum solution. There are four main reasons for investors applying for licenses outside mining complexes: government regulations, complexes unsuitable, cost and time, and quality and specification. The most important consideration when choosing mining complexes is the quality of the raw materials. The minerals in Riyadh region are as follows Gravel, which investors need in the largest quantities (40.9%), Sand (30.9%) and Subbase (12.7%). This survey result found out that 100% of investors were open to obtain permits inside mining complexes with a guarantee to invest for up to 20 years. To satisfy and attract investors in the mining sector these factors are important: good quality of raw materials is the main factor for mining complexes selection, projects, manufacturers, and cities under development, early stakeholders' engagement. Also, it's essential to avoid any future conflict and provide all public services (roads, telecommunications, electricity, water sources, etc.) needed in mining complexes.

**Keywords:** Mineral, Gravel, Sand, Subbase, Resources, Government Regulations, Mining Complexes.

### 1. INTRODUCTION

In 1931–1943 The journey to search for minerals and water supplies started mining agreement with a Saudi-British-American company was signed. In 1956 – 1968 directorate of Mineral Resources was established and Agreements with British, Canadian, French, & Japanese companies, to achieve mining objectives. Between 1996 and 2013 Strategic partnerships and joint ventures were developed to help meet mining goals. In 1997 Mining Company Ma'aden was established by a Royal mandate to practice various mining activities in Saudi Arabia.

2016 Vision 2030 was launched, the mining strategy was approved, and the National Industry and Logistics Services Development Program (NIDLDP) was launched. In 2016, it shows that the potential for Saudi Arabia to produce metals is largely vested in the deposits that serve as sources for gold, copper, zinc, lead, phosphate, and silver. While the potential exists in the longer term for other metals. The ministry's goal is to enable the industrial and mining sectors to achieve sustainable development in Saudi Arabia's Vision 2030. [1]

The National Industrial Development and Logistics Program (NIDLDP) is a significant initiative launched by the Saudi Arabian government as part of its Vision 2030 framework. Vision 2030 is a strategic roadmap aimed at diversifying the Saudi economy away from its heavy dependence on oil revenue and fostering sustainable economic growth and development. [2]

The NIDLP specifically focuses on advancing the industrial and logistics sectors within Saudi Arabia. The objective is concentrating on the following points: Promoting Industrial Development where the program aims to stimulate the growth of the industrial sector by attracting investments, fostering innovation, and creating an enabling environment for industrial enterprises. Also, enhancing Industrial Competitiveness through various measures such as improving infrastructure, streamlining regulations, and providing incentives, the NIDLP seeks to enhance the competitiveness of Saudi industries both domestically and internationally. one more objective is to expanding Industrial Infrastructure of the program to include plans to develop industrial zones, parks, and clusters across the country to provide the necessary infrastructure for industrial activities.

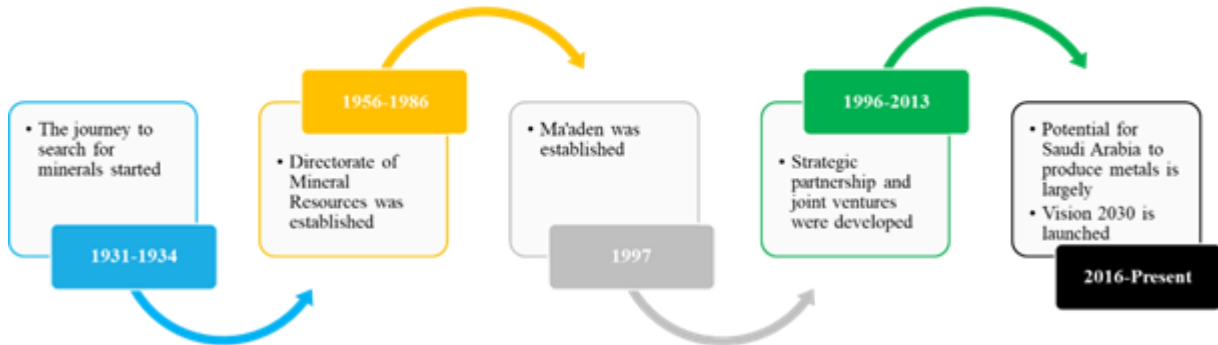
Moreover, supporting SMEs and Private Sector Participation: Recognizing the importance of small and medium-sized enterprises (SMEs) and private sector involvement in industrial development, the NIDLP aims to support their growth and facilitate their participation in industrial projects. In addition to that, promoting Local Content and Value-Added Manufacturing: The program emphasizes the importance of increasing local content in manufacturing and promoting value-added industries to reduce dependency on imports and create job opportunities for Saudi nationals.

The final objective is to developing logistics and transportation infrastructure: In addition to industrial development, the NIDLP focuses on enhancing the efficiency and effectiveness of logistics and transportation infrastructure to support the movement of goods and materials within the country and across borders. Overall, the NIDLP represents a comprehensive strategy to transform and diversify Saudi Arabia's economy by leveraging its industrial and logistics potential.

It involves collaboration between various government agencies, private sector stakeholders, and international partners to achieve its goals. By fostering industrial growth and enhancing logistical capabilities, the program aims to contribute to the long-term economic prosperity and sustainability of Saudi Arabia.[2]

The Mining Complexes Enhancement Factors in Riyadh, Saudi Arabia, signify a strategic initiative geared towards optimizing the operational efficiency and sustainability of mining activities within the region. These factors encompass a diverse range of elements including technological innovations, infrastructure upgrades, regulatory frameworks, investment incentives, environmental considerations, and capacity building measures.

By focusing on enhancing these critical factors, Riyadh aims to bolster the performance and competitiveness of its mining complexes. Through the adoption of advanced technologies, the implementation of robust infrastructure, adherence to stringent regulations, attraction of investments, environmental stewardship, and workforce development, Riyadh is poised to elevate its mining sector to new heights, fostering economic growth and sustainability in the process. [3]



**Figure 1: History of mining in Saudi Arabia**

In 2020, the ministry updated the mining investment law in the Kingdom to unleash the sector's potential, improve transparency and maintain investors' confidence. The new law also created an integrated mining system built for the long term, protecting workers and the environment alike. [4]

The Saudi government intends for the mining sector to help achieve Vision 2030 objectives:

1. Create growth engines beyond oil and gas.
2. Create high-value jobs for Saudi nationals.
3. Drive economic development of remote areas.

By 2030, the impact of the mining sector should come in the form of three macroeconomic results:

1. Grow the total sector GDP impact by USD 47 billion.
2. Create 219,000 new jobs.
3. Develop remote areas creating 40,000 jobs.

Saudi Arabia's mining sector relies on six main reasons to invest in KSA:

1. Large unexplored landmass encouraging foreign investment in mining.
2. Significant demand for mining products.
3. Investor-friendly mining law in alignment with global benchmarks.
4. Best-in-class taxation and incentives for investors.
5. Well-connected and robust infrastructure network.
6. Experienced, ever-growing talent pool.

Mining Complexes Enhancement Factors in Riyadh, Saudi Arabia, likely refer to the various elements and strategies implemented to improve and optimize mining operations and facilities within the region. These factors could include technological advancements, infrastructure

development, regulatory frameworks, investment initiatives, environmental considerations, and workforce training programs aimed at enhancing the efficiency, productivity, and sustainability of mining complexes in Riyadh. Enhancement factors could encompass initiatives such as introducing advanced mining technologies, implementing environmentally friendly practices, promoting responsible mining practices, fostering innovation in mineral extraction processes, enhancing safety protocols, and attracting investments to support the growth and development of mining complexes in Riyadh, Saudi Arabia. Experienced, ever-growing talent pool. [4]

#### **In General Mining law classified the minerals as follows.**

Mining laws typically classify minerals into different categories based on various criteria such as their economic value, geological characteristics, and intended use. Common classifications of minerals in mining laws include:

1. **Energy Minerals:** This category includes minerals used primarily as sources of energy, such as coal, oil, natural gas, and uranium.
2. **Metallic Minerals:** Metallic minerals are those that contain metal elements, including gold, silver, copper, iron, lead, zinc, and others.
3. **Industrial Minerals:** Industrial minerals are non-metallic minerals used in various industrial processes, construction, and manufacturing. Examples include limestone, gypsum, salt, silica, and potash.
4. **Precious Stones and Gemstones:** This category encompasses valuable stones such as diamonds, rubies, sapphires, emeralds, and others.
5. **Rare Earth Elements:** Rare earth elements are a group of minerals crucial for advanced technologies, including smartphones, electric vehicles, and renewable energy systems.

These classifications help regulate the extraction, processing, and trade of minerals, ensuring sustainable mining practices and effective resource management. [5]

#### **In Saudi Arabia Mining law classified the minerals as follows.**

- Class A: minerals, precious and semi-precious stones, and ores that require advanced operations and concentration such as Bauxite > 40%, Copper, Iron Ore > 40%, Nickel, phosphate, Rare Earth Elements, Zinc, Lithium, Gold, Silver, Lead.
- Class B; Non-metallic minerals, industrial minerals, and raw materials such as Bauxite < 40%, Dolomite, Iron Ore < 40%, Feldspar, Magnesite, Potash, Salt, Silica > 95%.
- Class C: Materials used for construction purposes such as Gravel, Crushed Marble, Clay, Basalt, Silica < 95%, Dimension Stone: Metamorphic (marble, gneiss, schist & Phyllite)

Mining strategy alignment with Vision 2030, and current active mining licenses up to February 2023 are 2,230 licenses. The mining investment law stipulates for four key types of licenses:

### **Reconnaissance license:**

A reconnaissance license in the context of mining in Riyadh, Saudi Arabia, typically refers to a preliminary permit that allows exploration activities to assess the potential of mineral resources in a specific area. This license grants permission for initial surveys, mapping, sampling, and other non-invasive activities to determine the presence and quality of minerals within a designated area.

For Mining Complexes Enhancement Factors in Riyadh, obtaining a reconnaissance license could be a crucial step in the exploration and development process. By conducting preliminary assessments under this license, mining companies can gather essential data to inform future mining operations, identify valuable mineral deposits, and evaluate the feasibility of establishing mining complexes in the region.

Factors such as geological surveys, mineral mapping, environmental considerations, and stakeholder engagements may influence the issuance and utilization of reconnaissance licenses in Riyadh, contributing to the enhancement of mining complexes through informed decision-making and strategic planning based on accurate data and assessments.

For a period not exceeding two years for an area designated by the applicant. A license may be extended or renewed for a single additional period not exceeding two years. As of today, active licenses are 40 licenses. [6]

Entitle the licensee to survey and explore the site designated in the license. The licensee shall have a non-exclusive right over the license site to:

- Examine the deposits covered by the license and collect samples.
- Prospect the area covered by the license, except for areas excluded under this Law.
- Use geophysical and geochemical methods, as well as other scientific methods.
- Carry out any other reconnaissance activity commonly used in the preliminary examination of lands with potential minerals or ores.
- Have access to non-confidential maps and data maintained by the Ministry. [6]

### **Exploration license:**

An exploration license in the context of mining in Riyadh, Saudi Arabia, is a permit that grants companies the right to conduct more detailed and extensive exploration activities to assess potential mineral deposits within a specified area. This license allows for activities such as drilling, trenching, and sampling to further evaluate the quantity, quality, and economic viability of mineral resources.

For Mining Complexes Enhancement Factors in Riyadh, obtaining an exploration license is essential for advancing the understanding of mineral potential in the region. Through detailed exploration activities conducted under this license, mining companies can gather precise data on mineral reserves, geology, and feasibility, which are crucial for making informed decisions about establishing and optimizing mining complexes.

Factors influencing the acquisition and utilization of exploration licenses in Riyadh may include geological surveys, environmental impact assessments, community consultations, and compliance with regulatory requirements. By securing exploration licenses and conducting thorough exploration activities, mining entities can enhance their understanding of mineral resources, support sustainable mining practices, and contribute to the growth and development of mining complexes in Riyadh, Saudi Arabia.

Up to 15 years in total with a maximum 5-year initial term plus one or more renewal periods of not more than 5 years each. As of today, active licenses are 653 licenses.

Grant the licensee the following exclusive rights to explore the minerals covered by the license.

- Collecting samples from the license site.
- Using any exploration method that precedes commercial production.
- Establishing camps as well as facilities necessary for the protection of exploration machinery and equipment.
- Using sand, gravel, or similar materials to the extent necessary to achieve the purposes of the license.
- Obtaining, during the validity of the exploration license, an exploitation license. [6]

#### **Mining license or small mine license:**

In Saudi Arabia, obtaining a mining license, also known as a small mine license, involves several steps and considerations. Riyadh, being the capital city, operates within the broader framework established by the Saudi government for mining activities. Here's an overview of the process and requirements for obtaining a mining license in Riyadh, Saudi Arabia:

1. **Understanding Regulations and Authorities:** The mining sector in Saudi Arabia is regulated by the Saudi Arabian Mining Company (Ma'aden) and overseen by the Ministry of Energy, Industry, and Mineral Resources. These entities establish regulations and guidelines for obtaining mining licenses.
2. **Identifying the Type of License:** In Riyadh or any other part of Saudi Arabia, there are different types of mining licenses available depending on the scale and nature of the mining operation. These may include licenses for small-scale mining operations, exploration licenses, or larger-scale commercial mining licenses.
3. **Preparation of Documentation:** Applicants need to prepare and submit various documents to the relevant authorities. These documents typically include:
  - Detailed project proposal outlining the scope, location, and nature of the mining operation.
  - Environmental impact assessment report detailing the potential environmental effects of the mining activity and proposed mitigation measures.

- Proof of financial capability to carry out the mining operation.
  - Technical qualifications and experience of the individuals or company applying for the license.
  - Any other documents specified by the regulatory authorities.
4. **Submission and Review:** Once the necessary documentation is prepared, it needs to be submitted to the Ministry of Energy, Industry, and Mineral Resources or the relevant regulatory body. The authorities will review the application to ensure compliance with regulations and assess the feasibility of the proposed mining operation.
  5. **Approval and Licensing:** If the application meets all requirements and is approved by the regulatory authorities, a mining license will be issued. This license grants the holder the legal right to conduct mining activities within the specified area and under the terms and conditions outlined in the license.
  6. **Compliance and Monitoring:** Once the mining license is obtained, the licensee must adhere to all regulatory requirements, including environmental standards, safety regulations, and reporting obligations. Regulatory authorities may conduct periodic inspections to ensure compliance with these requirements.
  7. **Renewal and Compliance:** Mining licenses typically have a validity period, after which they need to be renewed. The renewal process involves demonstrating ongoing compliance with regulatory standards and may require updated documentation and reports.

It's essential for prospective miners in Riyadh, Saudi Arabia, to familiarize themselves with the specific regulations and procedures governing mining activities and to engage with the relevant authorities to ensure a smooth and legally compliant licensing process. Consulting with legal advisors or experts experienced in the Saudi Arabian mining sector can also be beneficial in navigating the regulatory landscape and obtaining a mining license. [7]

Maximum mining license area of 50 km<sup>2</sup> for utilization with a duration limitation of 60 years (inclusive of renewals and/or extensions) and an initial term of up to 30 years, Maximum small mining license area of 1 km<sup>2</sup> for utilization with duration limitation of 40 years (inclusive of renewals and/or extensions) and an initial term of up to 20 years, covers Class A and B minerals. As of today, active licenses are 179 licenses. [8]

#### **Building Materials quarry licenses:**

In Riyadh, Saudi Arabia, acquiring quarry licenses for building materials plays a significant role in the enhancement of mining complexes. These licenses enable companies to extract materials such as limestone, sand, gravel, and other resources essential for construction and infrastructure development.

Factors related to quarry licenses for building materials in Riyadh include:

1. **Regulatory Compliance:** Obtaining licenses involves adhering to regulations set by the government to ensure responsible extraction practices and environmental protection.
2. **Resource Assessment:** Licenses require companies to assess the quantity and quality of materials available in the quarry to plan for sustainable extraction.
3. **Environmental Impact:** Companies must consider the environmental impact of quarry operations and implement measures to minimize disruption and protect natural resources.
4. **Community Engagement:** Engaging with local communities and stakeholders is crucial to address concerns, ensure social license to operate, and contribute positively to the region's development.
5. **Infrastructure Development:** Quarry licenses support the availability of essential building materials for infrastructure projects, contributing to the growth and advancement of Riyadh's mining complexes.

By obtaining quarry licenses for building materials in Riyadh, mining complexes can access necessary resources, promote sustainable practices, comply with regulations, and contribute to the development of infrastructure and construction projects in the region.

Maximum Building Materials quarry license area of 1 km<sup>2</sup> for utilization with a duration limitation of 10 years (inclusive of renewals and/or extensions) and an initial term of up to 5 years over Class C construction materials only; as of today, active licenses are 1,327 licenses. [8]

## 2. MATERIALS AND METHODS

The Plan, Do, Study, Act (PDSA) methodology is a structured approach used for continuous improvement in various fields, including business, healthcare, education, and more. Here's a detailed breakdown of each phase:

### 1. Plan:

- **Identify the Problem:** Define and understand the issue or opportunity for improvement.
- **Set Objectives:** Establish clear, measurable goals that align with the improvement opportunity.
- **Develop a Plan:** Create a detailed plan outlining the steps to be taken to achieve the objectives.
- **Predict Outcomes:** Anticipate the expected results of implementing the plan.



2. Do:

- Implement the Plan: Execute the plan as designed during the planning phase.
- Collect Data: Gather relevant data during the implementation to assess the outcomes.
- Document Observations: Record observations, challenges faced, unexpected outcomes, and any deviations from the plan.

3. Study:

- Analyze Data: Examine the data collected during the implementation phase to evaluate the results.
- Compare Results: Compare the actual outcomes against the predicted results.
- Identify Trends: Look for patterns, trends, and insights that can inform decision-making.

4. Act:

- Take Action: Based on the analysis and insights gained, decide on the next steps.
- Standardize or Adjust: Determine whether to standardize successful changes or make further adjustments.
- Plan for the Next Cycle: Develop a plan for the next cycle of improvement, incorporating lessons learned from the current cycle.

The PDSA cycle is iterative, allowing for continuous improvement through repeated cycles of planning, doing, studying, and acting. It emphasizes learning from experience, adapting to changing circumstances, and gradually refining processes to achieve better outcomes. This methodology encourages a systematic and data-driven approach to improvement, fostering a culture of learning and innovation within organizations. [9] We utilize Plan, Do, Study, Act (PDSA) methodology. This approach will guide us to follow a systematic way through all study processes to find the optimum solutions as shown in figure 2.

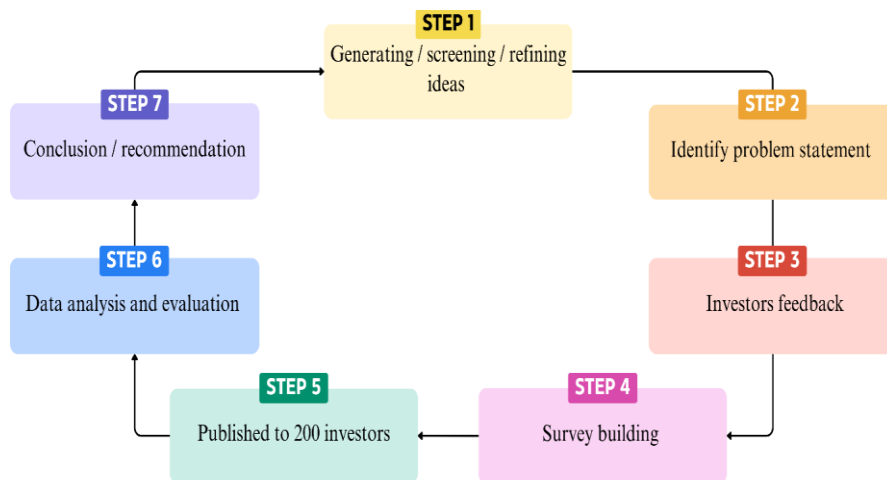
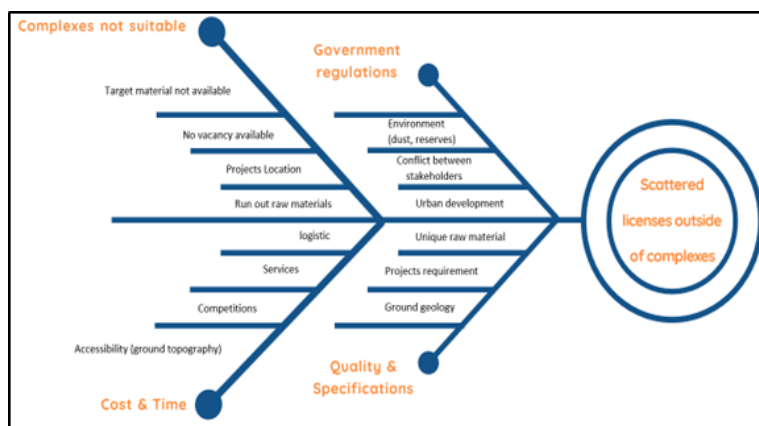


Figure 2: Methodology Cycle [10]

Based on the Ministry of Industrial and Mineral Resources scattered licenses outside of mining complexes are one of the main obstacles to control mining activities and mineral resources. Aiming to understand investors' point of view to apply for licenses outside of complexes and to find the optimum solutions to reach investors' satisfaction and ministry. To achieve the goal of this study the following resources have been allocated: the ministry database provides investors contact information, mining complexes location as maps, and exploration licenses applied outside of complexes. Arranging for a meeting with specialists in the mining sector to oversee the best way to get investors' feedback and to format the most efficient questionnaires; an interview approach to elicit information from investors by talking to them directly is also useful for obtaining confidential information, questionnaires/survey written set of questions designed to quickly accumulate information from a large number of responses it will be useful to get feedback from various investors in different geographic region. [10][11]

The brainstorming session was conducted to know the root causes of scattered licenses outside of mining complexes and the output of the session fishbone diagram has been initiated. We notice that there are four main causes: government regulations, unsuitable complexes, cost & time, and quality & specification as shown below the fishbone diagram in figure 3.



**Figure 3: Root Cause Analysis (Fishbone Diagram)**

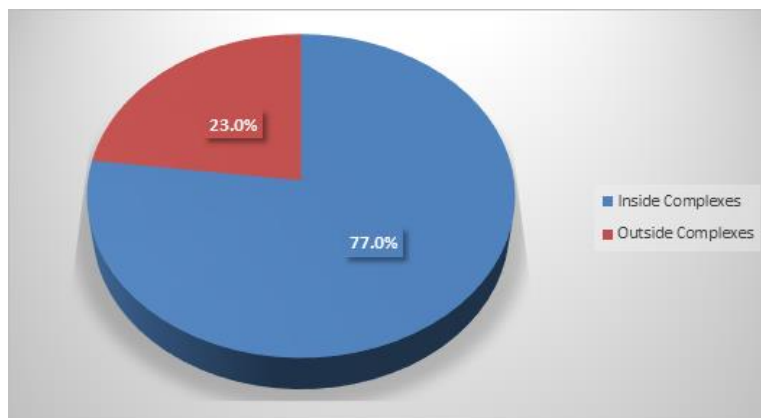
The survey has been created by taking into consideration the Fishbone Diagram, a survey containing 13 questions to get feedback from investors including closed-end and open-ended questions or prompts for more detailed responses. The results of a survey can be used to analyze patterns of behavior, establish trends, identify areas for improvement, or guide decision-making. Then, published to 200 investors by using email and we received 10% feedback, and it was not enough to understand investor's needs, so we used social media app to reach more investors, and feedback increased by 20%. Then we contacted through calling individually and responses increased by 20%, finally, we met the investors face to face until reached 81.5%, 163 investors. The output of the survey information was exported to MS Excel for the sake of analysis and evaluation; data was visualized as charts. Then a meeting has been arranged with ministry employees to verify the results and identify what works, what does not work, and what can be improved.

Assumptions are constraining during studying the complexes as below:

- License services prices are fixed.
- Raw materials prices are fixed.
- Raw material location.
- Lands owned by governments.
- Mining regulations classification licenses.
- Cities (public) zone. [12]

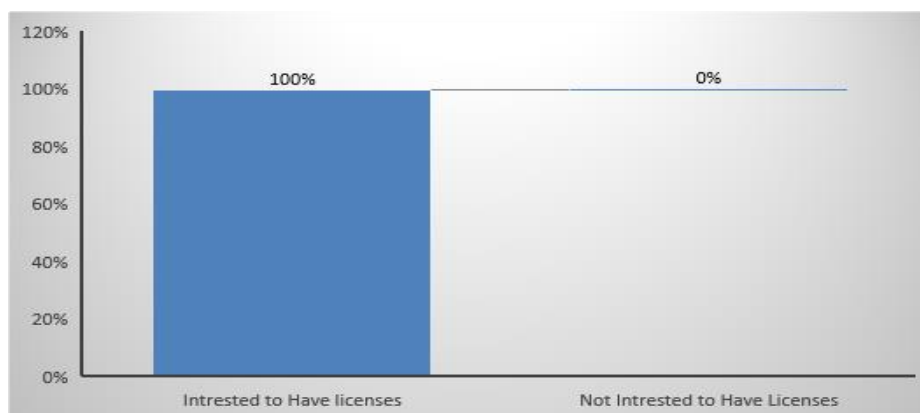
### 3. RESULTS AND DISCUSSION

Depending on survey feedback, most investors 77% are willing to get licenses inside mining complexes, and 23% of investors want to apply for a license outside of complexes as shown in figure 4.



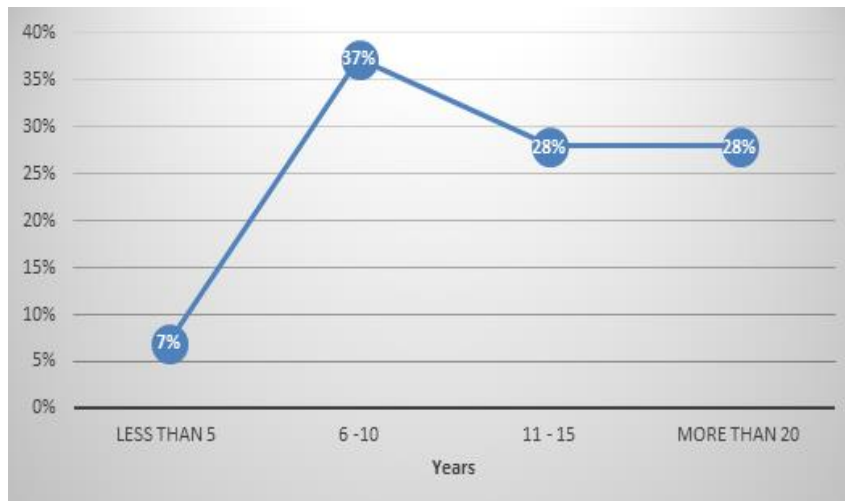
**Figure 4: Present investors' interest inside or outside complexes**

And we observed that 100% of investors are willing to have licenses inside mining complexes once that will provide them with long-term work sustainability of up to 20 years, as shown in figure 5.



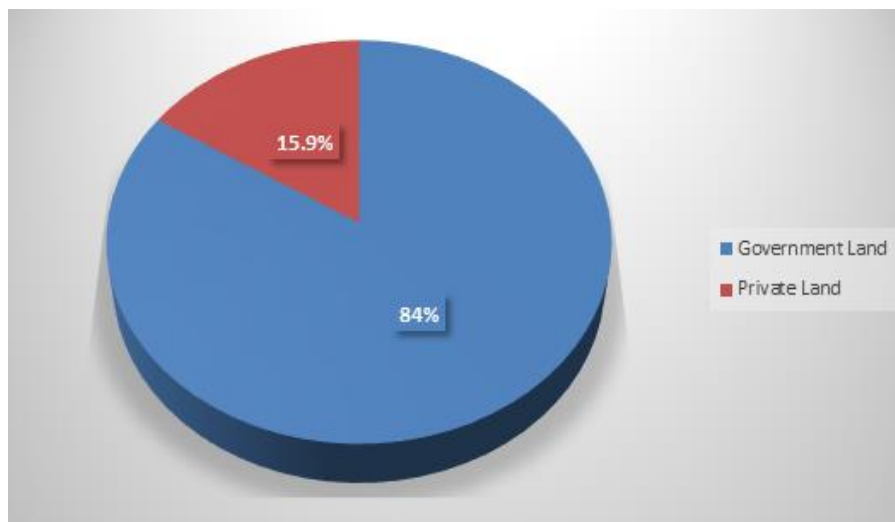
**Figure 5: Statistics of investors who preferred to work inside mining complexes.**

Investors are planning to work in mining activities at sites, based on statistics received from 6 to 10 years 37%, from 11 to 20 years 28%, and more than 20 years 28% as shown in figure 6.



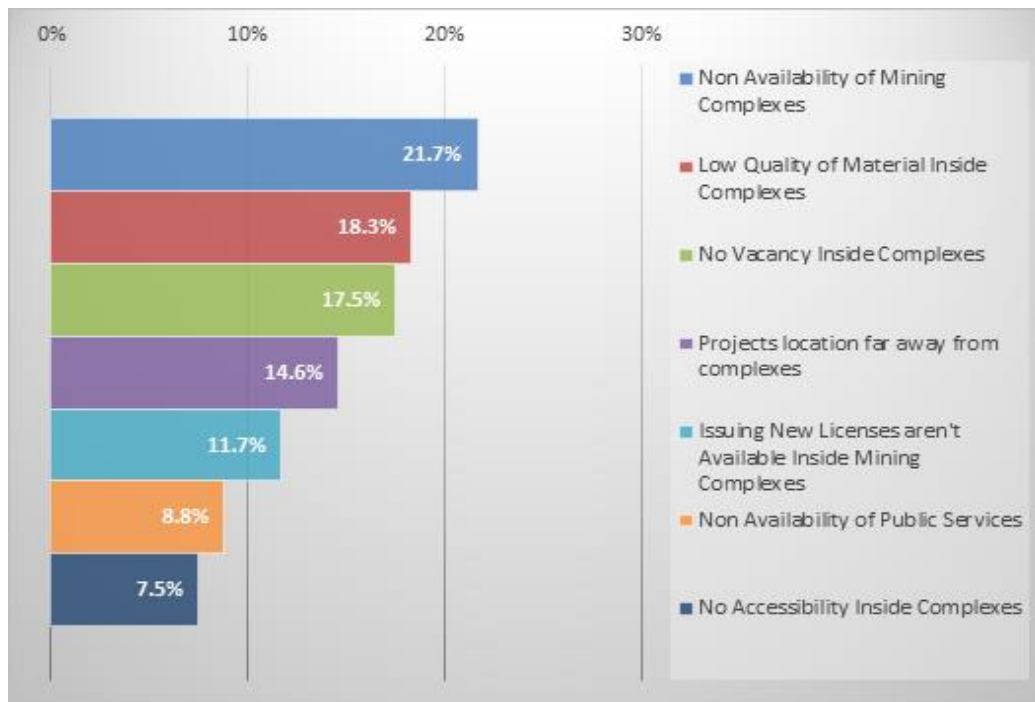
**Figure 6: Statistics of years targeted investment.**

84% of investors seeking to get licenses inside government land, and almost 16% in private land as per figure 7.



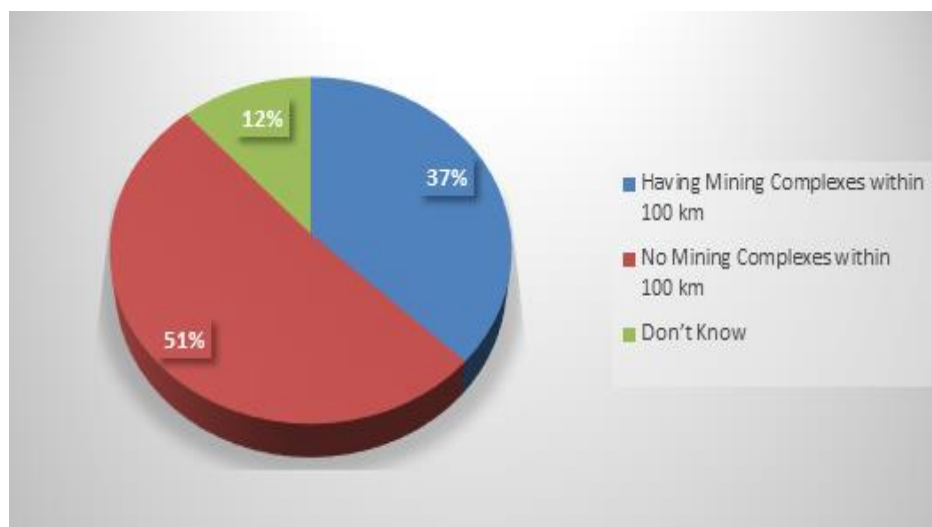
**Figure 7: Statistics present investors' interest in government or private land**

Referring to feedback received about why investors are applying for licenses outside mining complexes as shown in figure 8.



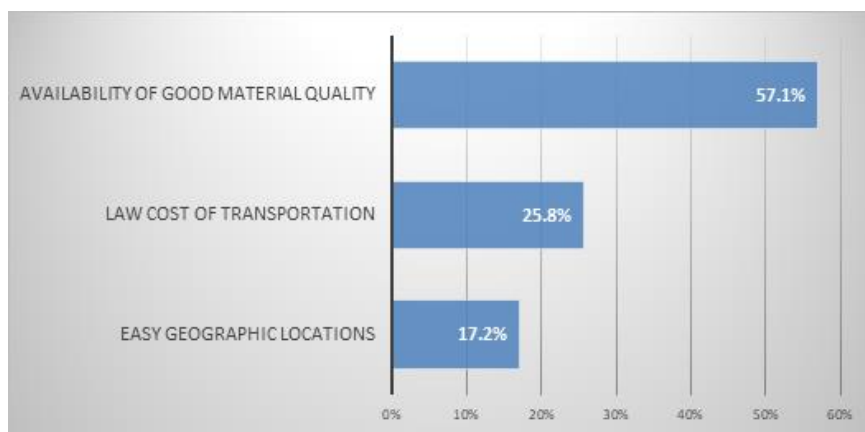
**Figure 8: Statistics Present Investor's Reasons for Applying for Licenses outside Complexes**

Observed that 21.7% of investors claimed to get licenses outside of mining complex due to no availability of complexes, and we verified the result note that 51% of investors declare nonavailability of mining complexes within 100 km near to interested area as shown in figure 9.



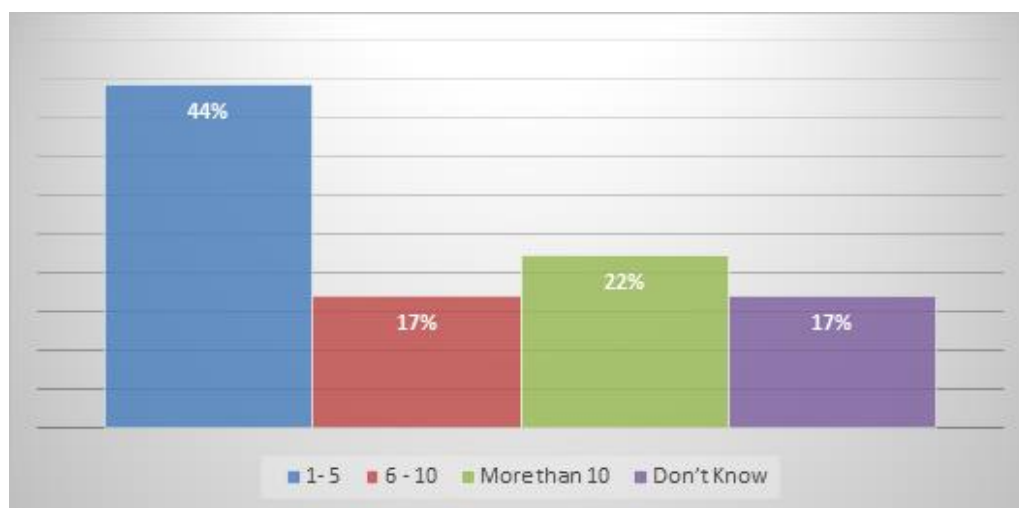
**Figure 9: Statistics of Availability Mining Complexes within 100 km**

Regarding materials 18.3% represent low-quality materials inside mining complexes which is another reason for investors to apply for licenses outside of complexes, and 57.1% of investors assure that the quality of material is one of the important characteristics in selecting a license's location, as shown in figure 10.



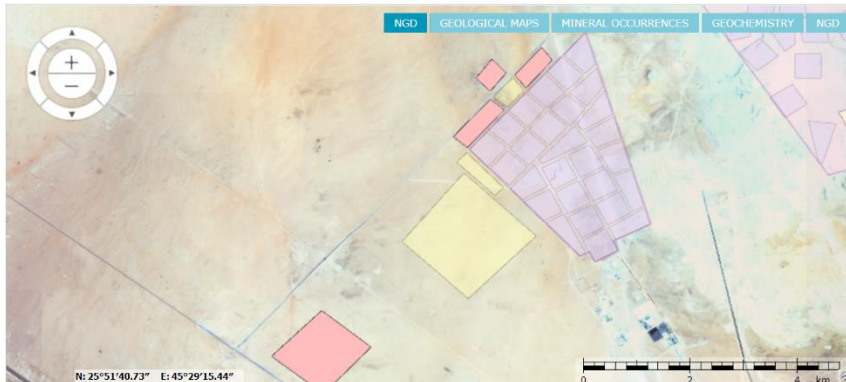
**Figure 10: Preferred Characteristics in Mining Complexes**

14.6% of investors applied for licenses outside of mining complexes because the projects are located away from complexes, and when we asked investors about the number of projects near their applied licenses, we got 44% of answers for those having less than 5 projects, 17% between 6 to 10 projects, 22% more than 10 projects as shown in figure 11.



**Figure 11: Statistics Present Projects under Development Near to Requested License**

17.5% of investors applying for licenses outside of mining complexes due to non-vacancies inside complexes, and 7.5% of them declared there is no accessibility inside complexes and difficult-to-reach sites, example shown in figure 12.



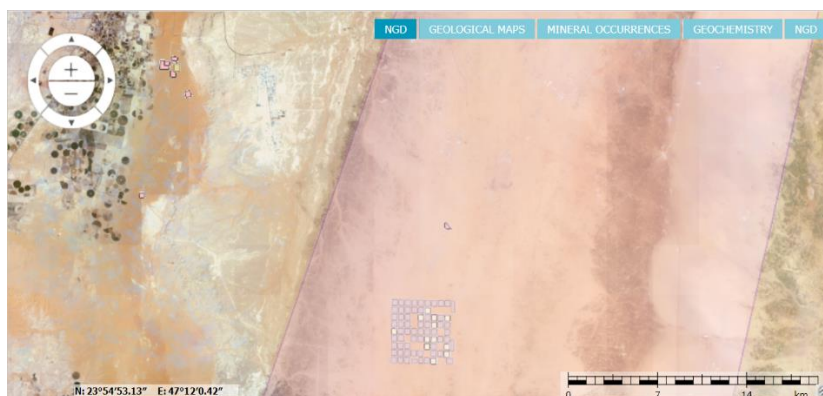
**Figure 12: Crowd Licenses Mining Complex [11]**

11.7% cannot apply for licenses inside complexes due to complexes near to development of Riyadh city, for example, as shown in figure 13.



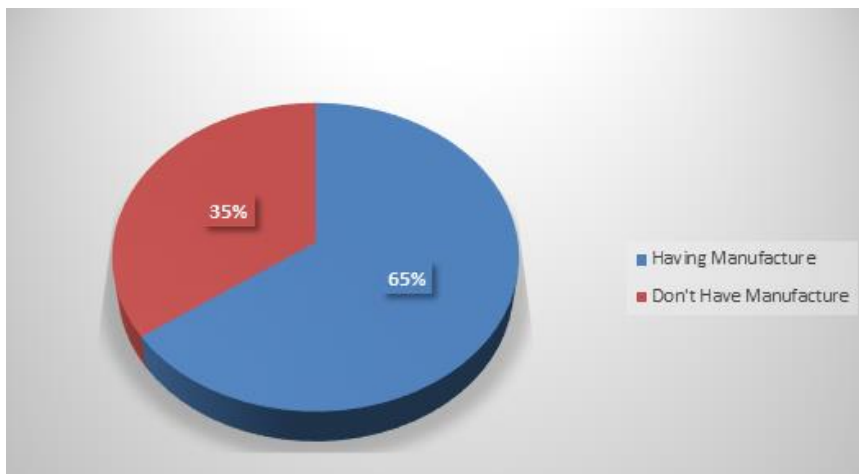
**Figure 13: Extended City Near to Mining Complex**

8.8% of investors informed that there is no pathway to reach mining complexes, figure 14 shows an example.



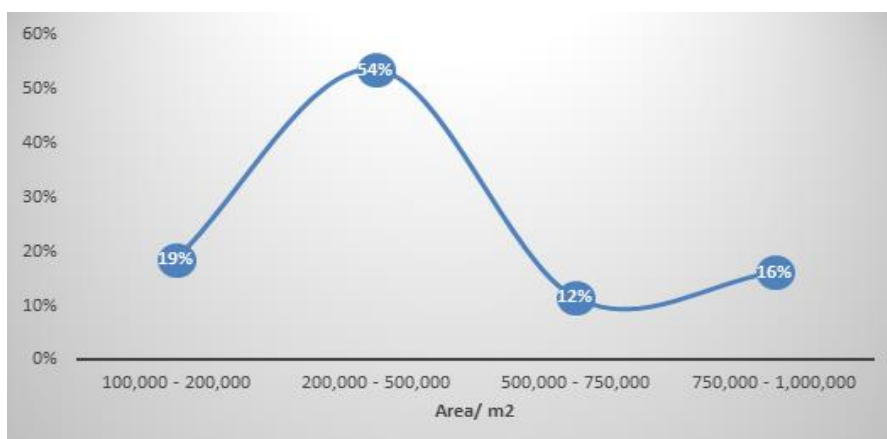
**Figure 14: No Pathway to Mining Complexes**

The investors who have manufacturing companies would like to have licenses nearby, 65% of investors utilize extracted raw materials to feed their production, as per per figure 15.



**Figure 15: Investors Who Have Manufacturing Near to Requested Licenses**

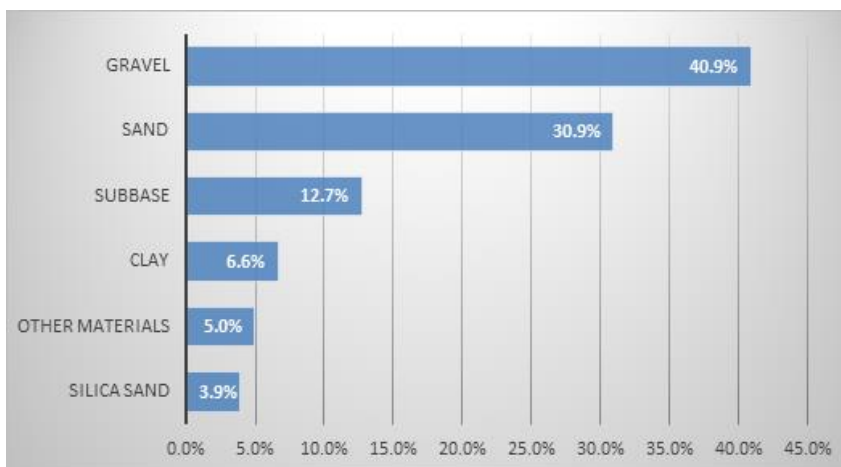
Mining complexes shall have enough area for licenses between 200,000 to 500,000 (square meters) referring to investors' feedback by 54% as shown in figure 16, and that will help investors to work in long-term investment and growth operations.



**Figure 16: Preferred Licenses Areas**

Most raw materials needed for a project are gravel which takes (up 40.9%) of investors' needs, sand (30.9%), and subbase 12.7%, the rest minor needed silica sand, marble, granite, limestone blocks, as shown in figure 17.





**Figure 17: Raw Materials Needed**

#### 4. CONCLUSIONS

Several major criteria will satisfy and attract investors in the mining sector. The three highest reasons for requesting licenses outside of mining complexes are no vacancies inside complexes, low quality of material, and non-availability of complexes. The quality of raw materials is the main factor for mining complexes selection; hence it is an essential part of this kind of business, especially for structure. Gravel and sand have the highest demand as per the ministry database and confirmed from investors' feedback shown in figure 17. Mining complexes shall be close to projects, manufacturers, and cities under development to reduce the cost of transportation, spread mining complexes an opportunity to improve new cities, hospitals, schools, and underground infrastructure to achieve one of the important mining sector targets. There 54% of investors feedback are preferring to get license areas from 200,000 to 500,000 m<sup>2</sup>, to achieve consumer delight and suitability the ministry also initiated a license competition by raising license areas to more than 250,000 m<sup>2</sup>. Avoiding conflict between complexes and other government sector land will allow the utilization of the full capacity of mining complexes. Public services must be taken into consideration while choosing the location of complexes, telecommunications, electricity, water sources, and accessibility inside and outside to facilitate traffic and transportation.

#### 5. RECOMMENDATIONS

The main recommendations of this work are to develop ideal mining complexes these are recommendations that will add value, eliminate issues, and fill gaps; to coordinate and align with all stakeholders internally and externally to make sure there is no conflict during the planning phase to reserve mining complexes and future services nearby complexes. Working to solve current issues occurring in mining complexes that impact the environment negatively, hence gives an advantage and guarantees to sustain activities inside mining complexes. Establishing manufacturers close to (or inside mining complexes) will improve creating transformative industries around and that will create new job opportunities and support the

purchasing power of the local market. In conclusion, here is an example of one complex that has high licenses applying shown in figure 18. Investing to improve mining complexes' security to protect investors' assets by installing cameras and microwave detection surrounding complexes' fences. Awareness sessions are to be conducted regarding mining policies, regulations, complex locations, and projects under development. Poor response and feedback from investors by using a questionnaire, so we advise arranging an awareness session to declare all doubt so can all investors have mutual understanding to fill out the survey in the proper way. Expand the area of mining complexes that have no vacancy for new licenses and have high demand.



**Figure 18: Mining complex near an industrial area**

### Conflicts of Interest Statement

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

### Acknowledgment:

There are many great achievements in the world, and we hope that this case study can help in achieving excellence in Mining and the 2030 vision. We would like to express our deepest appreciation to our families who have continuously encouraged us to achieve all our life goals. We are grateful to our colleagues in the Ministry of Industry and Mineral Resources, especially Eng. Ahmad Hakami who assisted us in developing this case study.

## References

- 1) Ministry of industry & mineral resources, Saudi Arabia mining (Jan,2022). <https://mim.gov.sa/mim/aboutmining.html>
- 2) Mohamed, T. M., Alharbi, A., Alhassan, I., & Kholeif, S. (2022). Applications of Industry 4.0 on Saudi Supply Chain Management: Technologies, Opportunities, and Challenges. *Machine Learning and Data Analytics for Solving Business Problems: Methods, Applications, and Case Studies*, 189-204.
- 3) National development and logistics programs, Mining Downstream Daleel (2023). <https://daleel.gov.sa/Sectors/Mining>
- 4) Ministry of industry & mineral resources, Saudi Arabia mining. <https://mim.gov.sa/mim/assets/img/overViewv2.pdf>
- 5) Saudi geological survey, National geological database portal (2023). <https://ngp.sgs.gov.sa/>
- 6) Mobbs, P. M. (2010). The Mineral Industry of Saudi Arabia. *Minerals Yearbook*, 3, 24.
- 7) Invest Saudi, Mineral resources in Saudi Arabia (2023). <https://www.investsaudi.sa/ar/sectors-opportunities/mining-metals>
- 8) Mining ministry website, Licenses requests, records and mining area (2023). <https://mining.mim.gov.sa/resources/images/docs/miningInvestment.pdf>
- 9) Leis, J. A., & Shojanian, K. G. (2017). A primer on PDSA: executing plan–do–study–act cycles in practice, not just in name. *BMJ quality & safety*, 26(7), 572-577.
- 10) Ministry of industrial and mineral resources (2023). <https://mim.gov.sa/mim/index-ltr.html>
- 11) Suzie Creighton, PDSA cycle (Sep,2022). <https://blog.lifeqisystem.com/what-is-a-pdsa-cycle>
- 12) Yigu Chen MPH, PMP, Paul A. VanderLaan MD, PhD, Yael K. Heher MD, MPH, Plan-Do-Study-Act model (Aug, 2020). <https://acsjournals.onlinelibrary.wiley.com/doi/full/10.1002/ency.22319>