

Engagement Strategy to Transform Nanotechnology based Products from Theories to the Factory Floor in the Middle East

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Introduction

Since the realisation of the unique properties of nanomaterials around the world, thousands of publications have been addressing the importance of nanotechnology, their disruptive effect on many industries, and the future potential to scale up many of the unique material properties at a cheaper cost for multiple applications. Up to the year 2018, It is estimated that more than 100 nanotechnology-related patents have been granted around the Middle East in the last 13 years [1]. Furthermore, many research institutes and universities are actively evolving to explore the utilisation of such unique properties to be used in multiple relevant industries in the region [2-3]. These come with the promise to introduce novel material that will contribute to the future of smart cities from the energy sector, manufacturing, and agriculture sector offering economic impact, and the potential to reduce the carbon footprint in the region. In comparison, there are few established nanotechnology manufactures in the area, and few commercialised nano-based products. The toxicity and regulations of nanomaterials are still uncertainty, and R&D spending is low [4]. Despite the considerate number of these publications, initiatives, and patents in this field yet, many of these struggles to reach production at a large scale. There are real reasons that stop such transformation of successful products to reach from the lab bench to the commercialisation phase. This article aims to highlight such challenges followed by strategic recommendations to reveal the full potential of nanotechnology in the region.

Market Insights and Analysis

There are several industries where nanotechnology can contribute to offer disruption, economic, and environmental impact in the

Middle East, from the pharmaceutical industry, medical devices, cosmetics, and artificial intelligence. However, despite this variety of opportunities in this section, the report focuses on the most relevant sectors where nanotechnology has the maximum potential to add value in the Middle East offering a new level of optimisation.

The Oil & Gas, and petrochemicals industries drive the energy sector and a large segment of the economy in the region demonstrating a high potential of growth [6], Saudi Arabia is among the key players in driving the oil, and petrochemical industry generating the most revenue in the region [7-8]. According to the Oxford Institute of Energy Studies, more than half of the oil reserve around the world exist in this region [9]. Other industries such as the financial sector, constructions, and IT are also well performed in the area, and was surveyed to be among the most popular choices to work at with a track of continuous growth [10-11-12]. Although the increase of oil prices contributed to the overall growth of the economy in the region, yet other industries mentioned such as financial services and small business was driving the GDP growth such as in Bahrain alternatively to oil in the last quarter of 2017 [13]. On the other hand, the construction industry and infrastructural growth demonstrate exceptional promise as well in reshaping the future of smart cities in the region. Neom project in Saudi Arabia, Dubai Opera house, the louver Abu Dhabi are a few examples of major well-known construction projects in the area [14]. However, despite the challenges due to the increase of the taxes, and prices on contractors in the regions, yet the industry is actively evolving to establish new infrastructure with multiple major maintenance and modernisation projects [15]. Moreover, it is estimated that more than 1400 constructions projects are currently running in the Gulf region only [16]. These projects will contribute to bringing more jobs opportunities, and increase the living proximity in the region. On the other hand, may emerge with impacting the mobility.

Finally, the IT, and electronics industry are also growing with

digitalisation being the future of the industrial revolution around the world, many global organisations are racing to adopt digital strategy to gain advantage in future, data analytics, big data, and machine learning provide insight and allow data-driven decisions, and rapid optimisations, which are vital metrics for the long-term growth. All of these are future attempts to further diversify the economy in the region from the dependency by the oil and gas industry.

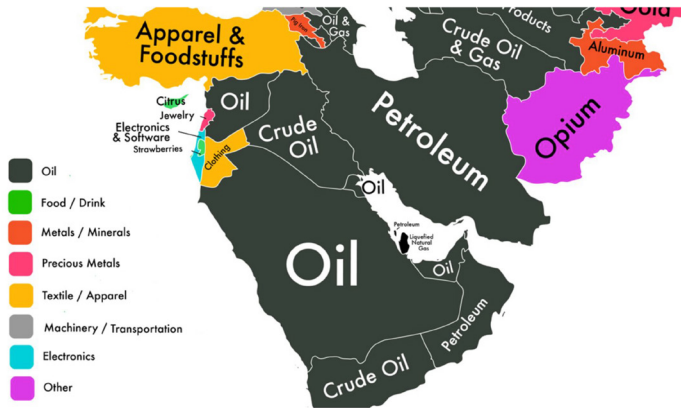


Figure 1: A representation of the dominant industry around the Middle East with oil being the most common driver of the economy in the region generating the highest revenues [17].

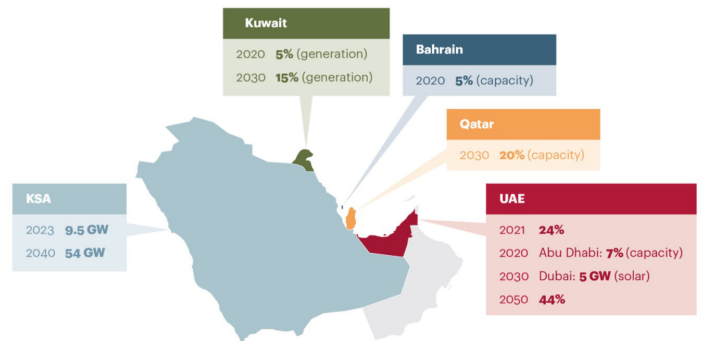
Future Initiatives and Opportunities

Despite such domination found by the oil industry, several programs and centres aim to diversify the economy and contribute to the future of sustainable development. The establishment of the middle east centre for sustainable development, the digital transformation program, the 2030 vision, and the concentrated solar power (CSP) project are few examples of such programs that will promote the use of sustainable sources, and diversify the oil-centred economy, and the region posses with excellent climate advantage for renewable energy especially for solar cells [18-19]. The deployment of nanotechnology in the region will act as a driver to reach such diversification with multiple future opportunities.

The unique mechanical and thermal properties found in Nanomaterial has the potential to create novel materials with a high level of durability. Furthermore, oleophobic and hydrophobic material combined with highly sensitive sensors will contribute to the future of Oil and gas from exploration, and drilling to production. Therefore, generate more revenues at a lower cost, lower HSE risk, and with lower carbon fingerprint [20-21]. Furthermore, due to the dramatic increase of oil demand in the region, renewable resources of energy will play a significant role in supporting such demand, and nanotechnology will contribute to increasing the efficiency, reduce the operational, and the manufacturing cost, which will reduce the air contaminations offering environmental impact and sustainability to meet such demand [9]. Novel nanomaterials can be used to intensify the absorption of lights for solar cells which is an example of the opportunities that nanotechnology has to offer. Furthermore, it is estimated that the medical devices industry weigh around \$678 million, and is expected to grow with the aid of nanotechnology offering high reactivity, targeted drug delivery,

high level of selectivity for drug manufacturing, medical dressing and medical devices[22].

GCC renewable targets



Sources: IRENA; News, A.T. Kearney analysis

Figure 2: The Middle East witness dramatic growth for oil demand estimated to be around 6% every year especially in the GCC region [9], this figure demonstrates the renewable energy target to help meeting such demand [23].

Eventually, new technologies such as additive manufacturing and Artificial Intelligence are to shape the way of future manufacturing, many industries are heavily investing in the research and development of such technologies, and nanotechnology will play essential roles in many aspects from sensing data to commercialising. Such realisation of the importance of nanotechnology in the region is critical, to allow the capitalisation of oil production, introducing new resources to meet the future demands for energy and reduce carbon fingerprint, and eventually to introduce new technologies to be in an advantage in the future.

Capabilities and Strength

The realisation of the capabilities and strengths that will help to launch Nano-based products in the region is essential. The capital investments and financial commitment in the area to invest in new technologies, research and developments are hugely funded in the region and thus work as an accelerator for innovation. Furthermore, the international collaborations in the Middle East to enable such innovation is at its peak. Many global companies in the region integrate many universities and research institutes from around the world into their research and development plan. Such step works as an accelerator at the research and development level [24-25-26].

Finally, the geographical location, along with the availability of land in the region is another advantage that enables to build a new infrastructure for this purpose. A prominent example of this is the Neom project, which is the design and urbanisation of a large city in Saudi Arabia to be built that is 33 times more the size of New York aiming to enable diversifying the economy in the region [14]. Such capabilities will aid to facilitate the successful commercialisation of a new revolutionised product that use nanotechnology to provide efficiency gain, energy sustainability, and disruptions across multiple industries. Most impacted sectors will be the oil and gas industry, and the petrochemical industry due to its high dependency on oil consumptions. The medical devices industry in the region is also expected to grow if investments are to be found at

early stages to compete with the growth of research in this market. Finally, it will be contributing to the digitalisation journey from electric vehicles, and to the future of digital manufacturing [27]. The result of this, it will be the production and commercialisation of disruptive technologies that could impact business, society, and the economy globally and in the region, and the next section will be a highlight of such challenges [28].

Challenges and Constrains

After the determination of the capabilities and potential of growth, in this part, a highlight of the challenges and constraints that limit such products to reach the market successfully. Starting with the oil and gas industry as considered being the most relevant industry, there is a significant potential to increase efficiency from exploration offering durability, and thermal resistance at the drilling phase, acceleration of the production line, and lower maintenance. Such potential extended at the consumption phase as the efficiency of fuel technology will help with reducing the consumption growth in the region. On the other hand, such potential comes with challenges, including the availability of nanomaterial manufacturer in the area that will tailor their process individually to meet the challenges found in the oil industry. Although, great international collaboration found in this field to reduce these challenges at the research phase, yet the number of nanotechnology patents produced in the region locally that are relevant to the oil industry is still considerably low to reach the production stage [29-30].

Furthermore, the manufacturing process of nanomaterials at a larger scale is still under development to meet the massive demand of the oil industry. The petrochemical industry will follow this potential; Nanotechnology will contribute to creating novel materials from energy harvesting devices, medical devices, catalysts, agriculture and finally to the medical applications offering a wide range of opportunities. In addition, large petrochemical companies such as the petrochemical giant BASF are massively investing in nanotechnology at early stages [31]. However, such a broad spectrum of opportunities offer a huge challenge by itself, and scattering of the priorities. Finally, these are few of the difficulties found in the industries relevant to the Middle East region where nanotechnology is predicted to grow. However, in this article is a classification of the real diagnoses and metrics that contribute for a successful product to penetrate the as highlighted:

- Education and public engagement
- Establishment of the priorities
- Recruitment processes and strategy
- Testing and quality assurance
- Policy and regulations
- Product maturity and marketing strategy

Design and implementation strategy

a. Education and public engagement: Initiation stage to the future of nanotechnology in the region

The development plan to launch the next generation of nano-based product which is started by the educational and the public engagement strategy. Re-designing the educational courses at

school and universities with an emphasis on nanotechnology across multiple disciplines will contribute to thriving the next generation of scientists in the field, that will assist to launch successful projects in the future. Surveying the curriculums and subjects offered across many universities in the region, few only provided nanotechnology as a study area, and very few will incorporate nanotechnology into their curriculum. However, nanotechnology is multi-disciplinary, and therefore it is essential to involve multiple disciplines at the educational phase, combined with public engagement strategy and seminar, this will enable the public to be more familiarised about the value added by nanotechnology and can be used as an early marketing plan if conducted in a realistic approach.

b. Establishment of the priorities: Highlight the key challenges and capabilities in the region to be transformed into a commercialised product

Secondly, it is essential to establish the priorities and strategy to be achieved; these priorities are to address the challenges found in the most relevant industries in the region with a focus on solving these challenges from a sustainability perspective, i.e., by offering business, economic and societal impact. However, such priorities require to be flexible to adapt to the changes in business needs. Many products fail to reach the market successfully as a change of requirements occurs at the end of the finalisation stage of the project. Such challenge introduces an extensive cost and latency. The implementation of the requirements should start at a low-level prototype stage, and then build up into realisation stage as the project reaches completion with collective engagement between researchers and key stakeholders. Such a process will ensure extensive quality check and enhanced consumer experience at the final stage.

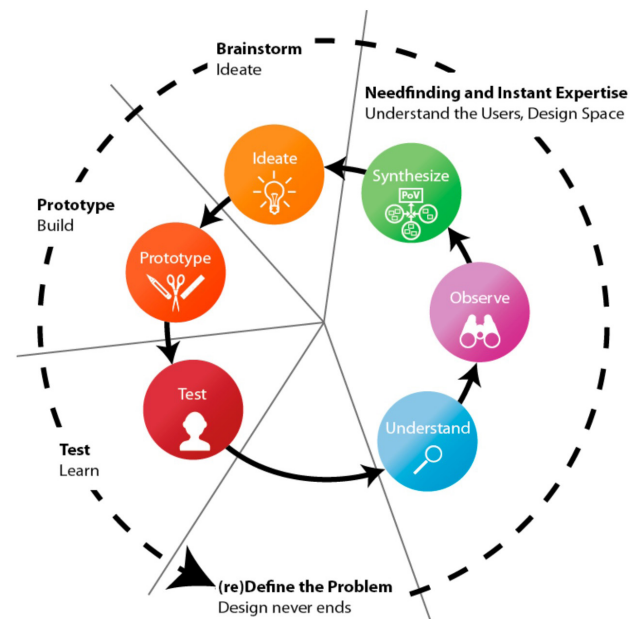


Figure 3: Design thinking approach is an innovative approaches used to ensure satisfactory user experience can be adopted as a versatile process for multi-disciplinary projects [32].

Finally, many products focus on the portability aspect only, by conducting market research and understanding the customer behaviours toward the commercially expected outcome. Although such an approach is excellent to tailor the product based on customers' needs, yet it is incomplete on its own. A product that aims to solve a known problem found in the region, driving societal, environmental, and economic impact focusing on sustainability is more likely to penetrate the market effectively thus gain public and governmental support.

c. Recruitment strategy: Innovative products start by hiring the right people to get the job done

A product that can drive a sustainable impact and disruption requires more than chemists and specialist in nanomaterial to trigger the project to the successful completion promptly with the maximum level of effectiveness. Most recruitments occur in the field of nanotechnology is based on material scientists or chemists. Therefore, this could include the manufacturing and characterisation parts.

However, there are far more factors to be incorporated into making a successful nanotechnology product than manufacturing novel materials. Financial planning, process enhancements, safety evaluation, supply chain management, and business strategy are required. This ensures the maximum value to be added while mitigation any risks and challenges that are associated with a project. Therefore, for this article, a survey was conducted on the most nanotechnology project around several universities, and the findings are that most of these projects lack the multi-disciplinary expertise required by a diverse field such as nanotechnology. Therefore, only reach the theoretical phase or the prototyping phase.

Furthermore, another survey has been conducted for this article aiming to track all jobs posting that address the field of nanotechnology in the Middle East. The study was carried out for six months starting from January 2018 until the end of June 2018 using two platforms, LinkedIn, and Glassdoor.

The findings of these survey are that tracking jobs posting in the Middle East, i.e., 22 countries on the leading media platform, the number of Jobs offering nanotechnology did not exceed 20 jobs at a time. Such numbers are an excellent illustration of the lack of maturity of the industry in the region, and it is yet to establish the required infrastructure that focuses on the production aspect of nanotechnology-based products. Eventually, throughout the years and after the establishment of many strategy documents that address nanotechnology, along with many conferences in this field, the process of recruitment in the region started to make a change from the traditional approach that accepts to hire, electrical, mechanical, computer, and material engineers mostly in the field. Modernising such process to include more specialised subjects such as computational electrical engineering, Nanotechnology, additive manufacturing, financial engineering will ensure that these skillsets are directed precisely to the business requirements to add value.

d. Quality assurance, testing, and regulations

Extensive testing and quality assurance are vital factors that contribute to the consumer experience in a product. Withdrawing a product, or a project after successfully launching, it reduces public trust, and reputation of the product in the market to recover [33]. However, nanomaterial poses with characteristics such as the high surface area to volume ratio which contributes to high reactivity offering optimisation in several disciplines. Such characteristic as well emerges with concerns and complexity within the topic of toxicity. There is uncertainty that is found regulating such materials, and each regulation different moving from the USA to European countries following different standards [4],[34]. Therefore, implantation of policy and standards along with quality assurance process are essential to ensure the safety, and yet standardisation of the product reaching the market. An internal auditing committee should be formed, with an international external auditing committee to ensure the safety of each product reaching the stores.

e. Product maturity and marketing strategy

After the successful establishment of the priorities and target market, followed by the suitable implementation approach done by a talented multidisciplinary team of nanotechnology experts that will ensure the standardisation of each product, the marketing of all this effort and the value it can add is a necessity. Therefore, different marketing campaign should be conducted, introducing the problem the product can solve. Eventually, the business strategy of the product is to be established, if the product is niche, innovative, or disruptive. Based on this product evaluation metrics the business strategy, and the marketing strategy to be initiated accordingly [35].

<p>DISRUPTIVE</p> <p>REQUIRES NEW BUSINESS MODEL</p> <ul style="list-style-type: none"> • Open source software FOR SOFTWARE COMPANIES • Video on demand FOR DVD RENTAL SERVICES • Ride-sharing services FOR TAXI AND LIMO COMPANIES 	<p>ARCHITECTURAL</p> <ul style="list-style-type: none"> • Personalized medicine FOR PHARMACEUTICAL COMPANIES • Digital imaging FOR POLAROID AND KODAK • Internet search FOR NEWSPAPERS
<p>ROUTINE</p> <p>LEVERAGES EXISTING BUSINESS MODEL</p> <ul style="list-style-type: none"> • A next-generation 3 series FOR BMW • A new index fund FOR VANGUARD • A new 3-D animated film FOR PIXAR <p>LEVERAGES EXISTING TECHNICAL COMPETENCES</p>	<p>RADICAL</p> <ul style="list-style-type: none"> • Biotechnology FOR PHARMACEUTICAL COMPANIES • Jet engines FOR AIRCRAFT MANUFACTURERS • Fiber-optic cable FOR TELECOMMUNICATIONS COMPANIES <p>REQUIRES NEW TECHNICAL COMPETENCES</p>

SOURCE: CORNING; GARY P. PISANO FROM "YOU NEED AN INNOVATION STRATEGY," JUNE 2015 © HBR.ORG

Figure 4: Using the correct strategy to leverage your most innovative Nano-based product is essential to maintain its production success in the market [35].

Conclusion

Nanotechnology demonstrates exceptional promise in reshaping the future of sustainability in the region across multiple industries. It is necessary to establish the capabilities and critical area of strengths in the region. The financial investments, government support, international collaboration and geographical location are few capabilities found in the Middle East. These capabilities are confronted by real challenges such as the dependency on oil

and gas in the region with a dramatic increase of such demand throughout the year, followed by traditional recruitment process, lack of public engagement, and misalignment between business and societal requirements and research and developments. These challenges stop very successful products and ideas to move further to penetrate the market successfully. Knowing the priorities and capabilities in the region is the first step to overcome these challenges, by capitalising on the strength and identifying future opportunities. Then, establishing the design and the strategy is essential, the correct procedure and process of implementation will allow the product to move to the testing phase at the optimum cost and with maximum added value. Then the testing and quality assurance stage and policy processes are essential; these steps will validate the effectiveness of the product and ensure it works as designed. Eventually, the right business model and strategy within the commercialisation phase is equally important, the wrong type of business model will end up with a failure within the first few months of launching the product. Therefore, driving the change, and adopting a new strategy to maintain the products in the market is a crucial final step to bring us closer to successful nanotechnology products.

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