



RESEARCH STRATEGY

2024 - 2030

First Cycle: Strategy Adjustment 2026

Content

01	Legacy: Sixty Years of Excellence	1
02	The Strategic Rationale: What Powers KFUPM's Research Vision	3
03	Articulating the Research Strategy	11
04	Identifying the KFUPM's Grand Challenges	15
05	Plan: Turning Strategy into Action	29

RESEARCH & INNOVATION

VISION

To be a globally recognized innovation-based research-intensive institution that solves grand challenges for the betterment of society and diversification of economy.

MISSION

To conduct interdisciplinary research in national and global priority areas in a conducive environment that attracts the best talents and provides world-class infrastructure.

VALUES

- ◇ Interdisciplinarity
- ◇ Collaboration
- ◇ Diversity, Equity, and Inclusion
- ◇ Openness and Transparency
- ◇ Resilience

A Message from Dr. Muhammad Al-Saggat

President of KFUPM



Dr. Muhammad Al-Saggat

President
King Fahd University
of Petroleum & Minerals

KFUPM's Research Strategy 2024–2030 represents an important step in the University's continued evolution as a globally competitive institution shaping the future of science, technology, and innovation. Guided by the Kingdom's Vision 2030, the strategy reflects our ambition to strengthen KFUPM's contribution to economic diversification, sustainability, and knowledge-based development.

By fostering world-class research, strategic partnerships, and interdisciplinary collaboration, we aim to address critical global challenges while creating meaningful societal impact. This strategy reinforces our commitment to advancing scientific discovery, nurturing innovation, and positioning KFUPM as a leading contributor to future-focused solutions that benefit both the Kingdom and the wider world.

Foreword from Dr. Ali Al-Shaikhi

Vice President of Research & Innovation



Dr. Ali Al-Shaikhi

Vice President of Research & Innovation
King Fahd University
of Petroleum & Minerals

We have taken a significant step forward in refining the University's research and innovation direction to better align with emerging scientific opportunities and evolving national priorities.

The Research Strategy 2024–2030 strengthens our focus on outcome-oriented research, expanded innovation goals, and stronger integration across research centers and disciplines. It also introduces new strategic priorities and research areas that enhance KFUPM's ability to accelerate technology development, commercialization, and real-world impact.

Supported by our established research ecosystem and disciplined execution frameworks, we will continue transforming knowledge into innovation and innovation into lasting global impact.

01 Legacy: Sixty Years of Excellence

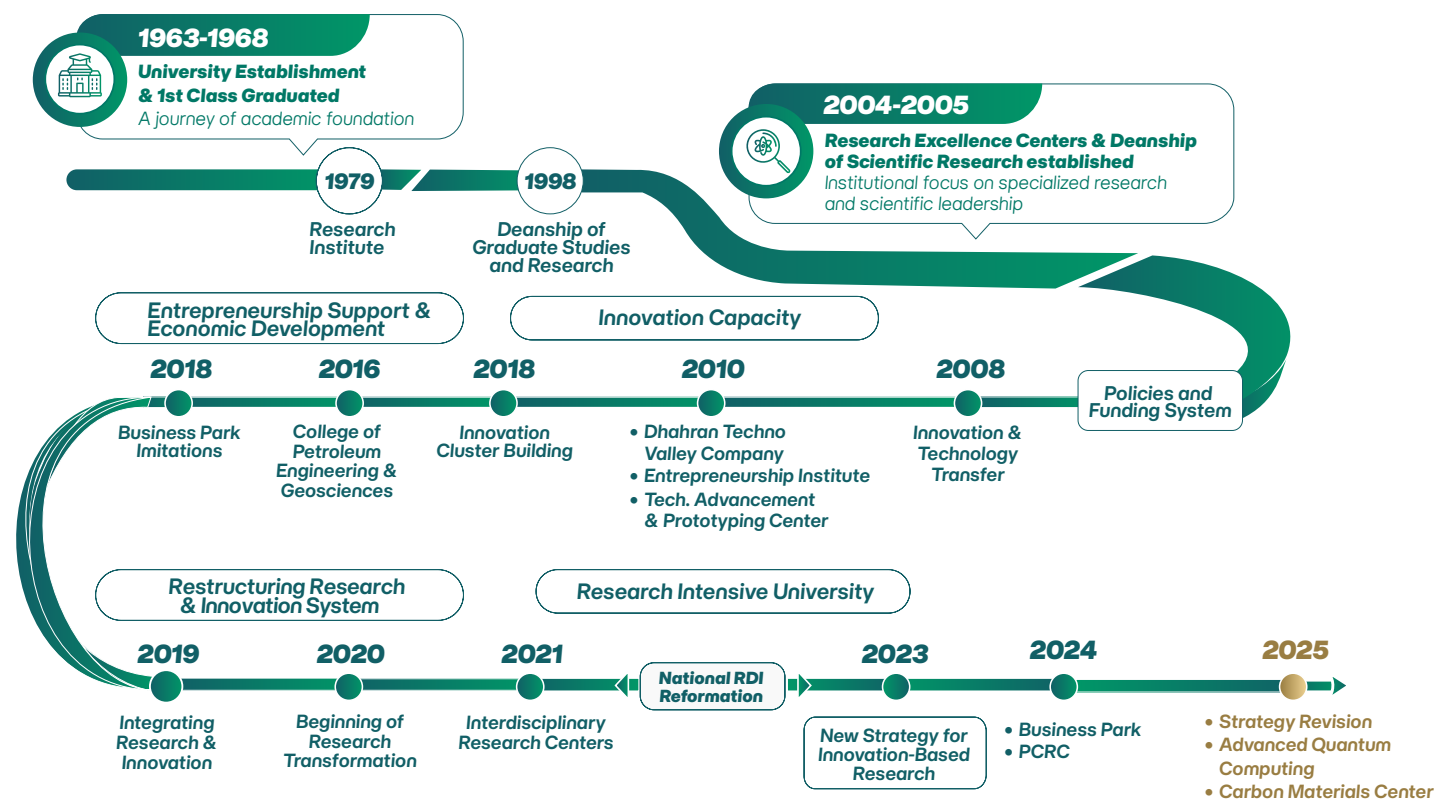
KFUPM is renowned for its exemplary track record in research and innovation, which has significantly contributed to addressing global challenges and positively impacting society. The institution's fundamental mission revolves around the pursuit of novel knowledge and insights, making it an indispensable player in academia. KFUPM's research endeavors consistently yield tangible outcomes that bring substantial benefits to both local and global communities.

KFUPM collaborates with local partners to drive research initiatives, fostering active participation. The

distinguished researchers at KFUPM are dedicated to devising groundbreaking solutions for pressing challenges in Saudi Arabia and globally.

This commitment to innovation underscores KFUPM's pledge to create a meaningful and enduring impact on society and humanity. The university's standing among global research institutions is evident through international indicators. This concerted effort exemplifies KFUPM's mission to contribute significantly to the advancement of knowledge and the betterment of society on a global scale.

Research Infrastructure



Dream Big and Accomplish

02 The Strategic Rationale: What Powers KFUPM's Research Vision

KFUPM's innovation-driven research strategy is anchored by four strategic pillars. At its core is the university's remarkable transformation, which has radically redefined its institutional priorities and bold aspirations. This internal evolution is further sharpened by rigorous, data-driven assessments of KFUPM's own research centers, offering a clear-eyed understanding of current strengths and untapped potential. Externally, the framework aligns seamlessly with sweeping national initiatives designed to accelerate research and development across the Kingdom, positioning the university as a primary engine of national progress.

Finally, the blueprint draws inspiration from global peers—specifically, how world-class, research-intensive universities structure their portfolios to tackle society's grand challenges. Together, these powerful forces converge to forge a forward-looking vision. This ensures KFUPM is not only deeply attuned to its changing ecosystem but remarkably equipped to

lead the R&D landscape, contributing significantly to local and national economic growth while cementing its identity as a global hub of translation and impact.



Innovation-based Research Strategy



The rapid economic and technological evolution of Saudi Arabia finds a powerful reflection in the ongoing transformation of KFUPM. This alignment mirrors the Kingdom's soaring ambitions, the expansive opportunities unfolding for its vibrant youth, and its rising global prominence across critical sectors. Launched in October 2019, KFUPM's proactive restructuring empowers the university to actively advance the core national development goals of the Kingdom's ambitious Vision 2030. This visionary journey positions the institution at the heart of Saudi Arabia's global ascent, propelled by a shared, unwavering commitment to disruptive innovation and long-term socio-economic progress.

Central to this mission is a steadfast focus on pioneering discovery, particularly across its historic engineering domains and emergent scientific frontiers. By deploying cutting-edge infrastructure and state-of-the-art laboratories, the university stands at the absolute vanguard of scientific breakthroughs, directly fueling economic diversification and societal prosperity. To spearhead this impact, KFUPM strategically launched an ambitious ecosystem of specialized hubs: 16 Interdisciplinary Research Centers (IRCs), 4 Applied Research Centers (ARCs), 4 Joint Research Centers (JRCs), and 2 Consortia. Together, these specialized entities serve as powerful engines for knowledge generation, breakthrough innovation, and high-impact collaborative exploration.

The IRCs are specifically engineered to systematically dismantle academic silos and build robust industry bridges. By converging



elite minds from diverse fields, these centers create a high-velocity research matrix capable of conquering complex, global grand challenges. This interdisciplinary cross-pollination fosters a dynamic ecosystem, delivering comprehensive, creative solutions to industrial demands and pressing societal challenges facing the region today. Complementing this framework, the ARCs focus intensely on market-driven engagement. They partner directly with prominent industrial and commercial enterprises to solve immediate practical hurdles, accelerate technology transfer, cultivate elite technical talent, and maximize the tangible economic footprint of academic discovery. Meanwhile, the JRCs are precision-built to target specific applied R&D frontiers, delivering bespoke, high-value solutions through dedicated, high-level alliances between KFUPM and key government or corporate stakeholders, driving tangible, real-world impact across the entire globe.

Twelve Mega Research Trends Were Identified and Clustered into Five Main Themes Relevant to KFUPM



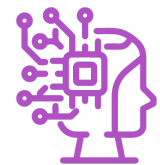
Energy, Utilities & Sustainability

The research and innovation strategy at KFUPM is carefully aligned with its overarching strategic plan and is an extension of its research transformation strategy. KFUPM is dedicated to achieving research excellence across a diverse array of disciplines. Twelve major research trends are identified for KFUPM's research context.



Industrials & Infrastructure

The University is determined in its commitment to nurturing new resources within these domains, as well as across a wide spectrum of disciplines, even those that may not fall within the designated signature areas. Within this research landscape, graduate students and post-doctoral fellows play pivotal roles and contribute significantly to a successful research environment.



Digitization and Technology

The newly developed research strategy is focused on addressing the national priorities related to research, development, and innovation (RDI). Furthermore, the strategic objectives outlined in this plan contribute to the achievement of the United Nations' Sustainable Development Goals.



Healthcare and Biotech

In doing so, KFUPM reaffirms its commitment to exerting a meaningful impact on global challenges and promoting a sustainable and equitable future for society.



Business, Finance and Economics

The strategy document is divided into four sections: the why, how, what, and implementation. It outlines the rationale, development methodology, identified grand challenges, and the proposed approach for implementation. This structured format ensures a clear and concise presentation of the university's research strategy.

Energy, Utilities & Sustainability



Energy of the Future



Environment and Circular Economy



Future of Mobility



Water Systems Evolution

Industrials & Infrastructure



Industry 4.0/5.0



Future of Defense Technology



Infrastructure/Cities of the Future



Advancement of Materials

Digitization and Technology



AI and Data Economy



Future of IoT and Connectivity

Healthcare and Biotech



Healthcare and Biotech Development

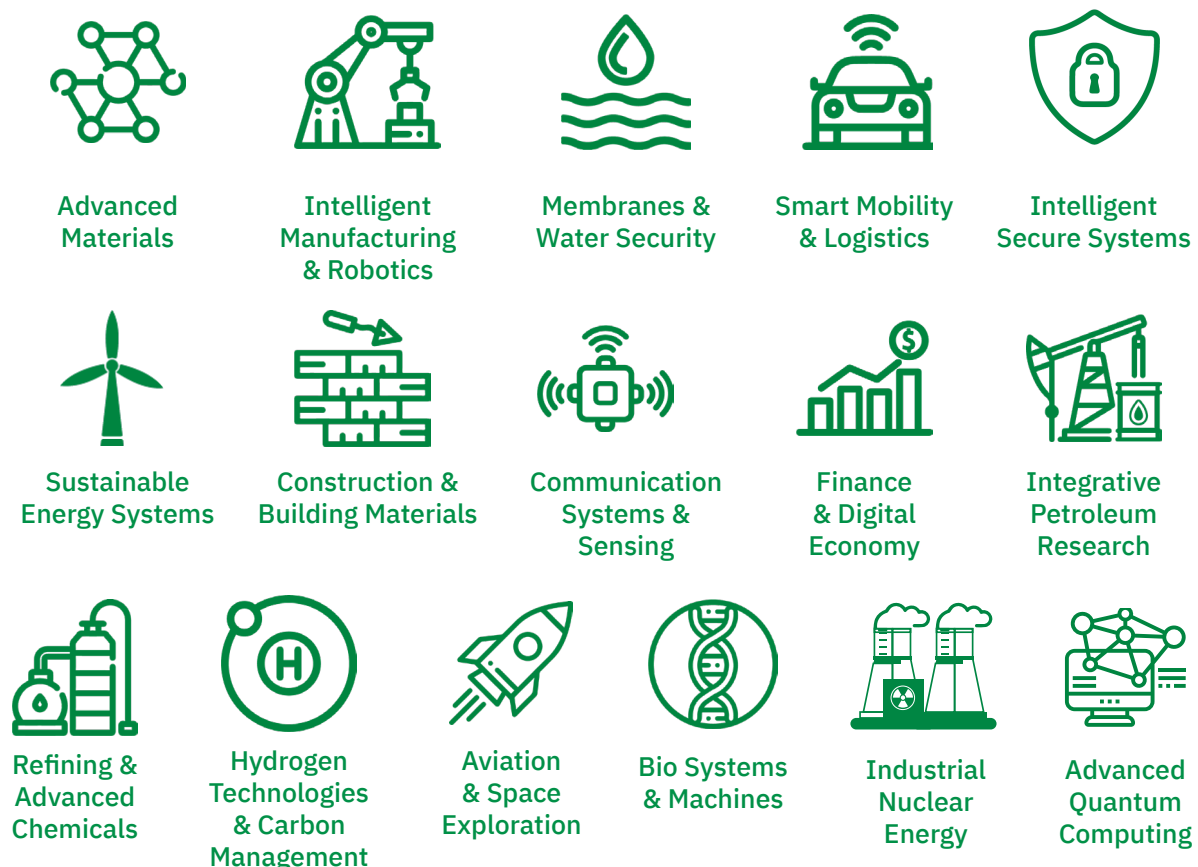
Business, Finance and Economics



Future of Business and Financial Systems

Research Centers

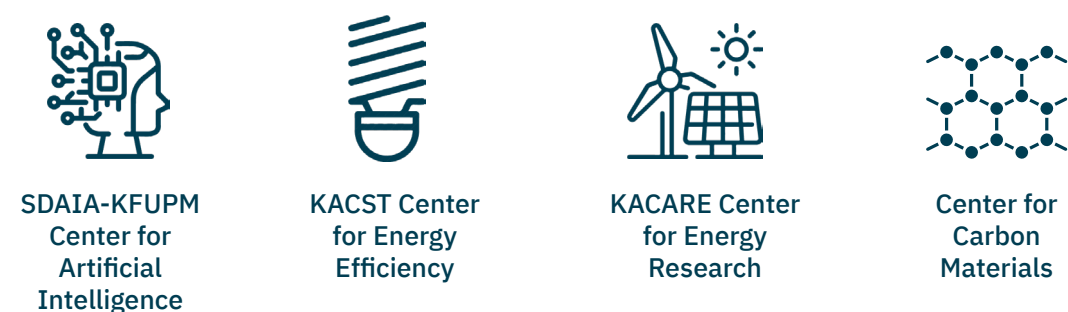
Interdisciplinary



Applied



Joint



Strategic Insights from Internal Assessments

As a cornerstone of institutional oversight, comprehensive bi-annual and year-end management reviews systematically evaluate the milestones, trajectories, and performance gaps across KFUPM's research centers and support entities. Over the two years following their inception, these rigorous diagnostics yielded critical insights that directly shaped the architecture of the university's overarching research strategy.

First, while the centers successfully mapped emerging global research trends, the data highlighted a vital need for a more discerning framework to articulate hyper-focused institutional priorities.

Second, the assessments revealed immense, untapped innovation potential, emphasizing the centers' latent capacity for driving groundbreaking advancements.

Third, despite gaining remarkable momentum in individual projects, the reviews signaled that robust innovation linkages must be established to catalyze truly impactful interdisciplinary collaboration.

Fourth, the discovery of early precursors to commercialization underscored the centers'

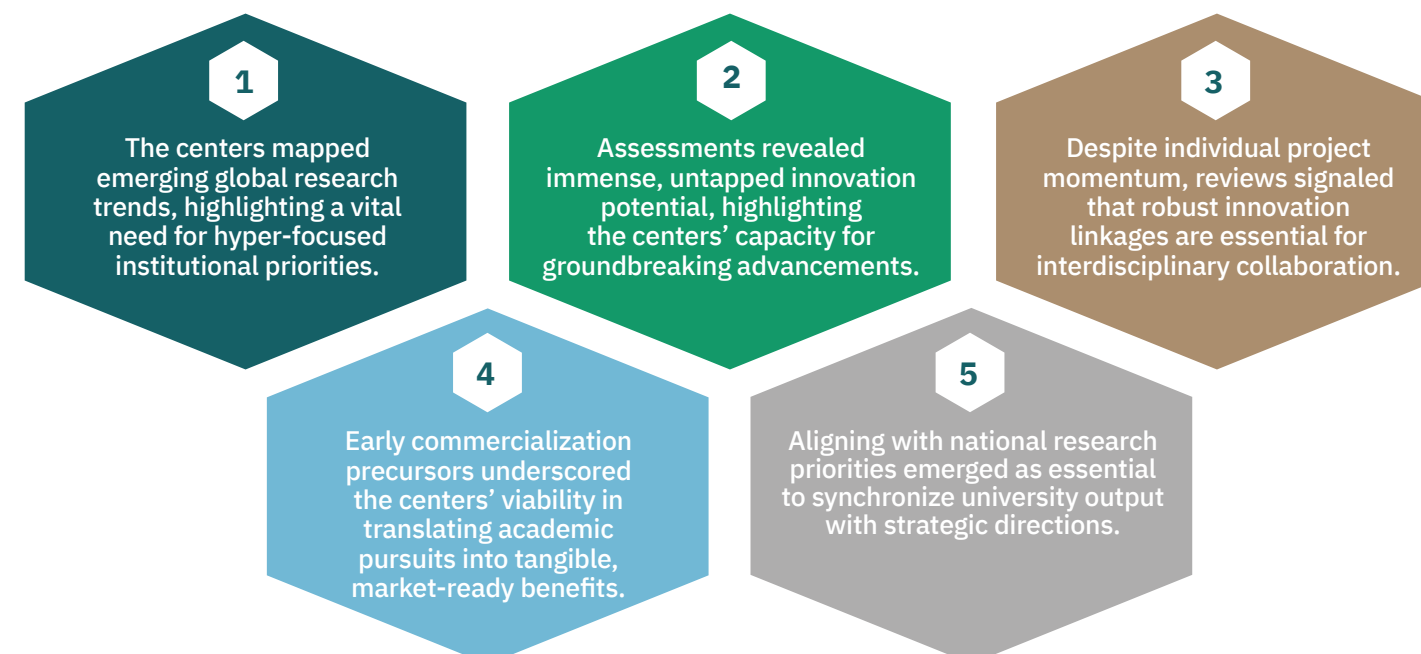


expanding viability in translating academic pursuits into tangible, market-ready benefits.

Finally, achieving formal, systemic alignment with national research priorities emerged as an essential step to synchronize the university's output with broader strategic directions.

Successfully addressing these five dimensions significantly enhances the operational effectiveness and footprint of KFUPM's R&D initiatives, fostering a highly cohesive, globally competitive, and profoundly impactful innovation ecosystem.

These aspects include:



KSA's National Priorities: Fueling Research and Innovation

To champion cutting-edge scientific discovery, Saudi Arabia introduced the transformative National Priorities for Research, Development, and Innovation. This visionary framework marks a decisive stride toward accelerating localized knowledge creation and technological advancement across the entire Kingdom. The initiative targets four critical pillars: energy and industrial leadership, sustainable environment and essential needs, economies of the future, and health and wellness. Each core domain holds immense strategic weight within the context of Saudi Arabia's long-term development, economic resilience, and expanding global relevance.

KFUPM has positioned itself as a premier institutional vehicle for realizing these ambitions, proactively aligning its comprehensive R&D strategy to perfectly synchronize with emerging national trends. The four government-mandated national priorities interface flawlessly with the five main thematic axes previously identified during the university's proactive transformation process.

This deep strategic consensus remains resolutely steadfast, ensuring all institutional research endeavors are actively devoted to elevating societal well-being and driving sustainable economic diversification goals. Consequently, the formulation of this modernized R&D strategy fully integrates these officially stated national priorities, utilizing them as an authoritative, guiding compass to uncover and address grand challenges.

National Key Focus Areas



Trailblazing Research Strategies: Grand Challenges as Inspiration

Elite, research-intensive universities increasingly anchor their strategic roadmaps around “grand challenges”; that are complex, systemic dilemmas that deeply impact society, the environment, and global progress. Far more than mere academic targets, these grand challenges serve as visionary catalysts; they elevate institutional ambition, push scientific frontiers, and compel the development of disruptive, interdisciplinary solutions capable of driving massive technological and societal leaps.

Emulating the world's leading institutions, KFUPM has placed these profound challenges at the very nucleus of its R&D strategy. This deliberate framework focuses global attention on localized demands, leveraging multidisciplinary synergy and elite global partnerships to fuel systemic breakthroughs. Ultimately, the objective is to ensure KFUPM's research portfolio serves as a powerful engine for Saudi economic diversification, while delivering lasting, transformative solutions for the broader advancement of global humanity.

Grand Challenges in Research Strategies



Interdisciplinary Innovation

Integrating multidiscipline for innovative problem-solving approach



Relevance to Economic/Society

Aligning research with national priorities, economic and societal challenges to maximize impact



Impact and Innovation

Pioneering Innovation in Grand Challenges

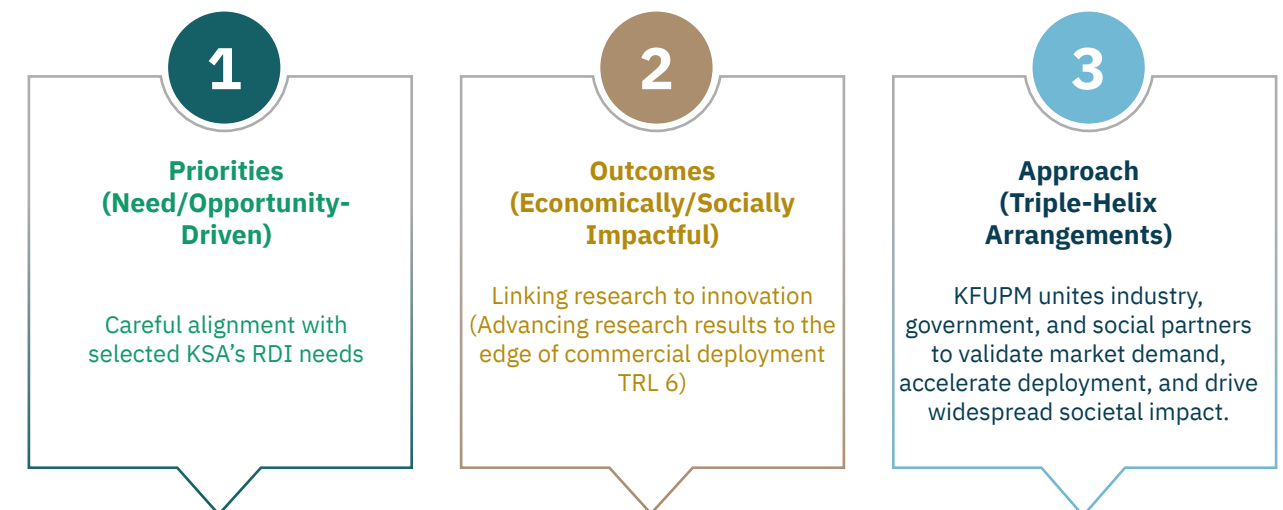
03 Articulating the Research Strategy

Redefining the Ecosystem: Inside KFUPM's Strategic Paradigm Shift

Representing a significant and deliberate departure from its historical operational models, KFUPM's new strategic vision introduces a purpose-driven framework anchored in three critical dimensions. First, it establishes a direct, synchronized link with the Kingdom's overarching national RDI objectives. Second, it implements an impact-oriented focus designed to fast-track innovation from the laboratory to the marketplace. Finally, it champions a comprehensive approach to alliances, forging strategic partnerships that encompass the full lifecycle of research and development.

This transformative methodology underscores a deeper, more mature institutional commitment. Moving forward, scholarly excellence at KFUPM will no longer be measured merely by publication counts, but by its practical relevance and collaborative ecosystem. In doing so, the university firmly establishes its role as a premier national asset uniquely equipped to solve Saudi Arabia's most pressing contemporary challenges.

The Impact-Driven Framework: Priorities, Outcomes, and Approach



At the core of the university's new era is a strategy built entirely around national needs and emerging opportunities. KFUPM has systematically aligned its agenda with the Kingdom's overarching RDI priorities, ensuring that every project addresses a specific, real-world challenge. This deliberate focus ensures that university research acts as a direct catalyst for national progress, transforming academic inquiry into practical solutions that advance the country's grandest ambitions.

KFUPM's new strategy focuses on real-world impact by seamlessly linking academic discovery with commercial innovation. The university's mandate spans the TRL spectrum—from initial knowledge creation (TRL 1) through system validation (TRL 6), and directly into the commercial arena. By actively translating intellectual property into diverse commercialization pathways, KFUPM bridges the gap between lab findings and market-ready solutions for the nation's socioeconomic challenges.

Multi-phase partnerships are given top priority in KFUPM's new strategy in order to fully integrate the innovation ecosystem. By uniting technology developers, end-users, and regulatory authorities, the university aligns its scientific goals directly with real-world industrial and market needs. This collaborative synergy enhances the practical relevance of KFUPM's research, ensuring that emerging innovations are seamlessly tailored to meet industry requirements and regulatory standards from day one.



A Framework for Developing KFUPM Innovation-Based Research Strategy

A comprehensive strategic planning initiative was meticulously organized, characterized by active engagement and consultation with esteemed stakeholders. These stakeholders included the Research Oversight Committee (ROC); distinguished research leaders; academic leaders; dedicated researchers; esteemed faculty members; and the Vice President for Research and Innovation (VPRI), who served as the sponsor and owner of the strategy development process. The plan was further refined and enriched by weaving together the invaluable inputs furnished by the various research centers. This collaborative interaction facilitated the delineation

of concrete action items imbued with purpose and strategic significance.

In essence, the strategic planning process exemplifies the harmonious orchestration of expertise and vision. The resulting product, a robust strategic research and innovation plan, serves as a testament to the efficacy of collaborative ideation, thoughtful prioritization, and the amalgamation of diverse perspectives. This strategic blueprint is poised to guide the institution toward the achievement of its research and innovation objectives with a comprehensive and well-coordinated approach.

The Blueprint for Success: How KFUPM Master Grand Challenges



Our approach embeds four established structural elements:

- ◆ **Goal Definition** by establishing clear, demarcated targets and long-term milestones
- ◆ **Accountability** by implementing robust appraisal and institutional accountability systems
- ◆ **Continuous Monitoring** through deploying precise progress tracking and quality control measures
- ◆ **Partnerships** via actively mapping out paths for strategic, collaborative alliances.

The approach to developing the research strategy encompasses several key steps:

1

Identification of National Priorities Relevant to KFUPM

The process commences by pinpointing the National Priorities that are relevant to KFUPM. This step ensures that the research strategy aligns with the broader national objectives.

2

Definition of University-Wide Grand Challenges

Then, the university-wide grand challenges are identified. These challenges are complex issues that can best be addressed through collaboration among various research entities across the University. This step emphasizes the importance of interdisciplinary efforts to effectively tackle significant challenges.

3

Establishment of Innovation Goals

Specific innovation goals are then identified at the center level. An anchor center is designated for each innovation goal, and the supporting centers are identified to contribute to the achievement of these goals. This step sets clear objectives for innovation within the research centers.

4

Definition of Research Centers Roles

Finally, the roles of each research center are outlined in relation to their contribution to achieving the innovation goals. Hence, these research centers play a crucial role in addressing the across-campus grand challenges. This step ensures that each center is strategically positioned to make a meaningful impact and contribute to the overarching research and innovation strategy.

5

Development of the Implementation Plan (2024-2030)

Following the establishment of innovation goals and the roles of the research centers, the next crucial step is to devise a comprehensive implementation plan covering the period from 2024 to 2030. This implementation plan serves as a roadmap for the practical realization of the research strategy, allowing for precise project management and resource allocation to attain the outlined innovation goals. It also underscores the strategic partnerships that will be sought or nurtured to ensure the successful execution of these projects.

6

Adjustment of the Research Strategy

Deeply synchronized with Saudi Arabia's national priorities, KFUPM's research strategy actively tackles major societal challenges through dynamic interdisciplinary collaboration. By embedding these innovative pursuits directly within its research centers, the university seamlessly connects cutting-edge discovery with teaching, learning, and public engagement. This integrated approach ensures that every scientific breakthrough directly advances the university's institutional mission and drives tangible value for the community.

04 What: Identifying the KFUPM's Grand Challenges

Grand Challenges represent the cornerstone of KFUPM's research strategy. They define the University's most ambitious research missions, addressing complex scientific, technological, and societal challenges that require interdisciplinary collaboration and long-term commitment. By focusing research efforts around Grand Challenges, KFUPM aims to concentrate its capabilities on areas where it can generate transformational knowledge, accelerate innovation, and create lasting economic and societal impact.

The identification of KFUPM's Grand Challenges followed a comprehensive and collaborative process. Beginning with the National Research Priorities most relevant to the University's mission and research strengths, our research community assessed how KFUPM could make distinctive contributions through its expertise, infrastructure, and partnerships. This process resulted in a set of Grand Challenges that align institutional capabilities with national aspirations

while positioning KFUPM at the forefront of emerging research domains.

To translate these Grand Challenges into actionable outcomes, the University established a set of measurable Innovation Goals. Each Innovation Goal defines a specific research objective with clear performance targets and implementation timelines, providing a practical pathway for achieving the broader Grand Challenge. Collectively, these Innovation Goals guide research programs, foster interdisciplinary collaboration across research centers, and enable systematic monitoring of progress toward the University's long-term strategic ambitions.

The Appendix presents a matrix summarizing KFUPM's Grand Challenges, the associated Innovation Goals, and the governance framework identifying the Champion, Anchor, and Supporting Centers responsible for delivering each goal.

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Central to this phase was a rigorous evaluation of our institutional footprint. We systematically analyzed how to best deploy our research expertise, advanced resources, and intellectual capital to address the KFUPM's Grand Challenges, ensuring a direct and lasting contribution to the National Priorities.



Energy and Industrial Leadership

- A1. Clean, Economic Hydrogen
- A2. Renewable Energy
- A3. Crude Oil-to-Chemical Conversion
- A4. Geoenergy Leadership
- A5. Electric Vehicles (EVs) and EV Batteries
- A6. Nuclear Energy



Sustainable Environment and Essential Needs

- B1. Innovative Water Research
- B2. Net Zero Emissions
- B3. Reuse of Materials and Products in Industry
- B4. Biodiversity



Economies of the Future

- C1. Cognitive Cities
- C2. Automation of Logistics
- C3. Industrial Robots
- C4. Net Zero Aviation
- C5. New Space Leadership
- C6. FinTech
- C7. Intelligent Manufacturing



Health and Wellness

- D1. Health and Bioengineering Innovation

A. Energy and Industrial Leadership



A.1 Clean, Economic Hydrogen



A.2 Renewable Energy



A.3 Crude Oil-to-Chemical Conversion



A.4 Geoenergy Leadership



A.5 Electric Vehicles (EVs) and EV Batteries



A.6 Nuclear Energy



A.1 Clean, Economic Hydrogen

KFUPM Grand Challenge

KFUPM will invent technologies and develop innovations that enable the following by 2030:

1. Produce hydrogen at less than \$0.5/kg.
2. Store hydrogen at less than \$0.2/kg.
3. Distribute hydrogen at less than \$0.3/kg.

Innovation Goals:

Develop the in-well hydrogen production process to TRL 5 by 2026

Develop efficient and sustainable hydrogen storage solutions with a cost of less than \$0.2/kg of H₂ by 2030

Reduce the cost of electrolyzer stacks (membrane, electrode, etc.) by 50% to produce green hydrogen by 2030

Identify the geological formations suitable for large scale hydrogen storage by 2026

Improve the cost of hydrogen production from hydrocarbons to less than \$0.5/kg by 2030

Optimize the cost of local distribution of hydrogen to less than \$0.3/kg by 2030

Survey 50% of KSA's geological formations for natural hydrogen sources by 2026

Establish a reliable, adaptable, and cost-effective hydrogen production system, fully powered by renewable energy sources, by 2030



A.2 Renewable Energy

KFUPM Grand Challenge

KFUPM will develop methods and applications that enable the following by 2030:

1. Achieve levelized cost of electricity (LCOE) 20% reduction for renewable energy systems in KSA climates.
2. Develop a Saudi electric grid with a ≤2.4 hours/year loss of load expectation (LOLE) at 50% renewable energy penetration.

Innovation Goals:

Develop renewable energy devices that extend lifespan by 20% under harsh environment (Ambient Temp 45–55 °C, Relative Humidity up to 90–95% RH, Soiling Loss 0.5–1% per day) by 2030

Develop control and adaptive protection technologies that cut fault clearance time to under 100 ms, keep grid frequency stable within ±0.5 Hz with 50% renewable penetration by 2030

Develop AI-driven monitoring, cooling, and cleaning technologies to reduce power degradation of renewable energy devices by 55% by 2030

Demonstrate operation of 10 kW redox flow batteries with a cost-effective electrolyte, enabling \$100/kWh by 2030



A.3 Crude Oil-to-Chemical Conversion

KFUPM Grand Challenge

KFUPM will develop the following by 2030:

1. Cost-effective and scalable catalysts/processes that convert 85% crude oil to chemicals
2. An integrated process that converts high-sulfur petroleum coke (more than 8% sulfur) to battery-grade carbon materials for energy storage

Innovation Goal:

Develop efficient and multifunctional catalysts and technology capable of removing 90% of impurities produced in cracking crude oil, resulting in a higher yield of light olefins and BTX aromatics at a conversion rate higher than 80% by 2030

Develop integrated processes to convert high sulfur petroleum coke to low-sulfur (less than 1% content) battery grade carbon materials (340 mAh/gr as specific capacity for graphite and 230 mAh/gr as specific capacity for graphene) by 2030

Develop scalable processes that convert at least 50% of heavy oils to carbon-fiber at a cost of \$10/kg compared to \$35/kg for conventional polyacrylonitrile(PAN) based route by 2030

Utilize quantum simulation to design multifunctional catalysts that simplify and optimize crude oil-to-chemicals processes by at least 10 times by 2030

Develop new formulations of polyacrylonitrile (PAN) and optimize their production processes aiming at the targeted production cost (\$10/kg) by 2030





A.4 Geoenery Leadership

KFUPM Grand Challenge

KFUPM will develop methods and applications that enable KSA to achieve the following by 2030:

1. Increase the recovery factors from subsurface reservoirs (hydrocarbons, geothermal fluids) by 30%.
2. Become the leader in achieving the global sustainability targets of hydrocarbon production, H₂ storage, CO₂ sequestration, and wastewater recycling in petroleum reservoirs.

Innovation Goals:

Consolidate geophysical methods (oil and gas, geothermal, CO₂/H₂, groundwater, etc.) in the characterization and monitoring phase by 2030

Develop and produce oilfield chemicals in a sustainable manner locally (field trial-proven) with the goal of increasing the production potential by 20% and reducing the overall carbon footprint by 50% by 2030

Develop H₂ and CO₂ storage capabilities for safely and economically sequestering the gases underground and handling the indirect global warming potential of gaseous H₂ by 2030



A.5 Electric Vehicles and EV Batteries

KFUPM Grand Challenge

KFUPM will develop an EV charging and propulsion ecosystem tailored toward a harsh environment (Ambient Temp 45–55 °C, Relative Humidity up to 90–95% RH)

Innovation Goals:

Develop Level 2 bidirectional EV chargers achieving 97% efficiency by 2030

Demonstrate ≥95% validated system-level efficiency for a 5–20kW EV motor drive system by 2030

Invent durable battery systems for EVs, achieving energy density exceeding 500 Wh/kg and >1,000 cycles by 2030



A.6 Nuclear Energy

KFUPM Grand Challenge

KFUPM will develop the following by 2030:

The University will demonstrate a thermal (non-nuclear core) prototype of a Small Modular Reactor (SMR) based on Gen-IV technology

Innovation Goals:

Optimize the licensed nuclear codes to perform design and safety analyses for the envisaged SMR design by 2030

Develop and test materials that are capable of operating at temperatures >600 °C to support Gen-IV SMR design by 2030

Develop a sustainable nuclear waste management strategy for the SMR design by 2030

B. Sustainable Environment and Essential Needs



B.1 Innovative Water Research



B.2 Net Zero Emissions



B.3 Reuse of Materials and Products in Industry



B.4 Biodiversity



B.1 Innovative Water Research

KFUPM Grand Challenge

KFUPM will invent technologies and develop systems to enable the following by 2030:

1. Develop a chemical system that reduces the energy consumption of wastewater treatment by 50%
2. Invent processes and membranes that can reduce desalination operating expenses by 50%
3. Develop AI algorithms that contribute to reducing the energy consumption of water distribution systems by 50%



Innovation Goals:

Develop chemically assisted membrane-based wastewater treatment systems (anaerobic ammonia oxidation and membrane bioreactor) that reduce energy consumption by 50% by 2030

Develop a high-recovery desalination process using advanced membranes and brine-mining technologies to cut net operating costs by 50% and convert brine into a strategic resource by 2030

Develop AI-based control systems for enhancing the energy consumption efficiency of KSA's water supply systems and management by 50%

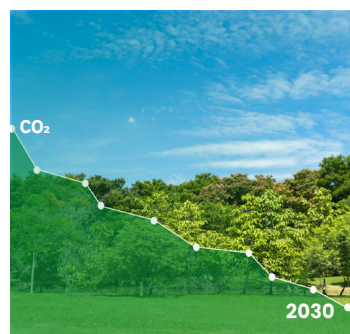


B.2 Net Zero Emissions

KFUPM Grand Challenge

KFUPM will invent technologies and develop systems that will achieve the following by 2030:

1. Contribute to reducing carbon emissions in KSA by 30%
2. Reduce the cost of CO₂ capture to less than \$40/C-ton
3. Reduce the cost of carbon storage to less than \$10/C-ton
4. Produce applications and materials that utilize 70% of captured carbon
5. Contribute to Net zero building



Innovation Goals:

Achieve a 60% reduction in cooling loads for residential buildings through passive envelope design by 2030

Reduce active energy system demand by 70% through the development of hybrid system technologies by 2030

Develop advanced combustion technologies to achieve 20% reduction in carbon emissions with respect to 2022 emission levels by 2030

Develop scalable up to 30% carbon utilization technologies for construction materials (for roads, buildings, and storage infrastructure) by 2030

Identify geological formations suitable for large-scale CO₂ storage by 2025

Develop technologies for the conversion of CO₂ to value-added chemicals by 2030

Reduce direct air capture (DAC) cost to <\$100/C-ton by 2040

Reduce point-source carbon capture cost to <\$80/C-ton by 2030

Develop software solutions for identifying the factors responsible for emissions and emissions estimation, modeling, and prediction at national and corporate levels by 2028

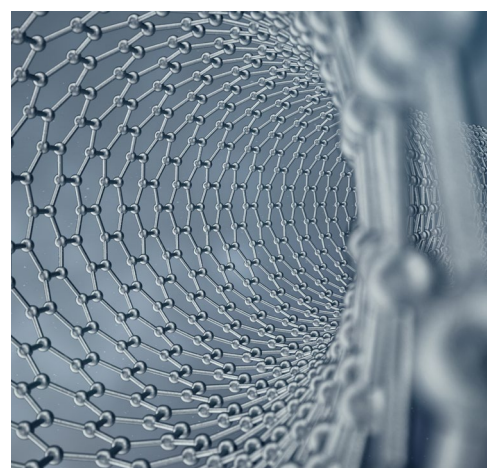


B.3 Reuse of Materials and Products in Industry

KFUPM Grand Challenge

KFUPM will develop innovative methods to achieve the following by 2030:

1. Create technologies and processes for increasing the reuse of waste materials to 30%t
2. Enable conversion of polymeric wastes into valuable products
3. Produce graphene from petroleum coke
4. Develop green and scalable technologies to extract, recover, and recycle critical metals in Saudi Arabia



B.3 Reuse of Materials and Products in Industry

Innovation Goals:

Demonstrate pilot-scale conversion and/or integration of microalgae biomass and waste-derived feedstocks into self-healing, smart, metamaterial, biomedical, and filtration materials compatible with conventional and additive manufacturing for marine, terrestrial, and airspace applications by 2030

Develop next-generation mechanical metamaterials for additive manufacturing to achieve a stiffness-to-weight ratio of ≥ 75 kPa.m³.g⁻¹ and a specific energy absorption of ≥ 20 J.g⁻¹ by 2030

Develop a green hydrometallurgical process for extracting gallium from domestic resources that achieves >70% recovery per loading-elution cycle by 2030

Develop cost-efficient technologies to convert at least 60% of biogenic wastes into sustainable aviation fuels (SAF) at a price comparable to that of conventional jet fuels by 2030

Produce lithium-ion battery-grade graphite that can achieve a delithiation capacity of ≥ 340 mAh.g⁻¹, from industrial emissions and underutilized materials by 2030

Develop and scale an electrolytic process for producing highly ordered graphite at >200 mA.cm⁻² current density, ≤ 2.0 V cell voltage, and >70% Faradaic efficiency by 2030

Develop cost-effective technology to convert at least 60% of plastic waste into valuable products (aromatics, olefins, paraffins, etc.) by 2030

Design ionic exchangers for metals hydrometallurgical production that achieve a loading capacity of >500 mg.L⁻¹ with matrix swelling of <35% by 2030

Recycle/reuse 30% of construction and demolition (C&D) waste in the construction sector by 2030

Develop environmentally friendly recycling technologies to achieve >95% recovery of critical minerals from spent batteries by 2030

Utilize 20% of KSA's industrial waste materials in the construction sector by 2030

Utilize 20% of the KSA's industrial waste materials in the construction sector by 2030



B.4 Biodiversity

KFUPM Grand Challenge

KFUPM will develop the following by 2030:

1. Develop a smart tools-based mapping strategy to enable KSA to conserve 30% of the biodiversity of its marine and coastal habitats by 2030
2. AI-based algorithms and applications for automated taxonomical identification of KSA's wildlife
3. An environmental surveillance network that enhances the ecosystem status assessment and management response by 50%
4. Development of four or more bio-environmental technologies merging biology, engineering, and AI to predict, prevent, monitor, and mitigate environmental risks (industrial, chemical, and ecological) across marine, terrestrial, and airspace environments to protect planetary health, food security, and human well-being in Saudi Arabia

Innovation Goals:

Develop an advanced, integrated, and smart environmental surveillance network that will enhance ecosystem status assessment and management response by 50% by 2030

Develop a smart tools-based mapping strategy to enable KSA to conserve 30% of the biodiversity of its marine and coastal habitats by 2030

Develop AI-based algorithms and applications for automated taxonomical identification of KSA's wildlife by 2030

C. Economies of the Future



C.1 Cognitive Cities



C.3 Industrial Robots



C.5 New Space Leadership



C.7 Intelligent Manufacturing



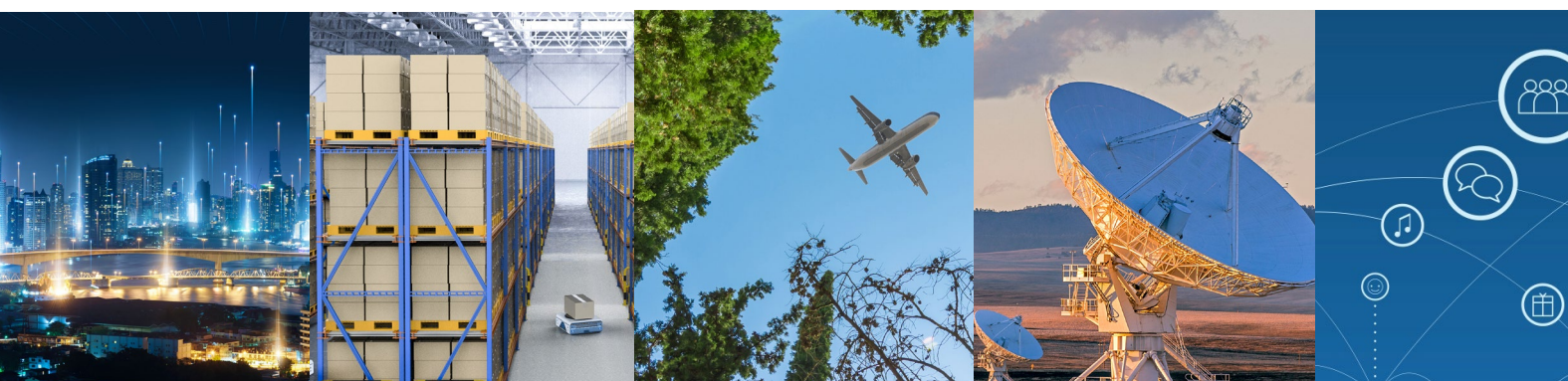
C.2 Automation of Logistics



C.4 Net Zero Aviation



C.6 FinTech



C.1 Cognitive Cities

KFUPM Grand Challenge

KFUPM will develop the following for cognitive cities by 2030:

1. Next-generation, energy-conscious backbone communications and sensing systems
2. Models based on cognitive skills for secure, privacy-preserving, and personalized cyber-physical-social systems
3. Decision-making algorithms based on cognitive skills to create smart mobility services and carbon-free smart transportation modes
4. Automation based on cognitive skills for optimizing services and improving quality of life

Innovation Goals:

Develop five quantum technologies with applications in cognitive-cities by 2035

Develop sustainable living models and decision-making algorithms for five cities by 2030

Develop zero-emission intelligent transportation systems and mobility services by 2030

Develop five quantum technologies with applications in cognitive-cities by 2035

Develop five secure and privacy-preserving human-centered AI-based systems for cognitive cities by 2030

Develop and test Post-Quantum Cryptography (PQC) protocols for the “secure and privacy-preserving” models by 2030

Develop green ML-based solutions for resource optimization in communications and/or sensing networks by 2030

Implement secure, privacy-preserving quantum communication links for personalized cyber-physical-social systems by 2030

Work with five cities to develop technologies to map nonstandard features on geographic information systems (GIS) maps by 2030

Develop Digital Twin frameworks for mobile communication networks under Saudi Arabia’s environmental and operational conditions by 2030

Create cost-effective frameworks for digital twins of urban cities for use in planning and predicting mobility, urbanization rate, and capacity by 2030

Develop AI-driven solutions for ultra-reliable and low-latency Non-Terrestrial Networks (NTNs) in mission-critical applications by 2030

Establish a seamless HPC-Quantum integration layer for energy-conscious backbone communication and complex city-wide sensing systems by 2030

Develop energy-efficient semiconductor platforms to support advanced sensing, processing, and communication applications by 2030

Develop Open RAN frameworks and solutions to empower next-generation communication networks with flexibility, scalability, and vendor diversity by 2030

Develop secure and resilient wireless communication frameworks to safeguard next-generation networks against unauthorized access by 2030

Develop and fabricate transparent and/or flexible microwave devices (including but not limited to absorbers, antennas, and energy-harvesting systems), designed for integration into urban structures and windows by 2030

Develop next-generation sensing and/or integrated sensing and communication technologies to jointly support reliable detection/localization and communication by 2030

Develop next-generation high-frequency communication systems that ensure reliable, high-data-rate, and non-line-of-sight connectivity through reconfigurable intelligent surfaces for future cognitive cities by 2030

Design and implement next-generation electronic circuits and systems that are energy-efficient, reconfigurable, and AI-enabled, addressing the performance and sustainability demands of emerging technologies by 2030

Develop and experimentally demonstrate reconfigurable antenna/surface technologies with flexible beam control and high efficiency, enabling adaptive next-generation connectivity, energy-efficient IoT, and advanced sensing applications by 2030

Develop an energy-efficient and resilient communication backbone that integrates free-space and underwater optical links, seamlessly connecting terrestrial, airborne, and underwater systems for reliable communication and environmental monitoring by 2030

Develop hardware-level fault-tolerant quantum units to ensure 5x more trustworthy and resilient cyber-physical city infrastructure by 2030



C.2 Automation of Logistics

KFUPM Grand Challenge

KFUPM will develop the following:

1. Automation systems that shorten freight forwarding and delivery times and reduce transportation costs of KSA's shipments by 50% by 2030
2. AI-based routing algorithms for autonomous ground and air vehicles for last-mile delivery of shipments by 2027
3. Develop an AI-Optimized national logistics and mobility system to redefine regional connectivity

Innovation Goals:

Develop smart path planning algorithms for last-mile delivery in order to reduce delivery time by 20% by 2027

Develop digital twins of inter-modal and multimodal supply chains to increase KSA's logistics performance by more than 25% by 2030

Develop intelligent autonomous systems (drones, automated guided vehicles, and humanoids) for automated last-mile delivery in order to reduce transportation costs by 50% by 2030

Design materials handling and shipment intralogistics models based on Internet of Things (IoT)/cloud computing that can be implemented in over 50% of KSA ports by 2030

Develop a Value-of-Information-based prioritization framework for logistics digitalization to identify the top five digital investments and achieve 20% reduction in misallocated or low impact digital spending by 2030

Develop AI models for intermodal and port operations to reduce transportation costs by 50%, improve logistics performance by over 25%, and cut last-mile delivery time by 20% by 2030

Develop quantum-inspired algorithms to optimize smart mobility services and carbon free transportation modes, targeting a 50% reduction in transport costs



C.3 Industrial Robots

KFUPM Grand Challenge

KFUPM will develop the following by 2030:

1. AI-based self-trainable industrial robots and systems for training industrial robots
2. Industrial robots possessing close-to-human tolerance-for-position capability.

Innovation Goals:

Harness learning-based approaches as cognitive engines for advanced robotics enabling systems to reason, learn, and act with a level of adaptability by 2030

Develop robots with high tolerance to system parameter variations and superior disturbance rejection, leveraging advanced sensing and actuation concepts, including contactless mechanisms, by 2030

Develop a fully functional six degrees of freedom (6-DoF) proof-of-concept demonstrator autonomous underwater vehicle capable of carrying out routine, dull, dirty, and dangerous tasks intelligently

Develop a fully functional proof-of-concept demonstrator unmanned surface vehicle capable of carrying out routine, dull, dirty, and dangerous tasks with minimal human intervention

Develop a fully functional 6-DoF proof-of-concept demonstrator unmanned aerial vehicle capable of carrying out routine, dull, dirty, and dangerous tasks intelligently



C.4 Net Zero Aviation

KFUPM Grand Challenge

KFUPM will achieve the following by 2040:

KFUPM will enable $\geq 50\%$ CO₂ equivalent emissions reduction per km in Advanced Air Mobility Technologies

Innovation Goals:

Demonstrate TRL 3 flight-readiness of hybrid and electric propulsion technologies for regional aviation, targeting $\geq 50\%$ reduction in mission-level CO₂ equivalent missions relative to representative 2023 regional aviation baselines by 2030

Demonstrate operational capability of electric-powered unmanned swarm systems (≥ 5 agents) for selected short-range missions, achieving up to 100% reduction in per mission carbon emissions relative to conventional manned mission equivalents by 2030

Develop and validate High-Fidelity Intelligence and Digital Twin frameworks in Design, Materials and Autonomy that enable a $\geq 10\%$ reduction in CO₂ equivalent per mission for next-gen aircraft by 2030



C.5 New Space Leadership

KFUPM Grand Challenge

KFUPM will develop the following by 2030:

1. Develop and Launch Spacecraft Systems for Earth Observation and Laser Communication
2. Develop Lunar Rover and Deep Space Technologies to Support Human Space Mission

Innovation Goals:

Deploy at least 1 Space-qualified CubeSat (6U+) for high-resolution Earth Observation and Novel Technology Validation by 2030

Develop Environment-tested Lunar Rover platform to enable Saudi human-robotic exploration missions by 2030

Deploy 90% accurate AI-powered Geospatial Platform to Provide Decision-making insights about Urban Planning and Environmental Monitoring using Satellite data by 2030

Develop Robust Space Situational Awareness framework for mitigating Extreme Space Weather and Debris effect, by providing early warning for Saudi space assets by 2030



C.6 FinTech

KFUPM Grand Challenge

KFUPM will develop the following by 2030:

1. Develop a resilient and Shariah-compliant digital finance ecosystem in the Kingdom through financial innovation, inclusive artificial intelligence (AI)-powered small and medium-sized enterprises (SME) finance, and intelligent automation for risk management and compliance across financial technology (FinTech) sectors
2. Create a national economic-intelligence platform to grow innovation-focused foreign direct investment (FDI) inflows into targeted innovation activities
3. Assess the impact of Fintech and Industry 4.0 technologies on the national economy and Saudi consumers while contributing to the digital ecosystem by promoting innovation, learning, and entrepreneurship to produce market products and services that create sustainable value for consumers and society at large
4. Develop trusted AI-enabled FinTech and digital responsibility solutions for tourism ecosystems to enhance visitor experiences, enable secure and transparent transactions, support data-driven governance, and strengthen stakeholder trust

Innovation Goals:

Develop an AI system for small and medium-sized enterprises (SME) lending that improves risk prediction and reduces new default inflows by $\geq 15\%$ by 2030

Develop adoption and usage research frameworks of 30 FinTech solutions across digital payment, digital capital raising, and neo banking by 2028

Develop an explainable AI analytics platform to achieve a $\geq 25\%$ reduction in fraudulent claims and a concurrent $\geq 10\%$ reduction in anomalous payment leakage by 2030

Develop a policy diagnostic framework for microfinance and crowd funding to quantify market barriers and recommend reforms that increase access by 20-30% by 2030

Design a national digital-economy foreign direct investment (FDI) acceleration policy package to cut approval time by 40 percent and double lead-to-commitment conversion by 2030

Create FDI analytics framework to quantify the impact of projects and reforms, supporting data-driven progress toward the 5.7% gross domestic product (GDP) FDI target by 2030

Develop two AI-enabled FinTech frameworks that increase the purchase of tourists' gifts by $\geq 10\%$ across 10 tourism businesses by 2030 through secure and transparent transactions and privacy aware personalization

Develop an explainable AI model for debt-based crowdfunding to strengthen borrower screening and investor protection, achieving $\geq 20\%$ reduction in platform default by 2030

Develop 20 emerging technology adoption and usage frameworks to advance digital transformation and assess economic impact across healthcare management, marketing, innovation and entrepreneurship, finance, creative industries, education, government, and real estate by 2030

Develop three esports tourism innovation models using insights from major events, esports gamers and audiences, and generate validated evidence of increased event-related tourist arrivals and a 5-10% uplift in average length of stay by 2028



C.7 Intelligent Manufacturing

KFUPM Grand Challenge

KFUPM will develop AI-enabled adaptive manufacturing platforms with digital twins for optimized, predictive, and resource-efficient manufacturing by 2030

Innovation Goals:

Develop adaptive, additive, and hybrid manufacturing technologies delivering four industrial prototypes with $\geq 30\%$ defect reduction and $\geq 20\%$ performance gains by 2030

Develop and deploy physics-constrained AI and digital twin frameworks, demonstrated through two operational digital twin systems for advanced manufacturing by 2030

Enable scalable manufacturing of programmable and stimuli responsive devices and micro-devices with up to 30% cost reduction and 50% operational lifetime improvement by 2030

D. Health and Wellness



D.1 Health and Bioengineering Innovation



D.1 Health and Bioengineering Innovation

KFUPM Grand Challenge

KFUPM will develop four or more bio-digital technologies to predict, prevent, diagnose, monitor, and treat major diseases (cardiovascular, metabolic, oncological, musculoskeletal, neurological, and infectious) through biological simulation, physical restoration, point-of-care diagnostics, and AI-driven prediction

Innovation Goals:

Develop a generative-design pipeline for patient-specific smart and passive biomaterials, implants, and prostheses integrating advanced materials and anthropometric customization for affordable musculoskeletal restoration by 2030

Develop at least two point-of-care diagnostic devices and at least one AI-driven wearable or implantable solution capable of predicting, preventing, and continuously monitoring at least one major disease domain by 2030

Develop energy-efficient, integrated, and miniaturized sensing and communication platforms and/or electronic systems to enable continuous remote health monitoring and sensitive, affordable screening of diverse biomarkers

Utilize quantum-classical hybrid algorithms to simulate molecular docking for three priorities viral or chronic disease targets, reducing the initial drug candidate screening time by 70% by 2030

Establish a Computational Biology and Bioinformatics platform collecting clinically validated datasets from $\geq 5,000$ patients across at least one major disease domain to enable AI-driven prediction and therapeutic optimization, while reducing healthcare costs by 15% within the study cohort by 2030

Develop an integrated VAD platform combining smart testing systems and cardiopulmonary simulation (phantoms, mock loops, and digital twins) to benchmark and optimize cardiac device performance for improved patient outcomes by 2030

Health and Wellness

4

National
Focus Areas



18

National
Priorities



45

Grand
Challenges



117

Innovation
Goals



22

Research
Centers



05 Plan: Turning Strategy into Action

KFUPM’s innovation-based research strategy thrives on highly collaborative effort and robust strategic partnerships. Because these goals are university-wide, successful execution demands active cooperation and alignment from every entity across the research and innovation ecosystem.

To ensure accountability and strategic agility, execution is governed by a clear hierarchy of leadership:

1. The Vice President for Research and Innovation (VPRI) & The Research Oversight Committee (ROC): This leadership tier spearheads the evaluation of progress against KFUPM’s grand challenges. Beyond monitoring, the ROC actively identifies emerging research strengths and dynamically adapts the overarching strategy to maximize growth and impact.

2. Champion Centers: Dedicated to each National Priority, these specialized centers act as the front line coordinators. They align institutional efforts to tackle grand challenges and fulfill national mandates by fostering cross-center coordination, streamlining communication, and consistently monitoring progress.

3. The Research Excellence Office (REO): Operating directly under the oversight of the VPRI, the REO serves as the critical engine for strategy execution. Working through three distinct modalities drives implementation, evaluates the specific requirements needed to meet innovation goals, and fosters institutional ownership, synergy, and clear communication.

The Research Excellence Office will serve as a vital pillar and operate through three distinct modalities:

1

Guiding Strategy Implementation

The office will serve as the guiding force, ensuring that the research centers adhere to the strategic vision and objectives.

2

Assessing Requirements for Innovation Goals

The office will play a critical role in assessing the essential requirements for achieving the innovation goals and aligning resources with these objectives.

3

Fostering Ownership, Synergy, and Communication

The office will facilitate communication of the strategic goals among the research centers, foster synergy among various stakeholders, and ensure transparent communication to enhance collaboration.

Championing National Priorities: Governance & Execution

To ensure a unified direction, a dedicated Champion Center is assigned to each National Priority. Operating at the core of this framework, the Champion Center bridges high-level national priorities with institutional execution by fulfilling four critical mandates:

- 1. Strategic Alignment:** Fosters strict coordination and synergy among diverse Anchor Centers and Supporting Centers, ensuring all research units move cohesively toward defined innovation goals.
- 2. Transparent Communication:** Serves as the central hub for knowledge-sharing and open communication across all research centers engaged in the National Priority.
- 3. Performance Monitoring:** Conducts rigorous, periodic reviews of ongoing activities and projects, measuring progress against established Key Research Results (KRRs).
- 4. Risk Mitigation:** Proactively identifies operational bottlenecks and systemic obstacles, deploying interventions to ensure KFUPM’s grand challenges are successfully met. By maintaining this operational oversight, Champion Centers transform isolated research efforts into a synchronized, high-impact pipeline that directly addresses national priorities.

National Focus Area	National Priority	Champion Center
Energy and Industrial Leadership	Clean, Economic Hydrogen	IRC for Hydrogen Technologies and Carbon Management
	Renewable Energy	IRC for Sustainable Energy Systems
	Crude Oil-to-Chemical Conversion	IRC for Refining and Advanced Chemicals
	Geoenery Leadership	Center for Integrative Petroleum Research
	EVs and EV Batteries	IRC for Sustainable Energy Systems
	Nuclear Energy	IRC for Industrial Nuclear Energy
Sustainable Environment and Essential Needs	Innovative Water Research	IRC for Membranes and Water Security
	Net Zero Emissions	IRC for Hydrogen Technologies and Carbon Management
	Reuse of Materials and Products in Industry	IRC for Construction and Building Materials
	Biodiversity	ARC for Environment and Marine Studies
Economies of the Future	Cognitive Cities	IRC for Communication Systems & Sensing
	Automation of Logistics	IRC for Smart Mobility and Logistics
	Industrial Robots	IRC for Intelligent Manufacturing and Robotics
	Net Zero Aviation	IRC for Aviation and Space Exploration
	New Space Leadership	IRC for Aviation and Space Exploration
Health and Wellness	FinTech	IRC for Finance and Digital Economy
	Intelligent Manufacturing	IRC for Intelligent Manufacturing & Robotics
	Health and Bioengineering Innovation	IRC for Bio Systems and Machines

Plan: Turning Strategy into Action

Review and Monitoring

The assessment of innovation goal achievement follows the “Objectives and Key Results” methodology, a framework for setting clear, measurable objectives and specific key results to gauge progress. This methodology mirrors the approach used in developing the research strategy, where innovation goals serve as “objectives.” Key research results are systematically evaluated to ensure effective strategy execution throughout the period (2024–2030).

Semiannual reviews of overall progress with the VPRI serve as a vital mechanism for monitoring and enhancing the alignment of Champion Centers with national research priorities. This section guides the intricate process of assigning, coordinating, and overseeing Champion Centers, enabling KFUPM to effectively pursue and attain its national research priorities and innovation goals.

Plan: Turning Strategy into Action

Strategic Partnerships: Ecosystem Mobilization

KFUPM’s innovation-driven research strategy places partnerships at the core of its execution. Research centers serve as the primary institutional vehicles for cultivating these alliances, bridging academic discovery with market application. To maximize impact, the lifecycle of every strategic partnership is governed by three rigorous operational phases:



Phase 1: Connect (Scouting & Strategic Alignment)

Research centers actively engage industry partners, including technology developers, end-users, and regulatory bodies, to co-develop research agendas aligned with KFUPM Research Strategy.

1. The Cluster Approach: To optimize institutional efficiency, research centers with intersecting innovation goals form collaborative “clusters.” When engaging shared industry stakeholders, a cluster operates as a single unified entity for all alignment workshops and joint coordination meetings.

“The lifecycle of strategic partnerships is governed by a structured three-phase framework: Connect, Manage, and Evaluate. It is designed to systematically align industry alliances with KFUPM’s innovation objectives, ensure proactive operational oversight, and rigorously audit performance to maximize national impact.”

2. Partner Vetting & Due Diligence: Centers must transparently log existing and prospective partner pipelines with central administration. Potential partners are rigorously assessed across a structured capability matrix:

- Strategic alignment of research interests and commitment
- Institutional reputation, financial capacity, and technical expertise
- Communication culture, collaborative practices, and comprehensive risk profiles

Phase 2: Manage (Operational Oversight & Synergy)

Sustaining momentum requires aggressive, proactive management. Cohesion is maintained through structured alignment workshops and frequent operational meetings that tie deliverables directly to KFUPM’s grand challenges and the broader national mission.

Reporting Mandate: Research centers must provide periodic updates on collaboration milestones, progress, and tangible outcomes to the Deanship of Research (DR) and the Research Excellence Office (REO).

Intervention & Recognition: This systematic oversight allows central leadership to step in early to resolve operational bottlenecks, deploy necessary administrative support, and amplify high-performing collaborations.

Phase 3: Evaluate (Bi-Annual Impact Auditing)

To ensure long-term viability and return on investment, all partnerships undergo a formal, bi-annual performance audit co-led by the Deanship of Research (Partnership Unit) and the Research Excellence Office.

Governance Action: Final audit reports are delivered directly to the Vice President for Research and Innovation (VPRI) and senior leadership at the partner organization. Outcomes from these evaluations drive high-level executive decisions to strengthen, re-scope, or terminate existing alliances, as well as identify new domains for exploration.

Plan: Turning Strategy into Action

Fostering Social Innovation for Societal Impact

KFUPM's plan for fostering social innovation and societal impact involves the ARC for Nonprofit and Social Development (Nonprofit Center) supporting all Research and Innovation centers. This support includes identifying direct and indirect societal impacts and the value on humanity as identified in the UN-SDGs through a comprehensive strategy.

The strategy focuses on key dimensions:

- Awareness and Engagement
- Operational sustainability
- Addressing community needs
- Sustaining societal impact

To ensure the success of this strategy, Nonprofit Center will carry out the following supporting activities to ensure the achievement of the four dimensions of the strategy:

- Conducting workshops to unify perceptions and confirm the involvement of all university Employees, Faculty, and researchers.
- Building institutional and Human capital capacities in research centers to provide social innovation services.
- Assisting research centers in building their operational plans according to the strategic indicators.
- Building tools and models to activate the strategy, supervise it, and measure its societal impact.



Plan: Turning Strategy into Action

Research for Humanity: Global Impact & Interdisciplinary Excellence

KFUPM recognizes its responsibility to deliver meaningful solutions to the interconnected challenges facing humanity and our planet. Through the "Research for Humanity" initiative, the university is cultivating a collaborative ecosystem where diverse intellectual minds intersect to address pressing local and global priorities. By mobilizing its advanced research infrastructure, KFUPM fosters transformative, cross-disciplinary synergy—uniting engineers, geologists, data analysts, social scientists, and historians to dismantle traditional intellectual silos, pioneer uncharted research territories, and execute high-impact joint projects.

At the core of this vision is an explicit commitment to the United Nations Sustainable Development Goals (SDGs). Recognizing that the 17 SDGs serve as an interconnected roadmap for a sustainable future, spanning climate action, resource security, and societal well-being. KFUPM actively harnesses the collective brilliance of its faculty and researchers to pioneer scalable, real-world solutions. Ultimately, the Research for Humanity initiative solidifies KFUPM's role as an institutional catalyst, driving impactful, collaborative research that advances human knowledge and safeguards current and future generations.



Strategic & Future-Focused

Implementing this research strategy demands building heavy, innovation-based partnerships with both industrial end-users and technology developers, unlocking private sector-backed investments, and capturing market-driven opportunities. Similarly, cultivating a highly effective ecosystem at a research-intensive university requires a robust, specialized infrastructure to jointly leverage research outcomes with partners. This infrastructure must programmatically support the entire technology pipeline:

- **Shaping & Ideation:** Defining the technology and identifying preliminary market-entry barriers (TRL 2–4)
- **Scaling & Validation:** Piloting technologies and validating performance against market-entry barriers (TRL 4–6)
- **System Integration & Deployment:** Finalizing full-scale demonstration, operational validation, and industrial-grade deployment to achieve market-readiness (TRL 7–9)

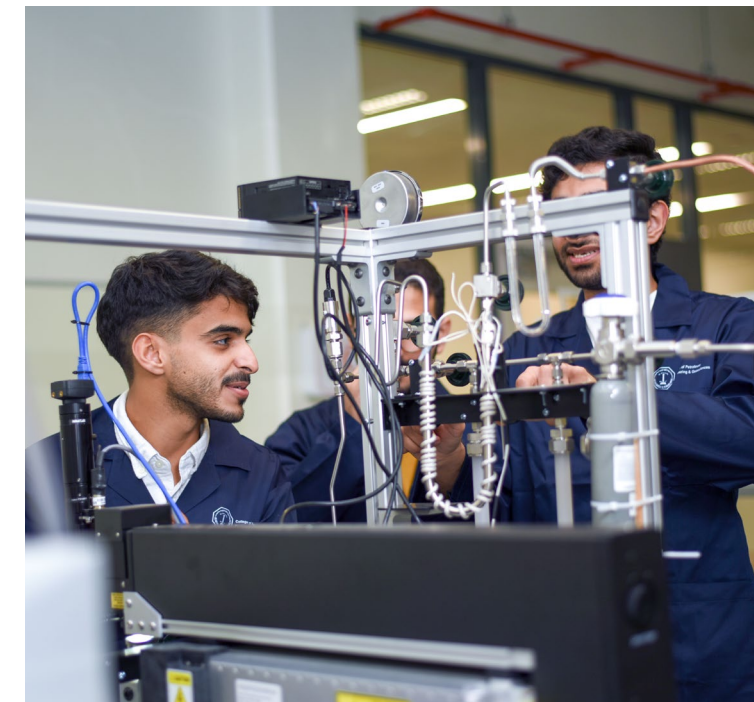
This infrastructure serves as a critical catalyst for experimental development and deployment capacities in capital-intensive fields, such as hydrogen generation, storage, and transportation; carbon capture; water purification; renewable energy; petroleum conversion; and advanced manufacturing. Concurrently, the rapid growth of cutting-edge R&D fields within digitalization and Fourth Industrial Revolution (IR4.0) sciences demands agile, distinct experimentation setups.

Integrating these setups with elite technical and engineering capabilities accelerates the development of production-ready, IR4.0-powered products, applications, and systems.

Beyond technology validation, these institutional arrangements systematically alleviate broader structural bottlenecks to ensure successful commercialization and macroeconomic diffusion. By anchoring national capacity to high-growth sectors, they foster robust domestic supply chains for emerging technologies, significantly enhancing resilience against global supply shocks. They act as vital market-makers, nurturing nascent commercial ecosystems and collaborating with established enterprises to unlock the economic potential of novel, research-backed discoveries. Furthermore, they partner closely with government entities to design the specialized workforce training systems required for these new industries, while simultaneously pioneering the modern regulatory standards and frameworks needed to govern newly created economies.



To bridge this gap from concept to market reality (TRL 3–9), infrastructure typically materializes in two high-impact forms: Thematic Centers for Innovation and Translational R&D Facilities. Thematic centers connect theoretical research directly with pressing corporate challenges, adapting existing solutions to address immediate industry needs. Translational facilities act as powerful partnership vehicles, leveraging advanced infrastructure and elite specialists to integrate disparate basic research into a cohesive, commercializable technology domain. Ultimately, both models serve a vital strategic purpose: they provide the collaborative platforms necessary to solve complex national and global challenges, aligning multi-sectoral stakeholders and diverse disciplines across the entire value chain, from initial proof-of-concept directly to full-scale market adoption.



Strategic Infrastructure Development: Attracting Public and Private Investment

1

National Alignment & Value Proposition

A clear roadmap demonstrating how the infrastructure directly accelerates national innovation priorities, addresses high-impact economic challenges, and delivers a measurable return on investment for funding bodies.

2

Technology Readiness & Scalability Pathways

A structured framework highlighting how the facilities will bridge the gap between applied research and commercial deployment, accelerating technologies from early-stage concepts to market-ready solutions.

3

Risk Mitigation & Governance Model

A robust operational and legal framework that outlines clear co-investment structures, intellectual property protection, and transparent governance to build long-term institutional trust with private investors success partners in general.

4

Ecosystem Integration & Shared Infrastructure

A collaborative blueprint illustrating how the infrastructure serves as an open, shared ecosystem connecting academia, industry, and government partners to foster co-creation and sustainable research and innovation growth.

Research Environment Enhancement

The success of university's research endeavors is not solely determined by brilliant minds and groundbreaking ideas. It hinges critically on the research environment, a complex ecosystem that nurtures, challenges, and directs the course of discovery. KFUPM is undertaking major steps to enhance the research environment in alignment with the overall research strategy to maximize research and innovation's economical and societal impacts.

KFUPM is taking major steps as part of the research and innovation strategy:

Centralize and Optimize Infrastructure: Establish state-of-the-art central research facilities equipped with cutting-edge technology and resources, accessible to all researchers across disciplines.

Streamline Policies and Regulations: Review and revise existing research policies and regulations to simplify processes, enhance transparency, and accelerate research progress.

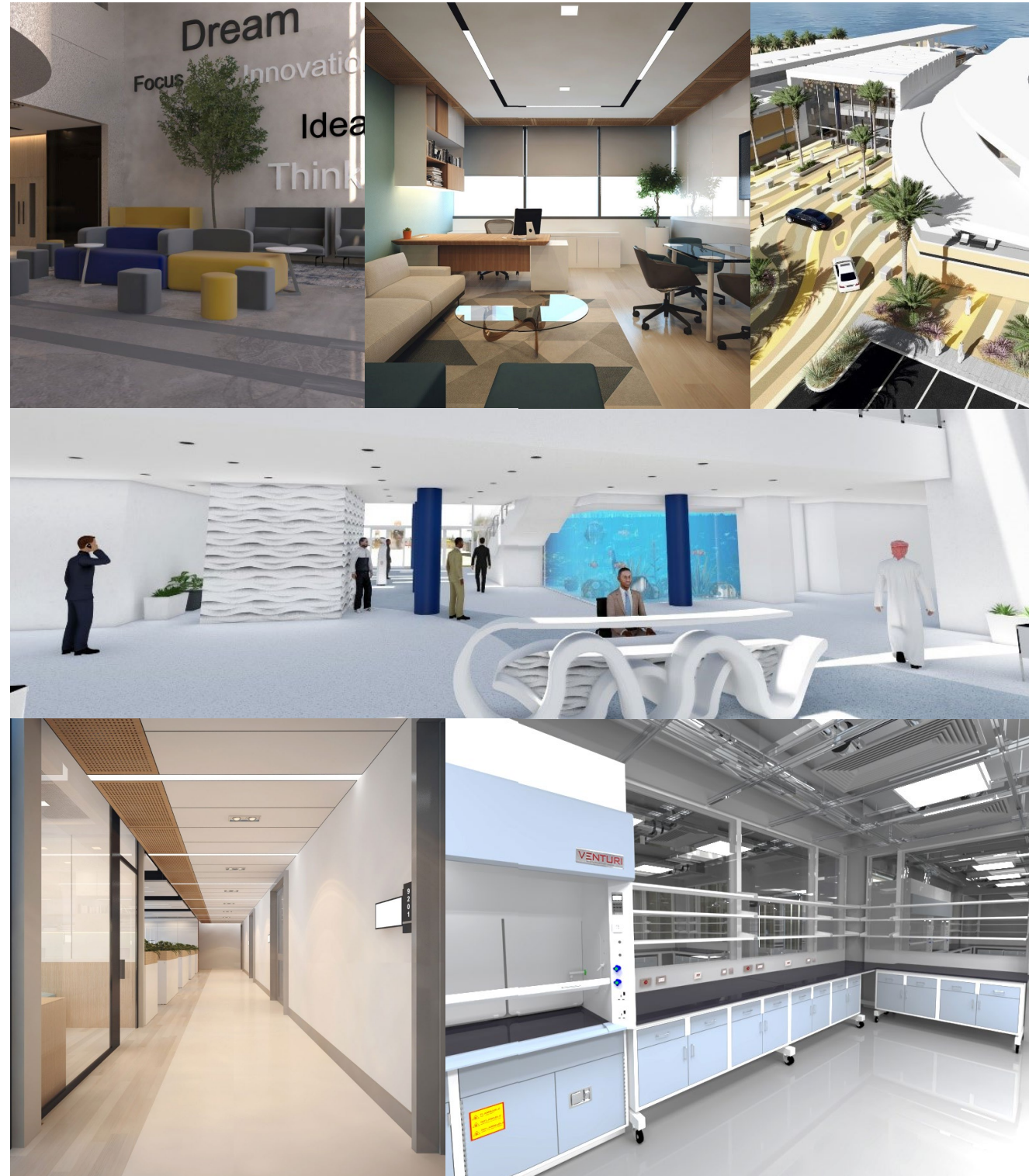
Revitalize Existing Research Labs and Facilities: transforming them into vibrant hubs for collaboration and experimentation.

Foster Interdisciplinary Synergy: Facilitate collaboration across disciplines through dedicated programs, shared resources, and flexible research spaces.

Attract and Retain Top Talent: Develop competitive research funding programs, mentorship initiatives, and career development opportunities to attract and retain world-class researchers.

Promote Knowledge Exchange: Foster open communication and knowledge sharing through seminars, workshops, and conferences, empowering researchers to learn from and inspire each other.

Bridge Industry and Academia: Strengthen partnerships with industry leaders to translate research findings into practical applications, benefiting society and the economy.



A vibrant and supportive research environment is the cornerstone of a successful university. By understanding its impact on the overall research strategy and investing in its development, universities can foster a culture of excellence, attract top talent, generate groundbreaking discoveries, and ultimately contribute meaningfully to the advancement of knowledge and society.

As a result of the new strategy, KFUPM will invest in enhancing research and innovation environment to:

1 Increase research impact: High-quality facilities, efficient processes, and collaborative environments will lead to groundbreaking discoveries and economical/societal impact.

2 Enhanced reputation and global recognition: KFUPM will attract prominent researchers, students, postdocs, and international partnerships, positioning it as a leading research hub.

3 Contribute to national development: Research outcomes will address national priorities in science, technology, and industry, fostering economic growth and societal progress.

4 Attracting and retaining top talent: Modern facilities, streamlined processes, and competitive support will attract and retain high-caliber researchers and students.

Innovation Goals National Research Priority Center Names

National Focus Area	National Research Priority	Grand Challenges (Adjusted in 2026)	Goal ID	Innovation Goals (Adjusted in 2026)	Aerospace	BioSys	Carbon	Refining	Conversion	Communication	Construction	Energy	Marine	Fintech	Hydrogen	Integrative	Logistics	Manufacturing	Materials	Nuclear	Security	SDAIA	Quantum	Water	Nonprofit	
Energy and Industrial Leadership	Clean, Economic Hydrogen	KFUPM will invent technologies and develop innovations that enable the following by 2030: 1. Produce hydrogen at less than \$0.5/kg 2. Store hydrogen at \$0.2/kg 3. Distribute hydrogen at less than \$0.3/kg	A.1.01	Develop the in-well hydrogen production process to TRL 5 by 2026																						
			A.1.02	Reduce the cost of electrolyzer stacks (membranes, electrode, etc.) by 50% to produce green hydrogen by 2030																						
			A.1.03	Improve the cost of hydrogen production from hydrocarbons to less than \$0.5/kg by 2030																						
			A.1.04	Survey 50% of KSA's geological formations for natural hydrogen sources by 2026																						
			A.1.05	Develop efficient and sustainable hydrogen storage solutions with a cost of less than \$0.2/kg of H ₂ by 2030																						
			A.1.06	Identify the geological formations suitable for large scale hydrogen storage by 2026																						
			A.1.07	Optimize the cost of local distribution of hydrogen to less than \$0.3/kg by 2030																						
	Renewable Energy	KFUPM will develop methods and applications that enable the following: 1. Achieve leveled cost of electricity (LCOE) 20% reduction for renewable energy systems in KSA climates by 2030 2. Solar PV capacity to reach 100 GW by 2030 3. Wind capacity to reach 50 GW by 2030 4. Load expectation (LOE) at 50% renewable energy penetration by 2030	A.1.08	Establish a reliable, adaptable, and cost-effective hydrogen production system, fully powered by renewable energy sources, by 2030																						
			A.2.01	Develop renewable energy devices that extend lifespan by 20% under harsh environment (Ambient Temp 45-55 °C, Relative Humidity up to 90-95% RH, Soiling Loss 0.5-1% per day) by 2030																						
			A.2.02	Develop AI-driven monitoring, cooling, and cleaning technologies to reduce power degradation of renewable energy devices by 55% by 2030																						
			A.2.03	Demonstrate operation of 10 kW redox flow batteries with a cost-effective electrolyte, enabling \$100/kWh by 2030																						
	Crude Oil-to-Chemical Conversion	KFUPM will develop the following by 2030: 1. Cost-effective and scalable catalysts/processes that convert heavy oil to high-value chemicals at 30% lower cost than conventional processes 2. An integrated process that converts high-sulfur petroleum coke (more than 8% sulfur) to battery-grade carbon materials for energy storage	A.2.04	Develop control and adaptive protection technologies that cut fault clearance time to under 100 ms, keep grid frequency stable within ±0.5 Hz with 50% renewable penetration by 2030																						
			A.3.01	Develop efficient and multifunctional catalysts and technology capable of removing 90% of impurities produced in cracking crude oil, resulting in a higher yield of light olefins and BTX aromatics at a conversion rate higher than 80% by 2030																						
			A.3.02	Develop scalable processes that convert at least 50% of heavy oils to carbon fiber at a cost of \$10/kg compared to \$35/kg for conventional polyacrylonitrile (PAN) based route by 2030																						
			A.3.03	Utilize quantum simulation to design multifunctional catalysts that simplify and optimize crude oil-to-chemicals processes by at least 1.0 times by 2030																						
			A.3.04	Develop new formulations of polyacrylonitrile (PAN) and optimize their production processes aiming at the targeted production cost (\$10/kg) by 2030																						
	Geoeconomy Leadership	KFUPM will develop methods and applications that enable KSA to achieve the following by 2030: 1. Increase the recovery factors from subsurface reservoirs by 10% 2. Become the leader in achieving the global sustainability targets of hydrocarbon production: H ₂ storage, CO ₂ sequestration, and wastewater recycling in petroleum reservoirs	A.3.05	Develop integrated processes to convert high-sulfur petroleum coke to low sulfur (less than 1% content) battery grade carbon materials (340 mAh/g as specific capacity for graphite and 230 mAh/g as specific capacity for graphene) by 2030																						
			A.4.01	Consolidate geophysical methods (oil and gas, geothermal, CO ₂ /H ₂ , groundwater, etc.) in the characterization and monitoring phase by 2030																						
			A.4.02	Develop and produce oilfield chemicals in a sustainable manner (locally (field trial-proven) with the goal of increasing the production potential by 20% and lowering the overall carbon footprint by 50% by 2030																						
	Electric Vehicles (EVs) and EV Batteries	KFUPM will develop EV charging and propulsion ecosystem tailored toward harsh environment at (Ambient Temp 45-55 °C, Relative Humidity up to 90-95% RH)	A.4.03	Develop H ₂ and CO ₂ storage capabilities for safely and economically sequestering the gases under ground and handling the indirect global warming potential of gaseous H ₂ by 2030																						
			A.5.01	Develop Level 2 bidirectional EV chargers achieving 97% efficiency by 2030																						
			A.5.02	Demonstrate 395% validated system-level efficiency for a 5-20 kW EV motor drive system by 2030																						
	Nuclear Energy	KFUPM will demonstrate a thermal (non-nuclear core) prototype of a Small Modular Reactor (SMR) based on Gen-IV technology by 2030	A.5.03	Invent durable battery systems for EVs, achieving energy density exceeding 500 Wh/kg and >1,000 cycles by 2030																						
			A.6.01	Optimize the licensed nuclear codes to perform design and safety analyses for the envisaged SMR design by 2030																						
A.6.02			Develop and test materials that are capable of operating at temperatures >600 °C to support Gen-IV SMR design by 2030																							
			A.6.03	Develop a sustainable nuclear waste management strategy for the SMR design by 2030																						

Innovation Goals National Research Priority Center Names

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Innovation Goals National Research Priority Center Names

National Focus Area	National Research Priority	Grand Challenges (Adjusted in 2026)	Goal ID	Innovation Goals (Adjusted in 2026)	Aerospace	Biosys	Carbon	Refining	Conversion	Communication	Energy	Marine	FinTech	Hydrogen	Integrative	Logistics	Manufacturing	Materials	Metrology	Nuclear	Security	SDAIA	Quantum	Water	Nonprofit		
Economies of the Future	Cognitive Cities	KEUPM will develop the following for cognitive cities by 2030: 1. Next-generation, energy-conscious backbone communications and sensing systems 2. Models based on cognitive skills for secure, privacy-preserving, decision-making algorithms based on cognitive skills to create smart mobility services and carbon-free smart transportation modes 3. Decision-making algorithms based on cognitive skills to create smart mobility services and carbon-free smart transportation modes 4. Automation based on cognitive skills for optimizing services and improving quality of life	C1.01	Develop next-generation security operations centers (SOCs) with 10+ capabilities for cognitive cities by 2030																							
			C1.02	Develop cyber-physical infrastructure that is 5× more trustworthy, resilient, and secure for cognitive cities by 2030																							
			C1.03	Develop five secure and privacy-preserving human-centered AI-based systems for cognitive cities by 2030																							
			C1.04	Develop five quantum technologies with applications in cognitive cities by 2035																							
			C1.05	Create cost-effective frameworks for digital twins of urban cities for use in planning and predicting mobility, urbanization rate, and capacity by 2030																							
			C1.06	Work with five cities to develop technologies to map nonstandard features on geographic information system (GIS) maps by 2030																							
			C1.07	Develop sustainable living models and decision-making algorithms for five cities by 2030																							
			C1.08	Develop zero-emission intelligent transportation systems and mobility services by 2030																							
			C1.09	Develop next-generation high-frequency communication systems that ensure reliable, high-data-rate, and non-line-of-sight connectivity through reconfigurable intelligent surfaces for future cognitive cities by 2030																							
			C1.10	Develop next-generation sensing and/or integrated sensing and communication technologies to jointly support reliable detection/localization and communication by 2030																							
	C1.11	Develop green ML-based solutions for resource optimization in communications and/or sensing networks by 2030																									
	C1.12	Develop an energy-efficient and resilient communication backbone that integrates free-space and underwater optical links, seamlessly connecting terrestrial, airborne, and underwater systems for reliable communication and environmental monitoring by 2030																									
	C1.13	Develop Open RAN frameworks and solutions to empower next-generation communication networks with flexibility, scalability, and vendor diversity by 2030																									
	C1.14	Develop energy-efficient semiconductor platforms to support advanced sensing, processing, and communication applications by 2030																									
	C1.15	Design and implement next-generation electronic circuits and systems that are energy-efficient, reconfigurable, and AI-enabled, addressing the performance and sustainability demands of emerging technologies by 2030																									
	C1.16	Develop AI-driven solutions for ultra-reliable and low-latency Non-Terrestrial Networks (NTNs) in mission-critical applications by 2030																									
	C1.17	Develop Digital Twin frameworks for mobile communication networks under Saudi Arabia's environmental and operational conditions by 2030																									
	C1.18	Develop and experimentally demonstrate reconfigurable antenna/surface technologies with flexible beam control and high efficiency, enabling adaptive next-generation connectivity, energy-efficient IoT, and advanced sensing applications by 2030																									
	C1.19	Develop and fabricate transparent and/or flexible microwave devices (including but not limited to absorbers, antennas, and energy-harvesting systems), designed for integration into urban structures and windows by 2030																									
	C1.20	Develop secure and resilient wireless communication frameworks to safeguard next-generation networks against unauthorized access by 2030																									
C1.21	Develop hardware-level fault-tolerant quantum units to ensure 5x more trustworthy and resilient cyber-physical city infrastructure by 2030																										
C1.22	Establish a seamless HPC-Quantum integration layer for energy-conscious backbone communication and complex city-wide sensing systems by 2030																										
C1.23	Implement secure, privacy-preserving quantum communication links for personalized cyber-physical-social systems by 2030																										
C1.24	Develop and test Post-Quantum Cryptography (PQC) protocols for the "secure and privacy-preserving" models by 2030																										
C2.01	Develop digital twins of inter-modal and multi-modal supply chains to increase KSA's logistics performance by more than 25% by 2030																										
C2.02	Design materials handling and shipment intra-logistics models based on 1 Internet of Things (IoT)/cloud computing that can be implemented in over 50% of KSA ports by 2030																										
C2.03	Develop smart path planning algorithms for last-mile delivery in order to reduce delivery time by 20% by 2027																										
C2.04	Develop intelligent autonomous systems (drones, automated guided vehicles, and humanoids) for automated last-mile delivery in order to reduce transportation costs by 50% by 2030																										
C2.05	Develop AI models for inter-modal and port operations to reduce transportation costs by 50%, improve logistics performance by over 25%, and cut last-mile delivery time by 20% by 2030																										
C2.06	Develop a Value-of-Information-based prioritization framework for logistics digitalization to identify the top five digital investments and achieve 20% reduction in misallocated or low-impact digital spending by 2030																										
C2.07	Develop quantum-inspired algorithms to optimize smart mobility services and carbon-free transportation modes, targeting a 50% reduction in transport costs																										
Automation of Logistics	KEUPM will develop the following: 1. Automation systems that shorten freight forwarding and delivery times and reduce transportation costs or KSA's shipments by 2027 2. AI-based routing algorithms for autonomous ground and air vehicles for last-mile delivery of shipments by 2027 3. Develop an AI-Optimized national logistics and mobility system to redefine regional connectivity																										

Innovation Goals National Research Priority Center Names

National Focus Area	National Research Priority	Grand Challenges (Adjusted in 2026)	Goal ID	Innovation Goals (Adjusted in 2026)	Aerospace	BioSys	Carbon	Refining	Conversion	Communication	Construction	Energy	Marine	Fintech	Hydrogen	Integrative	Logistics	Manufacturing	Materials	Metrology	Nuclear	Security	SDA	Quantum	Water	NonProfit	
Economies of the Future	Industrial Robots	KEUPM will develop the following by 2030: 1. AI-based self-repairable industrial robots and systems for routine industrial jobs. 2. Industrial robots possessing close-to-human tolerance-for-position capability	C3.01	Develop next-generation security operations centers (SOCs) with 10+ capabilities for cognitive cities by 2030																							
			C3.02	Develop robots with high tolerance to system parameter variations and superior disturbance rejection, leveraging advanced sensing and actuation concepts, including contactless mechanisms, by 2030																							
			C3.03	Develop a fully functional six degrees of freedom (6-DoF) proof-of-concept demonstrator autonomous underwater vehicle capable of carrying out routine, dull, dirty, and dangerous tasks intelligently																							
			C3.04	Develop a fully functional proof-of-concept demonstrator unmanned surface vehicle capable of carrying out routine, dull, dirty, and dangerous tasks with minimal human intervention																							
			C3.05	Develop a fully functional 6-DoF proof-of-concept demonstrator unmanned aerial vehicle capable of carrying out routine, dull, dirty, and dangerous tasks intelligently																							
	Net Zero Aviation	KEUPM will enable ±50% CO ₂ equivalent emissions reduction per km in Advanced Air Mobility Technologies by 2030	C4.01	Demonstrate TRL 3 flight-readiness of hybrid and electric propulsion technologies for regional aviation, targeting ±50% reduction in mission-level CO ₂ equivalent emissions relative to representative 2023 regional aviation baselines by 2030																							
			C4.02	Develop and validate High-Fidelity Intelligence and Digital Twin frameworks in Design, Materials, and Autonomy that enable a ±10% reduction in CO ₂ equivalent per mission for next-gen aircraft by 2030																							
			C4.03	Demonstrate operational capability of electric-powered unmanned swarm systems (≥5 agents) for selected short-range missions, achieving up to 100% reduction in per mission carbon emissions relative to conventional manned mission equivalents by 2030																							
			C5.01	Deploy at least 1 Space-qualified CubeSat (6U+) for high-resolution Earth Observation and Novel Technology Validation by 2030																							
	New Space Leadership	KEUPM will achieve the following by 2030: 1. Develop and launch spacecraft systems for earth observation and laser communication 2. Develop and test deep space technologies to support human space missions	C5.02	Deploy 90% accurate AI-powered Geospatial Platform to Provide Decision-making insights about Urban Planning and Environmental Monitoring using Satellite data by 2030																							
C5.03			Develop Environment-tested Lunar Rover platform to enable Saudi human-robotic exploration missions by 2030																								
C5.04			Develop Robust Space Situational Awareness framework for mitigating Extreme Space Weather and Debris effect, by providing early warning for Saudi space assets by 2030																								
C6.01			Develop an AI system for small and medium-sized enterprises (SME) lending that improves risk prediction and reduces new default inflows by ±15% by 2030																								
FinTech		KEUPM will achieve the following by 2030: 1. Develop a resilient and Shariah-compliant digital finance ecosystem in the Kingdom through financial innovation, inclusive artificial intelligence (AI)-powered small and medium-sized enterprises (SME) finance, and intelligent automation for risk management and compliance across sectors 2. Create a national economic-intelligence platform to grow innovation-focused foreign direct investment (FDI) inflows into targeted innovation activities by 2030 3. Assess the impact of FinTech and Industry 4.0 technologies on the digital ecosystem by promoting innovation, learning, and entrepreneurship to produce market products and services that create sustainable value for consumers and businesses 4. Develop trusted AI-enabled FinTech and digital responsibility solutions for tourism ecosystems to enhance visitor experiences, enable secure and transparent transactions, support data-driven governance, and strengthen stakeholder trust	C6.02	Develop an explainable AI model for debt-based crowdfunding to arrange thorough borrower screening and investor protection, achieving ≥20% reduction in platform default by 2030																							
			C6.03	Develop an explainable AI analytics platform to achieve a ≥25% reduction in fraudulent claims and a concurrent ±10% reduction in anomalous payment leakage by 2030																							
			C6.04	Develop a policy diagnostic framework for microfinance and crowd-funding to quantify market barriers and recommend reforms that increase access by 20-30% by 2030																							
			C6.05	Design a national digital-economy foreign direct investment (FDI) acceleration policy package to cut approval time by 40 percent and double lead-to-commitment conversion by 2030																							
			C6.06	Create FDI analytics framework to quantify the impact of projects and reforms, supporting data-driven progress toward the 5.7% gross domestic product (GDP) FDI target by 2030																							
			C6.07	Develop adoption and usage research frameworks of 30 FinTech solutions across digital payment, digital capital raising, and neo-banking by 2028																							
Intelligent Manufacturing		KEUPM will develop AI-enabled adaptive manufacturing platforms with digital twins for optimized, predictive, and resource-efficient manufacturing by 2030	C6.08	Develop 20 emerging technology adoption and usage frameworks to advance digital transformation and assess economic impact across healthcare management, marketing, innovation and entrepreneurship, finance, creative industries, education, government, and real estate by 2030																							
			C6.09	Develop two AI-enabled FinTech frameworks that increase the purchase of tourists' gifts by ±10% across 10 tourism businesses by 2030 through secure and transparent transactions and privacy-aware personalization																							
			C6.10	Develop three esports tourism innovation models using insights from major events, esports gamers and audiences, and generate validated evidence of increased event-related tourist arrivals and a 5-10% uplift in average length of stay by 2028																							
			C7.1	Develop adaptive, additive, and hybrid manufacturing technologies delivering four industrial prototypes with ≥30% defect reduction and ≥200% performance gains by 2030																							
Health & Wellness	Health and Bioengineering Innovation	KEUPM will develop AI-enabled adaptive manufacturing platforms with digital twins for optimized, predictive, and resource-efficient manufacturing by 2030	C7.2	Develop and deploy physics-constrained AI and digital twin frameworks, demonstrated through two operational digital twin systems for advanced manufacturing by 2030																							
			C7.3	Enable scalable manufacturing of programmable and stimuli-responsive devices and micro-devices with up to 30% cost reduction and 50% operational lifetime improvement by 2030																							
			D1.01	Develop an integrated VAD platform combining smart testing systems and cardiopulmonary simulation (phantoms, mock-loops, and digital twins) to benchmark and optimize cardiac device performance for improved patient outcomes by 2030																							
			D1.02	Establish a Computational Biology and Bioinformatics platform collecting clinically-validated datasets from ≥5,000 patients across at least one major disease domain to enable AI-driven prediction and therapeutic optimization, while reducing healthcare costs by 15% within the study cohort by 2030																							
			D1.03	Develop at least two point-of-care diagnostic devices and at least one AI-driven wearable or implantable solution capable of predicting, preventing, and continuously monitoring at least one major disease domain by 2030																							
			D1.04	Develop energy-efficient, integrated, and miniaturized sensing and communication platforms and/or electronic systems to enable continuous remote health monitoring and sensitive, affordable screening of diverse biomarkers																							
Anchor center	Supporting Center		D1.05	Develop a generative design pipeline for patient-specific smart and passive biomaterials, implants, and prostheses integrating advanced materials and anthropometric customization for affordable musculoskeletal restoration by 2030																							
			D1.06	Utilize quantum-classical hybrid algorithms to simulate molecular docking for three priority viral or chronic disease targets, reducing the initial drug candidate screening time by 70% by 2030																							
IRC-Aviation and Space Exploration (Aerospace), IRC-Bio Systems and Machines (BioSys), Center of Carbon Materials (Carbon), IRC-Refining & Advanced Chemicals (Refining), Pericardium Conversion Research Center (Conversion), IRC-Communication Systems & Sensing (Communication), IRC-Construction & Building Materials (Construction), IRC-Sustainable Energy Systems (Energy), IRC-Environment and Marine Systems (Marine), IRC-Finance & Digital Economy (Finance), IRC-Hydrogen Technologies and Carbon Management (Hydrogen), Center for Integrative Pericardium Research (Integrative), IRC-Smart Mobility & Logistics (Logistics), IRC-Intelligent Manufacturing & Robotics (Manufacturing), IRC-Advanced Materials (Materials), IRC-Advanced Materials (Materials), IRC-Hereditary, Standards & Testing (Metrology), IRC-Industrial Nuclear Energy (Nuclear), IRC-Intelligent Secure Systems (Security), IRC-SDA-Quantum Computing (Quantum), IRC-Materials & Trade Security (Water), IRC-for Nonprofit and Social Development (Nonprofit)																											



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