SIDF
صندوق التنمية الصناعية السعودي

50 YEARS عاماً

Market in Focus:

Digitalization in Manufacturing Sector

A Game Changer for Saudi Arabia's Industrial Sector

Contents

1. Introduction to Digitalization in Manufacturing

Digitalization in Manufacturing, a core component of Industry 4.0, refers to the integration of advanced digital technologies-such as the Industrial Internet of Things (IIoT), Artificial Intelligence (AI), Robotics, Big Data Analytics, Machine Learning (ML) and Cloud Computing-into the manufacturing ecosystem. This transformative paradigm shift enables manufacturers to optimize production processes, enhance resource efficiency, and create highly customized, on-demand products, while simultaneously improving decision-making and increasing overall competitiveness. By interconnecting machines, processes, and people, digitalization facilitates real-time data sharing, seamless communication, and agile supply chain management, thus enabling a smarter, more resilient, and sustainable manufacturing landscape.

The manufacturing industry plays a pivotal role in Saudi Arabia's economy, and its importance is further amplified in the context of Vision 2030. Vision 2030 is an ambitious plan and it's the main driver of Industry 4.0, intending to elevate the nation through comprehensive advancements. The strategic framework, laid out by the Saudi government, aims to diversify the Kingdom's economy and promote sectors such as manufacturing, mining, energy, logistics, entertainment, and tourism. The manufacturing sector is seen as a key driver for economic diversification, job creation, technological advancement, and sustainable growth. By transforming the sector through digitalization and Industry 4.0 technologies, the Kingdom hopes to strengthen its manufacturing capabilities, thereby making it more competitive on a global scale. This transformation aligns with the goals of Vision 2030, which include creating a thriving economy, a vibrant society, and an ambitious nation.

Digitalization in manufacturing is no longer a 'future trend' – for many industries it is now at the heart of their strategic and research agenda.

2. Benefits of Digitalization in Manufacturing Industries

IoT devices and sensors

By installing IoT sensors throughout the plant, the company can monitor critical parameters, such as temperature, pressure, flow rates, carbon emissions and, equipment performance in real-time.

This data can be used to optimize processes, reduce energy consumption, and minimize downtime.

Picture-2: Industrial IoT devices2

Robots and drones

Robots and drones can assist in inspecting the pipes for leakage, thermal scan for the tanks to monitor temperature, pressure gauge, taking pictures and videos of current status both inside & outside of the tanks.

Picture-3: Industrial IoT devices3

Wearable devices

Wearable devices provide real-time, hands-free video communication and employee location tracking. They can also identify employee fall detection and help to reduce response times and potentially save lives.

Virtual reality (VR) sets and augment reality (AR) can provide better training and maintenance.

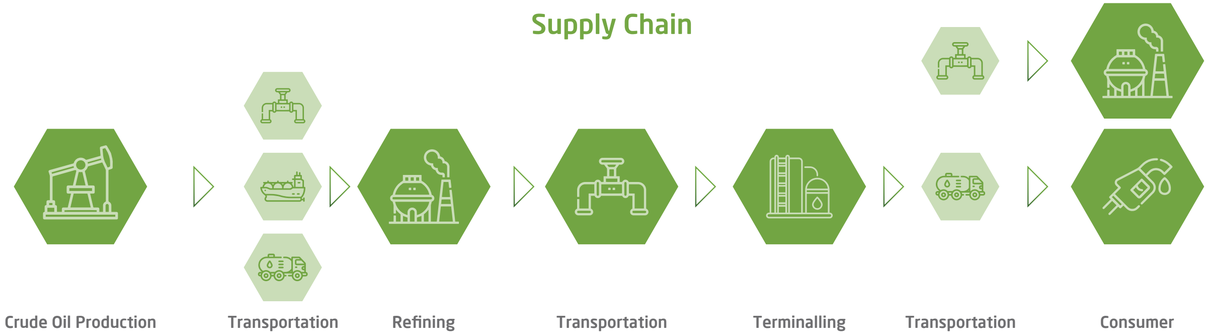
Picture-5: Helmet with camera, mic, and speakers5

Supply chain optimization

Real-time data from the production process, combined with AI-driven demand forecasting, can help the plant optimize its raw material procurement, inventory and logistics operations, leading to reduced inventory and better cash flow.

Let's consider another case with a car manufacturing plant that aims to improve its production efficiency and overall productivity. Here are some steps the plant could take to achieve this goal.

Picture-6: Supply chain6



Picture-6: Supply chain6

Implement IoT devices

By installing IoT sensors on the production line, the plant can collect real-time data on machine performance, product quality, and environmental conditions. This data can be used to monitor and control processes, identify bottlenecks, and optimize the production line.

Picture-7: IIoT sensors & robots7

Use data analytics

By analyzing the data collected from IoT devices, the plant can identify patterns and trends that may indicate inefficiencies or problems. For example, by analyzing machine performance data, the plant may discover that certain machines require more frequent maintenance. This allows the plant to schedule maintenance proactively and reduce downtime.

Automate processes

By introducing robotics and automation into the production line, the plant can automate repetitive and labor-intensive tasks. This frees up workers for higher-value tasks and improves overall productivity. For instance, installing robotic arms to perform tasks such as welding and painting can increase speed, consistency, and quality while reducing the risk of worker injury.

Picture-8: Visualizing data analytics8

Picture-7: IIoT sensors & robots7

Picture-8: Visualizing data analytics8

Leverage AI and machine learning:

The plant can use AI and machine learning for the assembly of car windshields and frames.

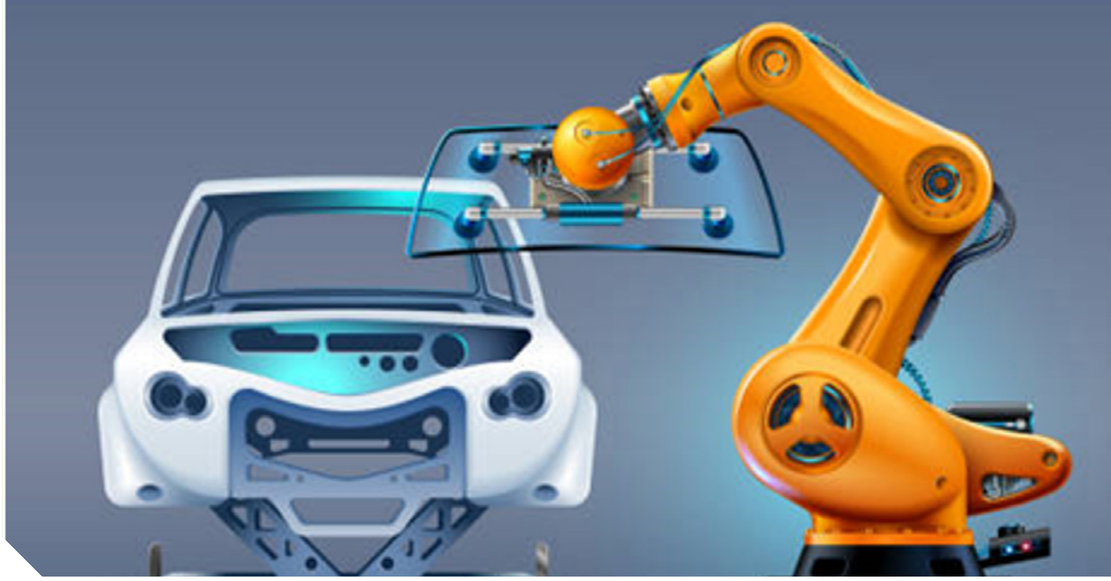
It is important to note that no two windshields and frames are exactly alike. Advanced algorithms and computer vision ensure precise fits, streamlining the process, reducing human errors and waste, and accommodating the unique characteristics of each windshield and frame. This leads to increased efficiency, cost savings, and vehicles with improved structural integrity and aerodynamics.

Picture-8: Precision matching of windshield & frame7

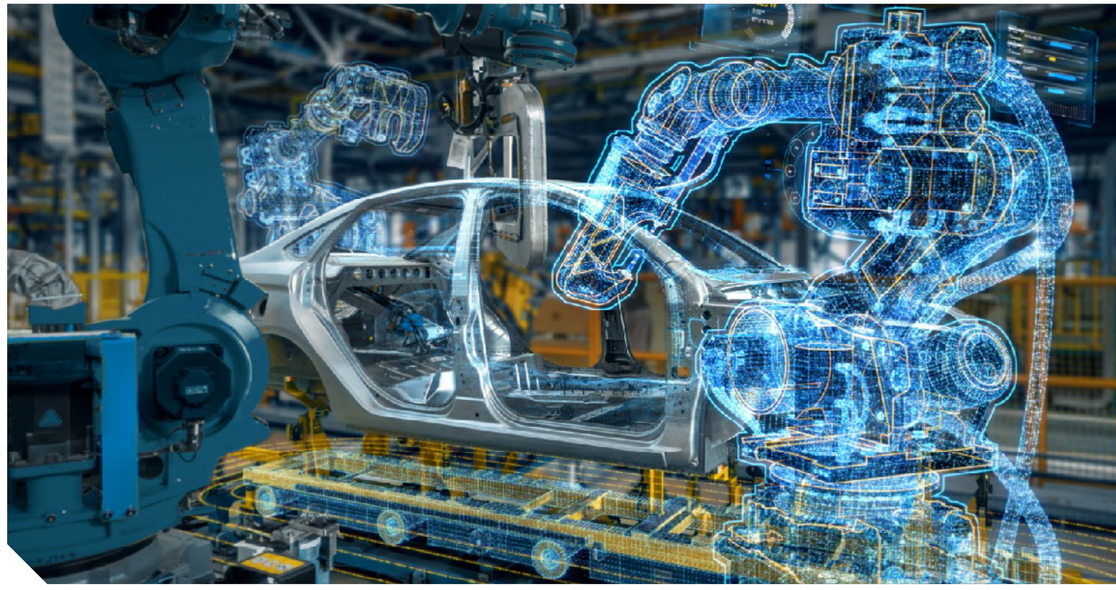
Employ digital twin technology:

By creating a digital replica of the physical production line, the plant can simulate and optimize production processes before implementing them in the real world. This allows the plant to test various scenarios and make data-driven decisions to improve efficiency.

Picture-9 Digital twin technologies simulate and optimize production processes9



Picture-8: Precision matching of windshield & frame7



Picture-9 Digital twin technologies simulate and optimize production processes9

Adopt flexible production

By implementing modular production systems and leveraging technologies to customize features like painting and dashboards, the plant can quickly adapt to changes in demand or product specifications. This allows the plant to be more responsive to customer needs and reduce inventory costs.

Predictive maintenance

Using data collected from IoT devices and applying machine learning algorithms, the plant can predict potential equipment failures and schedule maintenance proactively. This strategy reduces unplanned downtime and maintenance costs and increases overall equipment effectiveness (OEE).

Process optimization

Advanced process control (APC) systems can be used to optimize petrochemical processes by adjusting control variables based on real-time data from IoT sensors. This helps to improve product quality, reduce waste, and increase yield.

Energy management

IoT devices can collect energy consumption data across the plant, which can then be analyzed to identify areas for energy-saving improvements. By implementing energy-efficient equipment and optimizing processes, the plant can significantly reduce energy costs and its carbon footprint.

Remote monitoring and control

Plant operators can monitor and control processes remotely using secure, cloud-based platforms. This approach allows for centralized management and increased visibility across multiple plants or sites, leading to better decision-making and faster response time.

Product-as-a-Service:

Manufacturing service providers can apply the Product-as-a-Service (PaaS) model to cranes, forklifts, and drilling machinery, fundamentally transforming the traditional ownership model into a service-centric approach. Instead of selling these heavy machinery items outright, manufacturers can lease them to clients, offering added value through services like maintenance, repairs, software updates, and operator training, all included in the service fee. IoT technology plays a pivotal role here, enabling real-time monitoring of equipment usage, predictive maintenance, and ensuring optimal performance. This model not only provides a steady revenue stream for the manufacturer but also reduces the upfront cost for the customer, increases equipment uptime, and fosters a closer, long-term customer-manufacturer relationship.

In general, below is the list benefits:

- Improved efficiency and productivity
- Enhanced quality and innovation
- Increased flexibility and customization
- Optimized supply chain management
- Enhanced sustainability and waste reduction
- Improved safety and risk management

Investment & ROI of digitalization in factories:

The digitalization of manufacturing requires varying levels of investment depending on the size and specifics of the factory. For small-sized factories, an initial investment might range from 500,000 to 2 million SAR, covering basic IoT devices, simple automation tools, and data management systems. Medium-sized factories typically require more advanced integration, including comprehensive IoT connectivity, semi-autonomous robots, and advanced data analytics, necessitating an investment between 2 million to 10 million SAR. Large factories, seeking full-scale digital transformation, including AI-driven technologies, advanced robotics, digital twins, and predictive maintenance systems, might see investments ranging from 10 million to 50 million SAR or even more, depending on the project's complexity.

The general ROI for each segment varies significantly based on numerous factors such as the industry sector, specific technologies adopted, scale of implementation, and operational efficiency gains. However, smaller factories might anticipate an ROI within 2-4 years, medium-sized factories within 3-5 years, and larger factories potentially looking at a 4–7-year timeframe, given the more substantial upfront investments and complexities involved.

Factory Size	Investment in SAR	Expected ROI
Small	500,000 - 2M	2-4 years
Medium	2M - 10M	3-5 years
Large	10M - 50M+	4-7 years

Table-1: Investment & ROI of digitalization in factories

It's important to note these are estimated ranges and actual costs and ROI will vary based on individual circumstances, the scope of digital transformation, and external economic factors. Also, the benefits of digitalization extend beyond direct financial gains, including improvements in efficiency, productivity, quality, flexibility, sustainability, and risk management, which can be invaluable for long-term business resilience and growth.

3. Why Digitalization is Critical for Saudi Arabia

Digitalization in manufacturing is a key driver of industrial growth, directly aligning with the goals of Vision 2030 to diversify the economy and reduce dependence on oil revenues. Vision 2030 is an ambitious plan and it's the main driver of Industry 4.0, setting a model for the nation to advance through multifaceted technological and industrial developments.

Diversification of the Economy:

Saudi Arabia has been highly dependent on oil for economic growth. To decrease this reliance, the government is actively seeking to diversify the economy, and digitalization has emerged as a crucial component of this strategy. The integration of digital transformation in sectors like manufacturing, e-commerce, FinTech, EdTech, and HealthTech holds great potential in achieving economic objectives. This enables a future where the nation's economy is less dependent on oil and gas.

Economic Growth and Job Creation:

Through the adoption of digital technologies, new sectors and industries can be developed, leading to increased economic growth and job creation. This is particularly important in a country like Saudi Arabia, which has a significant youth population.

Increase in Efficiency:

Digitalization can make manufacturing processes more efficient, reduce waste, and lower costs. Technologies such as AI, IoT, and big data analytics can help companies predict and avoid potential issues, automate certain tasks, and improve decision-making.

Creation of High-Skilled Jobs:

The digital transformation of manufacturing could lead to the creation of high-skilled jobs in technology and engineering. This can help the country progress towards a knowledge-based economy and address issues of unemployment among the highly educated youth.

Improvement in Quality:

Digital technologies can help improve the quality of manufactured products. With advanced analytics and real-time monitoring, manufacturers can ensure high-quality production, reduce errors, and meet international standards, which in turn can boost exports and competitiveness.

Boosting Innovation:

Digitalization often requires a new way of thinking and encourages innovation. By embracing digital technologies, Saudi companies can stimulate innovation, develop new products and services, and compete more effectively in the global marketplace.

Sustainability:

As part of Vision 2030, Saudi Arabia is committed to sustainable development. Digital technologies can support this goal by making manufacturing processes more efficient and reducing their environmental impact.

Data-Driven Decision Making:

Using IoT and other digital technologies, companies can collect vast amounts of data that can be analyzed for insights. This can help drive strategic decisions and give Saudi Arabian companies a competitive edge.

Smart Cities:

Saudi Arabia has ambitious plans for smart city projects like NEOM. Digital technologies are crucial for the development of such cities, which aim to be global models for sustainable living, innovation, and business.

4. Initiatives and Support

Saudi Arabia has recognized the importance of digitalization in the manufacturing sector as part of its broader economic diversification strategy, as outlined in Vision 2030. Saudi Arabia has initiated programs to promote digitalization in the country's manufacturing sector:

National Industrial Development and Logistics Program (NIDLP): Launched in 2019, NIDLP aims to transform Saudi Arabia into a leading industrial powerhouse and global logistics hub by fostering growth in various sectors, including manufacturing. The program promotes the adoption of advanced technologies such as IoT, AI, and robotics to enhance productivity and competitiveness.

(More info: https://www.vision2030.gov.sa/media/5hlpbuuq/2021-2025-national-industrial-development-and-logistics-program-delivery-plan-en.pdf)

Saudi Industrial Development Fund: SIDF provides the following programs and services to support digitalization in the manufacturing sector.

1 Tanafusia Program:

This supports financing automation, digitization and Industry 4.0 solutions projects to improve the efficiency of Saudi manufacturers.

2 SIRI Assessments:

SIDF is equipped with Smart Industry Readiness Index (SIRI) assessors to conduct Industry 4.0 assessments and to determine areas where Saudi manufacturers can improve their capabilities and compete within Saudi and the rest of the world.

3 Advisory Services:

SIDF has also launched Advisory Services to small and medium enterprises (SMEs) to enhance their performance and help achieve sustainable growth. The advisory services offer SMEs the opportunity to capitalize on SIDF's technical and marketing expertise through 3 main services: go-to-market strategy, plant performance optimization and cost optimization.

4 Industry Benchmarks:

SIDF will provide benchmarking of firms' industrial operations and their efficiencies within the Saudi market and international market.

5 SIDF Partners:

SIDF has partnered with multiple service providers such as META 2i, etc. to promote Saudi manufacturers to help implement Industry 4.0 solutions.

(More: https://www.sidf.gov.sa/en/ServicesforInvestors/Programs/Pages/Tanafusiya.aspx)

Saudi Authority for Industrial Cities and Technology Zones (MODON):

MODON is responsible for the development and management of industrial cities and technology zones in Saudi Arabia. It actively supports the implementation of smart manufacturing technologies and helps attract investments in digital transformation projects.

6 Research and Development:

The Saudi government has been investing in R&D initiatives, particularly in areas related to Industry 4.0 and digitalization. Institutions like King Abdullah University of Science and Technology (KAUST) and King Abdulaziz City for Science and Technology (KACST) are at the forefront of research in advanced manufacturing technologies.

These efforts, along with other initiatives, demonstrate the Saudi government's commitment to accelerating digital transformation in the manufacturing sector as a means of enhancing the country's global competitiveness and achieving the goals outlined in Vision 2030.

5. Emerging Technologies in Digital Manufacturing

1 Industrial Internet of Things (IIoT):

The IIoT is a network of interconnected industrial devices, machines, and systems that collect, share, and analyze data. It enables real-time monitoring, predictive maintenance, and optimization of industrial processes. IIoT leverages advanced technologies like sensors, edge computing, and cloud services to improve efficiency, productivity, and safety in various sectors such as manufacturing, energy, and transportation.

2 Artificial Intelligence (AI) and Machine Learning (ML):

AI refers to the simulation of human intelligence in machines programmed to think, learn, and solve problems. ML is a subset of AI that allows machines to learn from data, identify patterns, and make decisions with minimal human intervention. These technologies are used in various applications, including natural language processing, image recognition, and recommendation systems, to improve customer experiences, optimize operations, and enable data-driven decision-making.

3 Robotics and Automation:

Robotics and automation involve the design, development, and implementation of intelligent machines that can perform tasks without human intervention. These technologies enhance productivity, reduce human error, and optimize resource utilization. They are widely used in manufacturing, logistics, healthcare, and agriculture for tasks like assembly, material handling, inspection, and maintenance.

Picture-10: Robotics and automation performing the packaging 10

4 Big Data and Advanced Analytics:

Big Data refers to the large volume of structured and unstructured data generated by various sources, including social media, IoT devices, and business processes. Advanced analytics involves the use of sophisticated techniques and tools, such as data mining, predictive analytics, and machine learning, to extract valuable insights from this data. Companies use these insights to optimize operations, enhance customer experiences, and make informed decisions.

5 Additive Manufacturing (3D Printing):

Additive manufacturing, or 3D printing, is a process that creates three-dimensional objects by depositing materials layer by layer based on a digital model. This technology enables rapid prototyping, customization, and on-demand production, leading to reduced waste and lower costs. It is used in various industries, including aerospace, healthcare, automotive, and construction.

6 Augmented Reality (AR) and Virtual Reality (VR):

AR and VR are immersive technologies that provide users with interactive, computer-generated experiences. AR overlays digital information onto the real world, while VR creates a completely simulated environment. These technologies are used in various applications, such as training, design, marketing, and entertainment, to enhance user experiences and improve processes.

7 Digital Twin and Simulation:

A digital twin is a virtual replica of a physical asset, process, or system that simulates its real-world counterpart. It enables real-time monitoring, analysis, and optimization through the use of data, AI, and simulation. Digital twins are used in various industries, such as manufacturing, energy, and transportation, for predictive maintenance, process optimization, and product development.

8 Blockchain and Secure Data Exchange:

Blockchain is a decentralized, distributed ledger technology that enables secure, transparent, and tamper-proof data exchange between multiple parties. It provides a high level of trust, security, and traceability in data transactions, which can be used in various applications such as supply chain management, identity management, and secure data sharing.

6. The Current State of Saudi Arabia's Manufacturing Industries

As of 2023, the manufacturing sector in Saudi Arabia is undergoing significant growth and transformation.The sector is diverse, encompassing industries such as petrochemicals, food processing, metal fabrication, construction materials, pharmaceuticals, mining, renewable energy, and automotive manufacturing.

Here are some key points regarding digitalization in the manufacturing sector:

6.1 GDP, Number of factories and workforce in factories

Year	GDP in Trillions Saudi Riyals	Number of Factories	Workforce in Factories
2022	2.974	10,562	1,031,284
2021	2.736	9,968	990,076
2020	2.632	9,922	952,215
2019	2.752	9,027	894,198
2018	2.729	8,521	841,367

Table-2: Number of factories & workforce in KSA

6.2 Distribution of factories in major sectors as of year 2022:

Sl No	Sectors	No. of Factories	No. of Employees
1	Basic Chemicals	645	94,590
2	Cement, Plaster, Concrete, Clay and Semi-Finished Steel Products	1,557	159,594
3	Refined Petroleum, Plastics and Synthetic Rubber Products.	528	75,124
4	Base Iron and Steel	371	54,433
5	Fertilizers and Nitrogenous Compounds	56	8,256
6	Base Precious and Non-Ferrous Metals	94	15,553
7	Structural Metal Products and Multi-Purpose Machines	33	6,363
8	Dairy Products, Non-Alcoholic Beverages; Mineral Water and Other Bottled Water	376	71,410
9	Bakery Products	300	41,433
10	Glass and Glass Products	207	20,727

Table-3: Distribution of factories in major sectors as of year 2022

7. Future Trends in Digitalizing Manufacturing Industries

Saudi Arabia has been actively promoting the digital transformation of its manufacturing industries as part of its Vision 2030 initiative, creating numerous investment opportunities in the country. Given its strategic location at the crossroads of Africa, Asia, and Europe, Saudi Arabia serves as an invaluable hub for businesses targeting these markets.

Below is the global market size of segments in the digitalizing manufacturing industries.

Global Market in US $ billion						
Segments	**2018**	**2019**	**2020**	**2021**	**2022**	**CAGR**
Industrial Internet of Things (IIoT)	23.38	27.35	28.40	33.90	40.51	12%
Robotics & Automation	11.18	13.14	13.71	16.45	19.77	12%
AI & ML	9.73	11.48	12.03	14.50	17.51	12%
Big Data & Advanced Analytics	7.60	9.01	9.48	11.47	13.90	13%
Advanced Manufacturing	7.07	8.25	8.55	10.19	12.16	11%
AR & VR	9.07	10.73	11.28	13.63	16.50	13%
Digital Twin & Simulation	5.16	6.14	6.49	7.88	9.59	13%
Blockchain & Secure Data Exchange	3.77	4.50	4.77	5.81	7.09	13%
Others	5.77	6.59	6.69	7.80	9.12	10%
Total	**82.73**	**97.19**	**101.39**	**121.62**	**146.14**	**12%**

Table-4: Historical market value in segments of digitalization T4

Global Market in US $ billion									
Segments	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**CAGR**
Industrial Internet of Things (IIoT)	48.5	58.18	70.04	84.41	101.3	120.7	142.2	164.3	34%
Robotics & Automation	23.81	28.76	34.87	42.35	51.26	61.64	73.26	85.47	33%
AI & ML	21.17	25.68	31.26	38.11	46.3	55.87	66.63	77.99	32%
Big Data & Advanced Analytics	16.88	20.56	25.12	30.75	37.51	45.45	54.42	63.96	31%
Advanced Manufacturing	14.54	17.44	20.99	25.3	30.39	36.26	42.76	49.49	34%
AR & VR	20	24.32	29.68	36.28	44.19	53.46	63.92	75.02	31%
Digital Twin & Simulation	11.69	14.29	17.54	21.56	26.4	32.11	38.61	45.56	30%
Blockchain & Secure Data Exchange	8.67	10.63	13.08	16.13	19.81	24.18	29.15	34.51	30%
Others	10.67	12.53	14.76	17.42	20.49	23.93	27.63	31.31	39%
Total	**175**	**212**	**257**	**312**	**377**	**453**	**538**	**627**	**33%**

Table-5: Future market value in segments of digitalization T5

Forecasted CAGR is around 30% due to the following reasons.

1. Increase in adoption
2. Technology maturation
3. Data-driven insights
4. Industry-specific tailoring
5. Enhanced connectivity
6. Competitive pressure
7. Economic growth

Digitalizing in manufacturing past and future

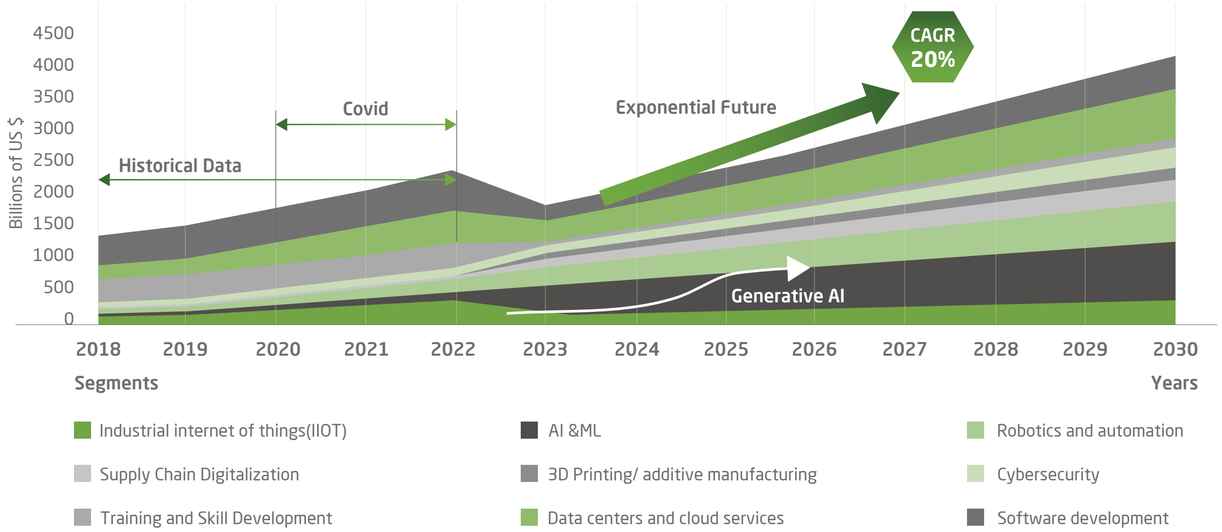


Chart-1: Historical & future market value in segments of digitalization C1

Market size in various segments over the years

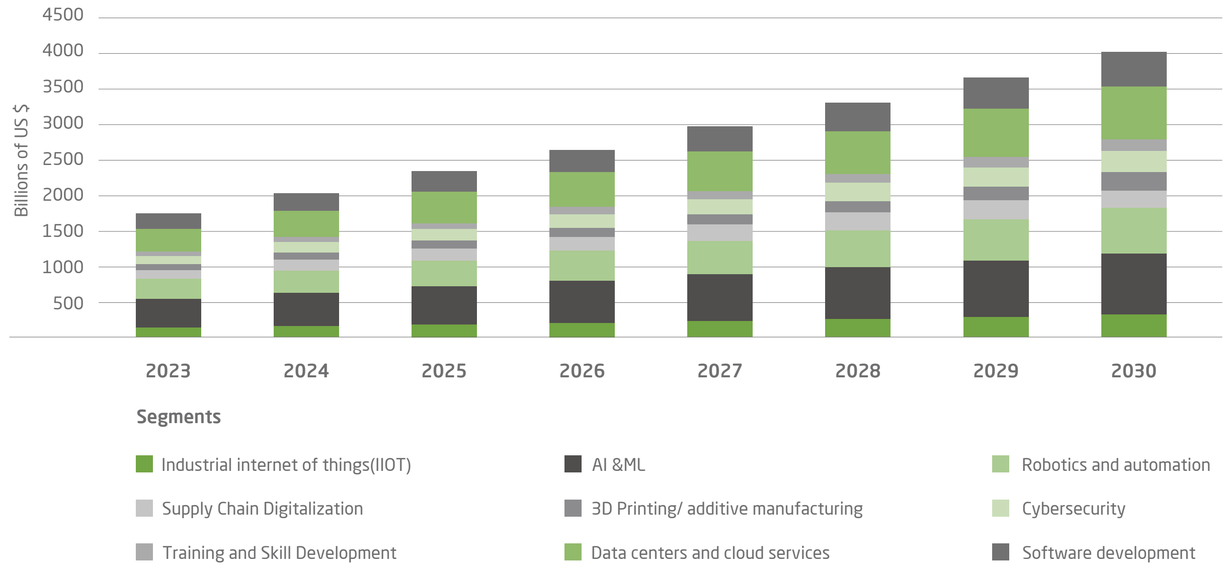


Chart-2: Historical & future market value in segments of digitalization C2

Future trends

1 AI & ML

The investment opportunity in AI and ML in Saudi Arabia holds significant potential for various sectors, including manufacturing. The integration of AI and ML in the manufacturing sector offers several investment opportunities in Saudi Arabia. Here are some potential areas for investment:

Predictive Maintenance:

AI and ML can be leveraged to optimize maintenance operations by predicting equipment failures and recommending preventative actions. Investing in predictive maintenance solutions can help manufacturing companies reduce downtime, increase equipment efficiency, and lower maintenance costs.

Quality Control and Inspection:

AI-powered computer vision systems can enhance quality control processes by automatically inspecting products for defects or inconsistencies. Investing in AI-driven inspection systems can improve product quality, reduce waste, and enhance overall manufacturing efficiency.

Machine Learning for Manufacturing:

Machine learning can be used to optimize production processes, predict demand, and personalize customer experiences. This can improve efficiency, productivity, and profitability.

Supply Chain Optimization:

AI and ML algorithms can optimize supply chain operations by analyzing data and predicting demand patterns. Investing in AI-based supply chain management solutions can help manufacturers streamline their operations, reduce costs, and improve customer satisfaction.

Robotic Process Automation (RPA):

RPA involves automating repetitive tasks using software robots. Integrating RPA with AI and ML capabilities can enable intelligent automation, resulting in improved productivity and efficiency in manufacturing processes. Investing in RPA solutions tailored for the manufacturing sector can yield significant benefits.

2 3D Printing/Additive Manufacturing

The landscape for 3D printing and additive manufacturing is witnessing notable expansions. The ministry has begun issuing industrial licenses for fully additive manufacturing factories, thereby providing a regulatory framework that supports the establishment and expansion of such enterprises within the nation.

Below are some areas that investors may consider:

Materials production:

3D printing requires specific materials like polymers, metals, ceramics, and even biological materials. Investors could consider producing these domestically, thus reducing the need for importing them.

3D printing of parts and components:

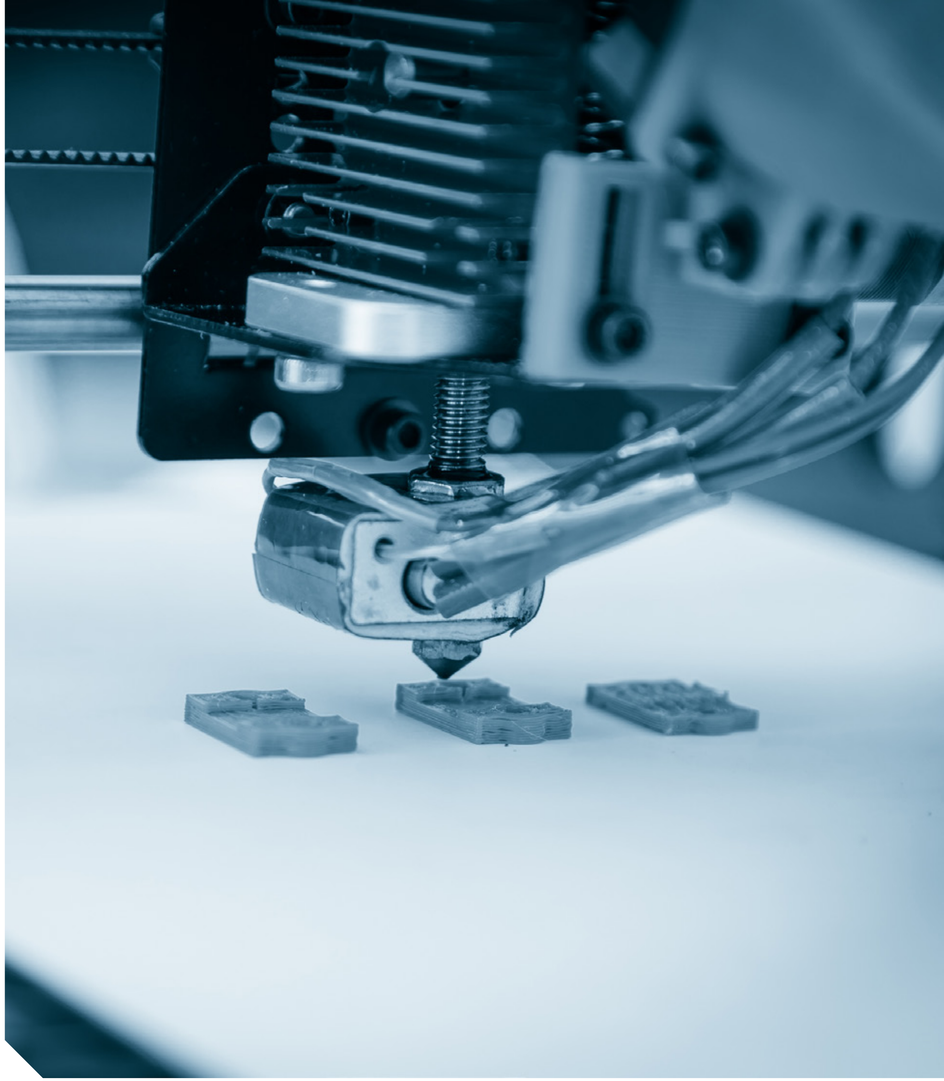
3D printing can be used to produce parts and components for a wide range of industries, including automotive, aerospace, medical, and defense. This can reduce costs, improve quality, and speed up production.

3D printing of medical devices:

3D printing can be used to produce medical devices, such as prosthetics and implants. This can improve patient care and reduce costs.

3D printing of construction materials:

3D printing can be used to produce construction materials, such as bricks and concrete. This can reduce costs and improve the speed of construction.



3 Robotics and Automation

Initiatives like Neom, Oxagon and many more which are under Saudi Vision 2030 seek to transform large portions of the economy by integrating robotics and automation, moving away from manual labor activities especially in the manufacturing sector. This creates a wide range of investment opportunities in robotics and automation, especially in the digitalization of the manufacturing sector.

Robotics for manufacturing:

Robots can be used to automate a wide range of tasks in manufacturing, such as welding, painting, and assembly. This can free up human workers to focus on more complex tasks, improve safety, and reduce costs.

Computer vision for manufacturing:

Computer vision can be used to inspect products for defects, identify and sort materials, and track inventory. This can improve quality, reduce waste, and optimize production schedules.

Infrastructure and facilities:

Industrial sector require significant infrastructure development. This could involve constructing new smart factories equipped with the latest automation technologies or retrofitting existing facilities. Investors can participate by funding these projects or investing in the companies that will execute them.

To take advantage of these opportunities, investors should build strong partnerships with both local and international stakeholders, including universities, research institutions, technology providers, material suppliers, and potential customers. Investors can enable Saudi industries to enhance productivity, efficiency, and product quality.

Case Studies: Digitalization Success StoriesS1

Digitalization Boosts Efficiency and Profitability:

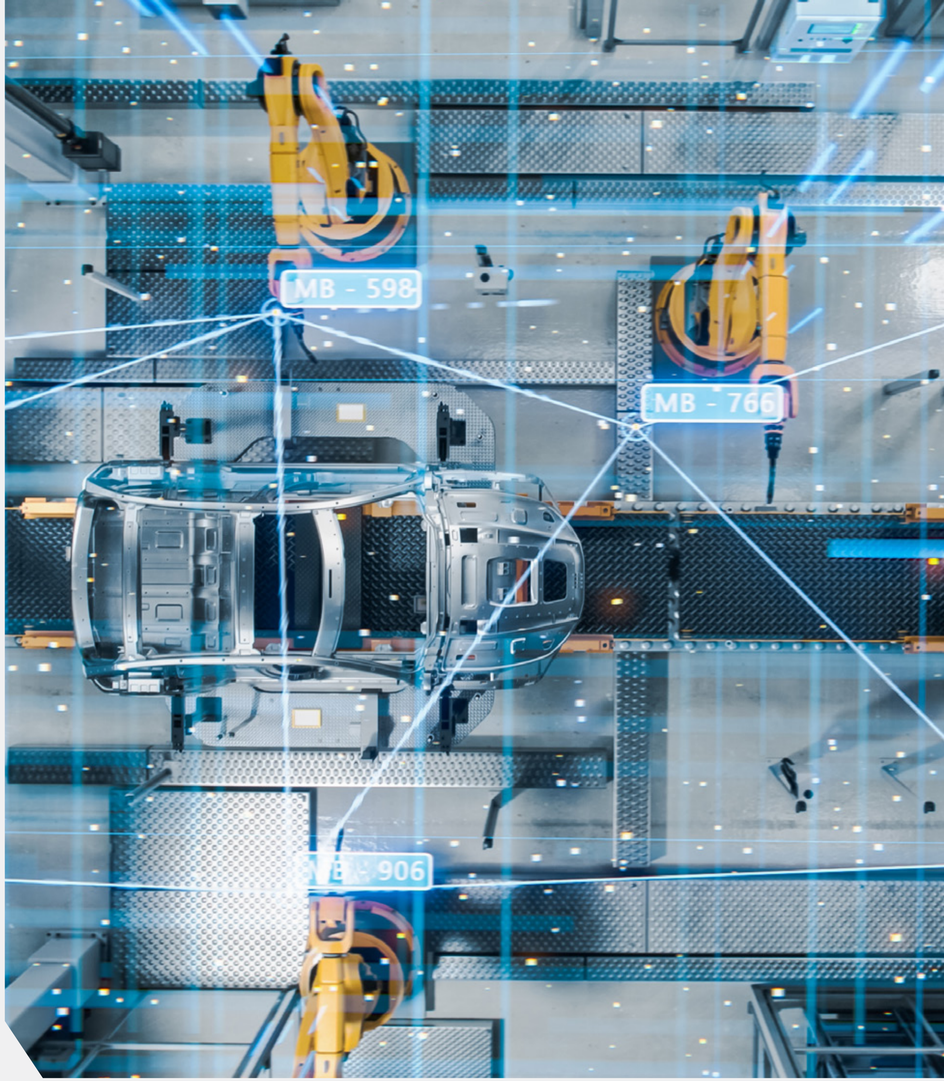
A Case Study of Zamil Steel Industries

1 Introduction:

Zamil Steel, a leading manufacturer of steel structures, started its digitalization journey of automation of its shop floor in the year 2021 with the primary objective of improving Overall Equipment Effectiveness (OEE) and profitability. The plant implemented digital solutions to enhance machine efficiency, track manufactured components and assembly, and minimize wastage. This case study highlights the key steps and outcomes of Zamil Steel's digital transformation.

2 Objectives:

- Improve Overall Equipment Effectiveness (OEE)
- Enhance profitability through operational efficiency
- Implement effective tracking mechanisms for manufactured components & assembly
- Reduce material wastage and improve resource utilization



3 Implementation Strategy:

Zamil Steel initiated the digitalization process by conducting a prototype implementation on a limited number of machines. The following key components were integrated into their system:

a. IIoT Integration:

IIoT devices were integrated into the shop floor to capture live product data. This data was then combined with information from the Enterprise Resource Planning (ERP)and manufacturing execution system (MES) to track the progress of components and their location throughout the production cycle.

b. Edge Gateways:

These devices were deployed to collect and transmit real-time data from the shop floor. They acted as intermediaries between the physical machines and the digital ecosystem.

c. Sensor Devices:

Various sensors were installed across the shop floor to capture critical data points such as consumption of welding wire, job order, operator, machine performance, temperature, and component measurements. These sensors provided granular insights into the manufacturing process.

d. ThingWorx Platform:

Zamil Steel utilized the ThingWorx platform to centralize data collection, analysis, and visualization. This platform enabled seamless integration with other systems and facilitated real-time decision-making.

e. Work Order and Barcode for Material Management and Assembly Tracking:

Zamil Steel recognized the need for efficient material management and assembly tracking. To address this requirement, they customized their work order process and implemented barcoding systems. The following details the implementation and benefits of these customizations:

e1. Customized Work Order Process:

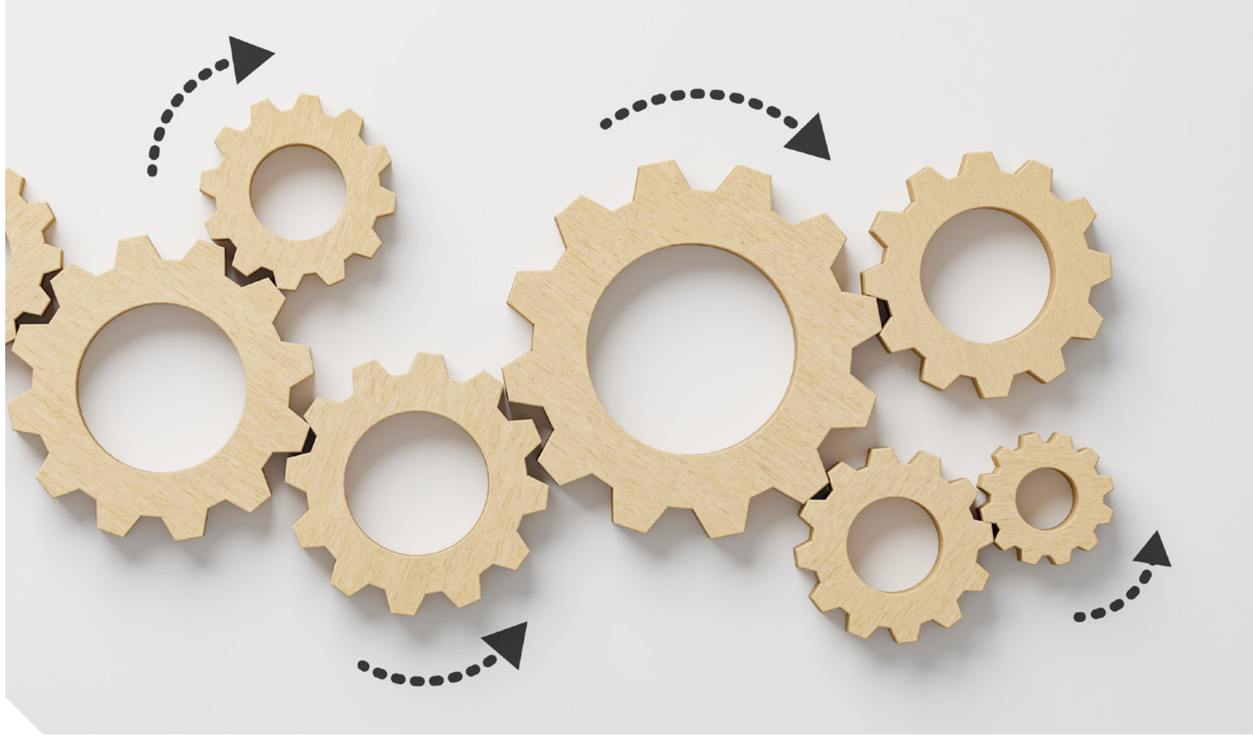
Zamil Steel tailored their work order process to streamline material management and assembly tracking. The customization involved integrating the digital ecosystem with their existing ERP system. Key features of the customized work order process included:

- Material Assignment: Each work order was assigned specific materials required for assembly. This information was digitally linked to the ERP system, ensuring accurate and efficient material allocation.
- Real-time Updates: As the assembly progressed, real-time updates were recorded in the work order system. This enabled the facility to have instant visibility into the status of each assembly, facilitating effective planning and resource allocation.
- Prioritization and Scheduling: The customized work order process allowed for prioritization and scheduling of assemblies based on urgency, materials availability, and production capacity. This optimized the plant's workflow and reduced bottlenecks.

e2. Barcode Implementation:

To enhance material management and assembly tracking, Zamil Steel implemented barcoding systems. This involved assigning unique barcodes to individual materials and assemblies. Key aspects of the barcode implementation included:

- Material Identification: Each material was affixed with a barcode label containing essential information such as part number, description, and quantity. This ensured accurate identification and minimized errors in material handling.
- Assembly Tracking: Barcodes were also assigned to assemblies, enabling seamless tracking throughout the production process. Assemblies were scanned at various stages, including component integration, quality checks, and final inspection. This allowed for real-time tracking and traceability, reducing the risk of errors, and improving quality control.
- Data Integration: The barcode system was integrated with the MES and ERP system, enabling automatic data capture and synchronization. This eliminated manual data entry and reduced the chances of human error, resulting in more accurate and reliable data for decision-making.



4 Results:

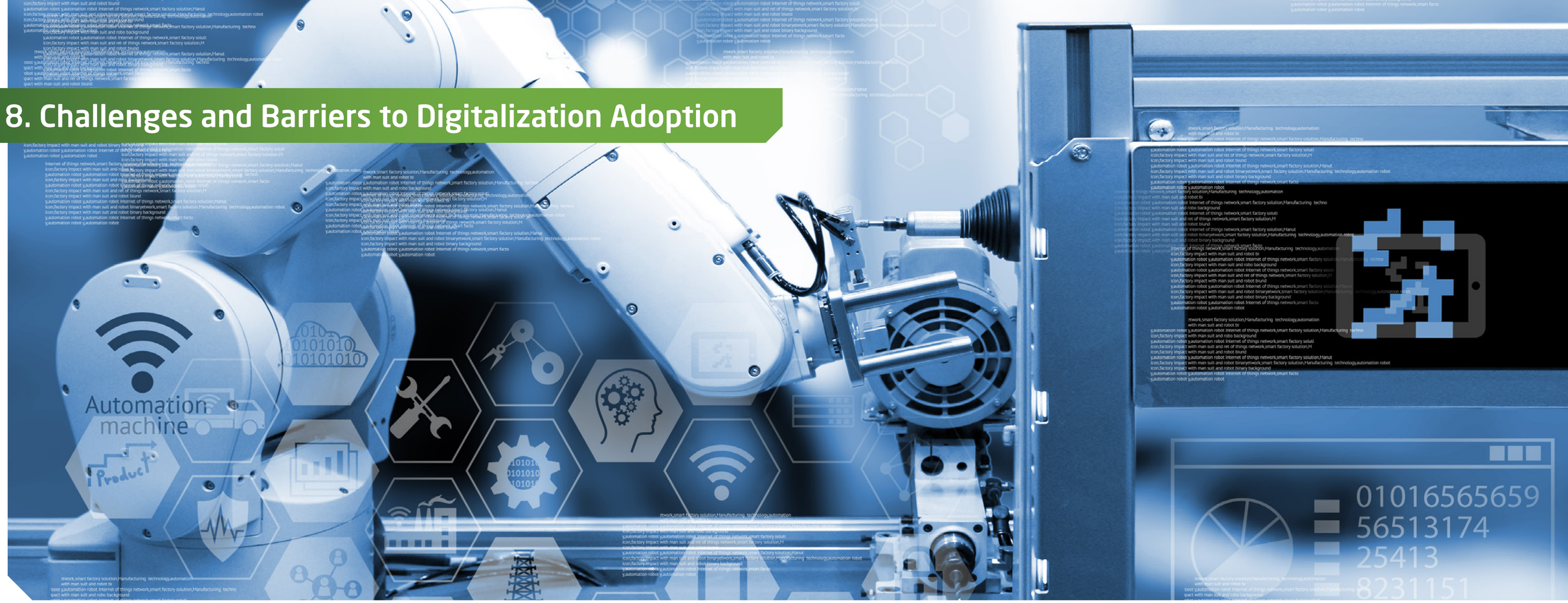
The digitalization efforts at Zamil Steel are yielding significant improvements in OEE and profitability. The following outcomes have been observed:

- OEE Improvement: The initial OEE, which stood at 52%, has witnessed a substantial increase and reached 65% after the implementation of digital solutions. This improvement has been achieved through enhanced machine efficiency, reduced downtime, and improved utilization of resources.
- Return on Investment: Zamil Steel is realizing a return on investment within a span of 24 months. The cost savings resulting from improved efficiency, reduced wastage, and optimized resource utilization are contributing to this positive financial outcome.
- Revenue Increase: The digital transformation has resulted in a significant annual revenue increase of SR 24,000,000. This revenue growth is primarily attributed to improved operational efficiency, better quality control, and enhanced production output.

5 Conclusion:

Zamil Steel's digitalization initiative successfully addressed their objectives of improving OEE and profitability. By implementing edge gateways, sensor devices, and leveraging the ThingWorks platform, the plant achieved notable results. The integration of IIoT devices with ERP and MES systems enabled effective tracking of components throughout the manufacturing process. This case study highlights the positive impact of digitalization on Zamil Steel's operations, emphasizing the importance of leveraging digital technologies to drive efficiency and profitability in the steel manufacturing industry.

8. Challenges and Barriers to Digitalization Adoption



In Saudi Arabia, the adoption of digitalization in the manufacturing sector still faces various challenges and barriers, despite having relatively good digital infrastructure and connectivity compared to many other countries. One of the key challenges is the limited digital skills and expertise among the workforce. Although the country has made significant efforts to promote digital literacy and technical education, there is a need for further investment and training programs to enhance the digital capabilities of the workforce. Additionally, the conservative nature of the manufacturing industry in Saudi Arabia, coupled with resistance to change and a preference for conventional methods, can impede the widespread adoption of digital technologies. Overcoming these barriers requires a concerted effort to promote a culture of innovation and digital transformation, along with targeted initiatives to build digital skills and awareness among the manufacturing workforce.

9. Roadmap for Successful Digital Transformation

Digital transformation is an essential part of growth and survival in today's fast-evolving business world. It is the process of leveraging digital technologies to create new-or modify existing-business processes, customer experiences, and culture to meet the changing business and market requirements. With the advent of Industry 4.0, digital transformation takes on a new level of significance, creating smarter factories and more connected businesses. This roadmap lays out high-level strategic steps towards a successful digital transformation, including assessing Industry 4.0 readiness with the Smart Industry Readiness Index (SIRI) framework. It outlines a journey of taking on low-hanging fruits and scaling up.

Digital Transformation Roadmap

1. Assessment:

The first step in the digital transformation journey is to understand where you currently stand. To ensure that your organization is ready for digital transformation, it is essential to first conduct an Industry 4.0 readiness assessment using the SIRI framework. This tool helps organizations to identify key areas for improvement and maps out the steps required to leverage Industry 4.0 technologies effectively. The SIRI assessment focuses on three core areas: Process, Technology, and Organization. Within these, there are 16 dimensions, such as automation, connectivity, intelligence, and training and education. A thorough assessment will yield a roadmap customized for your organization, highlighting your strengths and areas of improvement.

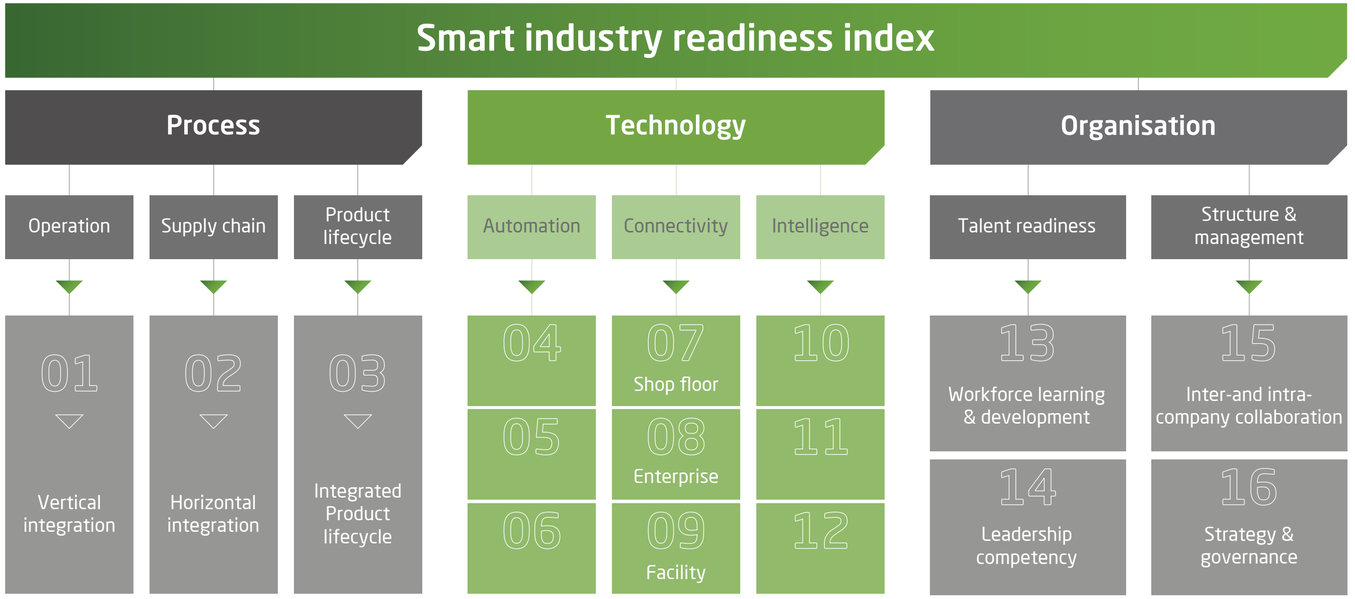


Diagram -1 The 16 Dimensions of SIRI Assessment D1

These dimensions paint a holistic picture of your organization's readiness for Industry 4.0, highlighting strengths and uncovering potential improvement areas. The assessment outcomes can guide your focus towards the aspects that require immediate attention, thus shaping a comprehensive digital transformation strategy.

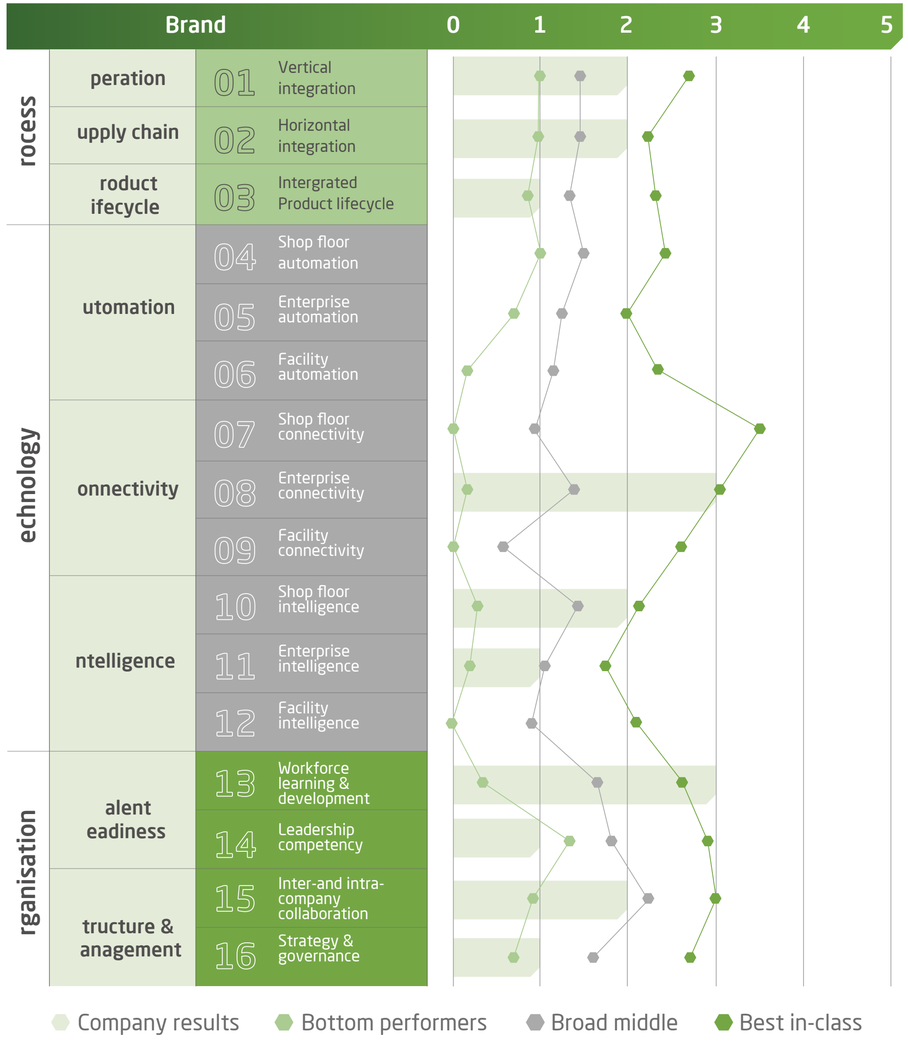


Diagram -2 The 16 Dimensions of SIRI Band Score D2

2. Plan:

Following the assessment, the next step is to establish a clear vision for your digital transformation, setting out the strategic objectives you aim to achieve. The vision should be ambitious but grounded in the realities identified in the SIRI assessment. The strategy should outline the timeline, resources, potential hurdles, and expected outcomes for each stage of the transformation process.

Digital transformation should be focused on identifying and implementing low-hanging fruits—areas where small changes can yield significant returns. It could be as simple as automating repetitive tasks, integrating cloud-based data management, or implementing machine learning algorithms for predictive maintenance. These changes are comparatively easy to implement and bring immediate benefits, demonstrating the value of the transformation and securing early buy-in from stakeholders.

3. Identify and Prioritize Projects:

With the strategy in place, identify potential projects aligned with your transformation vision. Prioritize these projects based on their feasibility, impact, and alignment with the business objectives. Consider initiating with "low-hanging fruit" projects, which offer significant value with relatively low implementation complexity. This approach helps to build momentum, demonstrate early success, and gain stakeholder buy-in.

Diagram -3 Prioritize the projects D3

4. Implementation:

Once the projects are identified and prioritized, it's time to implement. Establish dedicated teams for each project, clearly define roles and responsibilities, and ensure the availability of necessary resources. Regular progress tracking and open communication lines are critical at this stage to ensure smooth execution and manage any unforeseen issues promptly.

In your roadmap, you should be identifying and implementing small, high-impact projects. These projects may be slightly more complex than the low-hanging fruit, but they are still manageable and provide significant benefits. For example, you could introduce IoT devices into your production line to monitor performance and anticipate issues, or you could use AI to optimize your supply chain. These projects not only have high return on investment but also serve as learning opportunities for scaling up your transformation efforts.

5. Monitor and Evaluate:

To ensure that your digital transformation initiatives are on track, it's crucial to constantly monitor their progress against defined objectives. Regular evaluations help identify any deviations early, allowing timely corrective actions. Use quantitative measures such as key performance indicators (KPIs) and qualitative feedback from stakeholders for comprehensive performance evaluation.

6. Scale and Iterate:

Once a project demonstrates success, consider scaling it across the organization. While scaling, it's also essential to iterate and refine the project based on the insight gained from the initial implementation. This approach allows you to leverage the full potential of successful projects, driving substantial value for your organization.

7. Continuous Improvement:

Digital transformation is an ongoing journey, not a destination. The business landscape, customer expectations, and technologies continue to evolve, necessitating a mindset of continuous improvement. Central to this evolution is a robust workforce training and development strategy that prepares employees to leverage digital tools and technologies effectively.

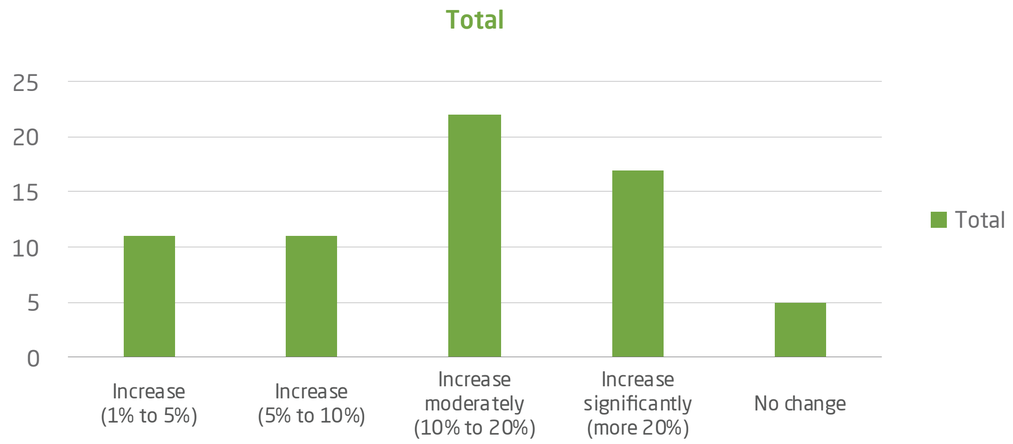
Consistent training and development are paramount to equip your workforce with the necessary digital skills to drive the transformation journey. A digitally competent workforce can better adapt to technological shifts, catalyze innovation, and enhance customer service delivery. As digital skills become increasingly vital in today's ever-changing technological landscape, regular reassessment of your digital transformation strategy, learning from the successes and failures, and staying abreast of technological advancements are integral to ongoing success. Updating your workforce training and development programs to reflect these changes is crucial.

Appendix

A. Consolidated Survey Results

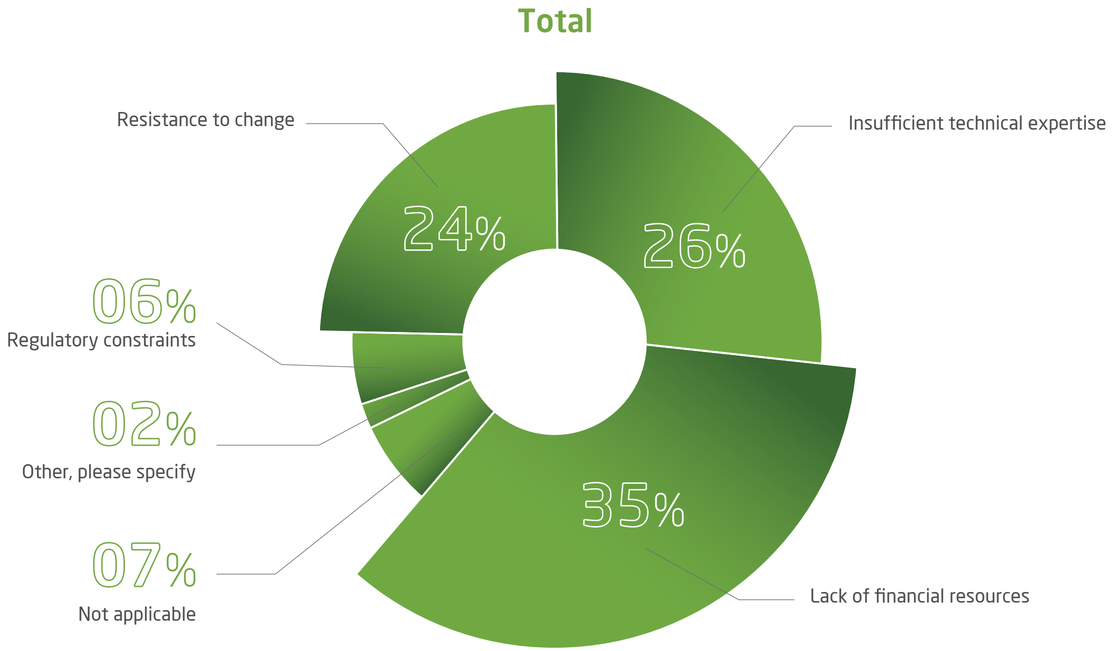
Survey results from 77 companies.

Companies willing to increase their budget for Digitalization in Manufacturing.



Graph-1 Budget allocation for Digitalization in KSAG1

The challenges facing companies in the digitalization of their business operation.



Graph-2 Challenges faced by companies in KSAG2

B. Additional Resources and References

McKinsey: https://uat.mckinsey.com/industries/advanced-electronics/our-insights/capturing-value-at-scale-in-discrete-manufacturing-with-industry-4-0

PWC: https://www.pwc.com/gx/en/industries/industry-4-0.html

Deloitte: https://www2.deloitte.com/us/en/insights/focus/industry-4-0.html

BCG:

MIM: https://mim.gov.sa/mim/index-ltr.html

Statista: https://www.statista.com/statistics/611004/global-industrial-internet-of-things-market-size/

1. xnergytech: https://www.xnergytech.com/myservice/automative-manufacturing/
2. Advantech
3. Boston Dynamics
4. https://atlantic.swagelok.com/en/about-us/swage-talks-blog/virtual-services
5. Boston Dynamics
6. https://stillwaterassociates.com/deregulation-mexico/
7. GIS Reports Online
8. https://blog.3ds.com/topics/virtual-experience/virtual-twin-experiences-powered-by-data-science/
9. https://www.packagingstrategies.com/articles/97361-rapid-robotics-and-universal-robots-partner-to-deploy-cobots

T1 Saudi Industrial Development Fund

T2 Ministry of Industry and Mineral Resources

T3 Ministry of Industry and Mineral Resources

T4 Ministry of Industry and Mineral Resources

C1 McKinsey and Statista

T5 UNIDO, UNCTAD, NIST, ITA, ISA, World Economic Forum, Eurostat, Company Annual Reports, Grand View Research

C2 McKinsey and Statista

S1 Zamil Steel Industries

D1 International Centre for Industrial Transformation (INCIT) - SIRI

D2 International Centre for Industrial Transformation (INCIT) – SIRI

D3 International Centre for Industrial Transformation (INCIT) - SIRI

S1 SIDF Survey Results

S2 SIDF Survey Results

R1 World Digital Competitive Ranking

https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-digital-competitiveness-ranking/

C. Glossary of Terms

1. Additive Manufacturing (3D Printing): A process that creates three-dimensional objects by depositing materials layer by layer based on a digital model.
2. AI (Artificial Intelligence): The simulation of human intelligence in machines, enabling them to perform tasks, learn, and make decisions.
3. Agile Supply Chain Management: A flexible and responsive approach to managing the flow of goods, services, and information across the supply chain.
4. Big Data Analytics: The process of examining and extracting insights from large volumes of structured and unstructured data.
5. Blockchain: A decentralized and secure technology that enables transparent and tamper-proof data exchange.
6. Cloud Computing: The delivery of computing services, including storage, processing power, and software, over the internet.
7. Cybersecurity: The practice of protecting computer systems, networks, and data from digital attacks, unauthorized access, or damage.
8. Digital Transformation: The process of leveraging digital technologies to create new or modify existing business processes, customer experiences, and culture to meet the changing business and market requirements.
9. Digital Twin: A virtual replica of a physical asset, process, or system that enables real-time monitoring, analysis, and optimization.
10. Industrial Automation: The use of control systems and technology to automate industrial processes, improving efficiency, productivity, and safety.
11. Industrial Internet of Things (IIoT): A network of interconnected devices, machines, and systems in the industrial sector that collect, share, and analyse data.
12. Industry 4.0: The current trend of automation and data exchange in manufacturing technologies, including cyber-physical systems, the Internet of Things (IoT), cloud computing, and cognitive computing.
13. Integration with ERPs: Integration of systems or processes with Enterprise Resource Planning (ERP) systems, which are software platforms that manage core business operations and data.
14. IoT (Internet of Things): A network of physical devices, vehicles, appliances, and other objects embedded with sensors, software, and connectivity to exchange data and perform tasks.
15. IoT Sensors: Devices that collect data on various parameters, such as temperature, pressure, flow rates, and equipment performance.
16. Key Performance Indicators (KPIs): Quantitative measures used to evaluate the performance or success of a project or initiative.
17. Machine Learning (ML): A subset of AI that enables machines to learn from data and improve their performance without being explicitly programmed.

D. List of Acronyms

1	AI	Artificial Intelligence
2	AM	Additive Manufacturing
3	API	Application Programming Interface
4	AR	Augmented Reality
5	AWS	Amazon Web Services
6	B2B	Business-to-Business
7	B2C	Business-to-Consumer
8	BPM	Business Process Management
9	BOM	Bill of Materials
10	CAD	Computer-Aided Design
11	CAM	Computer-Aided Manufacturing
12	CNC	Computer Numerical Control
13	EHS	Environment, Health, and Safety
14	ETL	Extract, Transform, Load
15	ERP	Enterprise Resource Planning
16	FMEA	Failure Mode and Effects Analysis
17	GDP	Gross Domestic Product
18	GE	General Electric
19	HMI	Human-Machine Interface
20	IBM	International Business Machines
21	IIoT	Industrial Internet of Things
22	IoT	Internet of Things
23	IT	Information Technology
24	JIT	Just-in-Time
25	KACST	King Abdulaziz City for Science and Technology
26	KAUST	King Abdullah University of Science and Technology
27	KPI	Key Performance Indicator
28	MES	Manufacturing Execution System
29	ML	Machine Learning
30	MODON	Saudi Authority for Industrial Cities and Technology Zones
31	NEOM	Smart city project in Saudi Arabia
32	NIDLP	National Industrial Development and Logistics Program
33	OEE	Overall Equipment Effectiveness
34	PaaS	Product-as-a-Service
35	PLC	Programmable Logic Controller
36	QC	Quality Control
37	QMS	Quality Management System
38	RFID	Radio Frequency Identification
39	ROI	Return on Investment
40	RPA	Robotic Process Automation
41	SAP	Systems, Applications, and Products
42	SIDF	Saudi Industrial Development Fund
43	SIRI	Smart Industry Readiness Index
44	SKU	Stock Keeping Unit
45	SPC	Statistical Process Control
46	TPM	Total Productive Maintenance
47	UI	User Interface
48	UX	User Experience
49	VR	Virtual Reality
50	WIP	Work in Progress

Thank You