Closing the Gap

Survey Insights to Bridge the Divide
in Industry 4.0 Preparedness

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Global Overview and *Context*

Globally, the defining technologies of Industry 4.0 are permeating gradually into supply chains and manufacturing processes. These include (but not limited to) Internet of Things, Industrial Internet of Things, cyber-physical systems, artificial intelligence, cognitive computing to create smart and integrated industrial ecosystems.

Manufacturers are adapting themselves to absorb these advanced technologies to optimize operational efficiency, improve product quality and offer real time customized products. This transformation is also driven by the need for greater agility in production, real-time data-driven decision-making hence being able to respond respond better to evolving market demands.
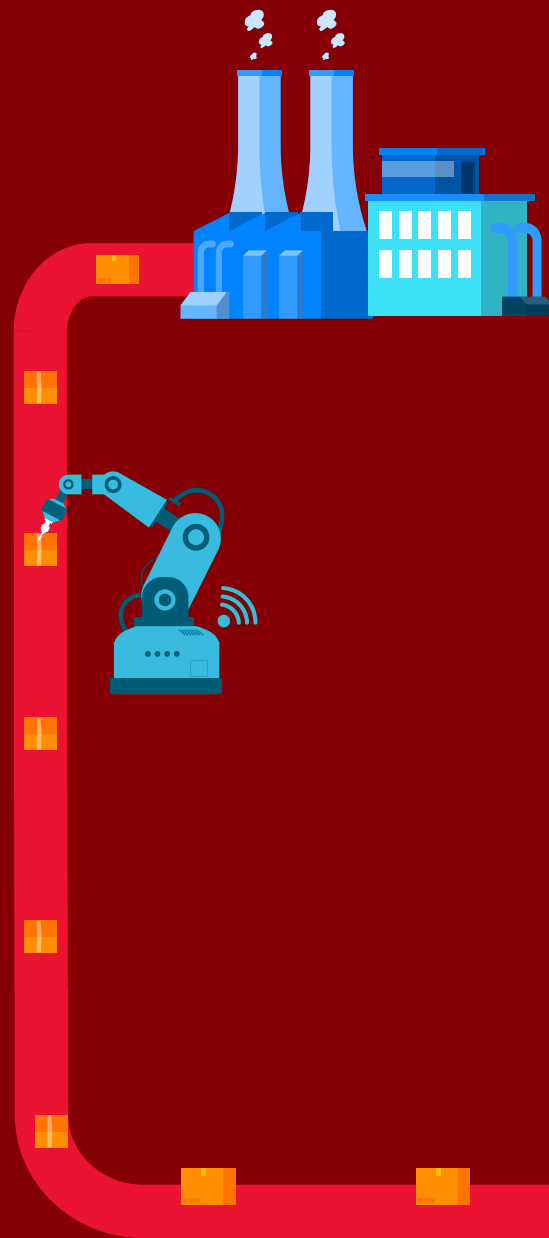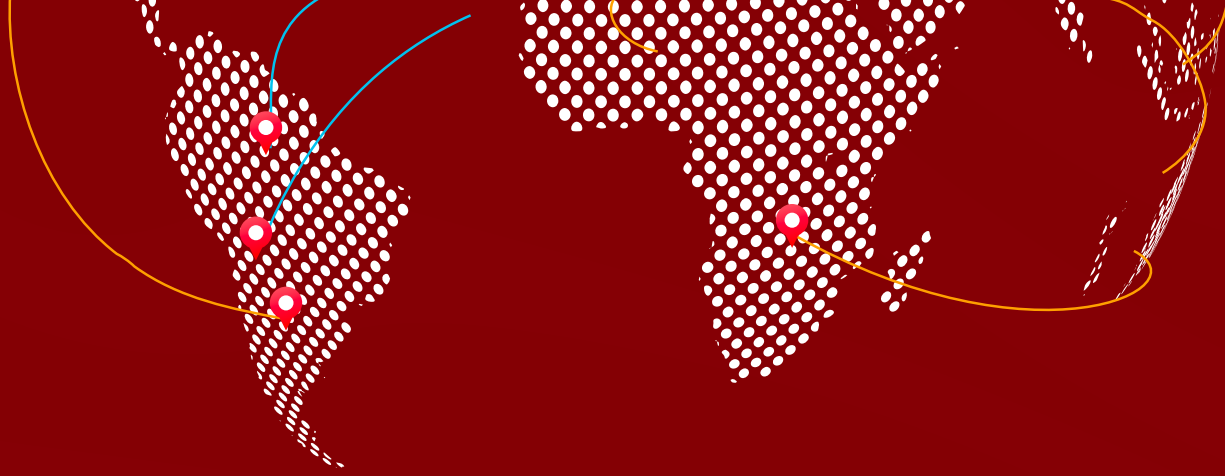
While there has been world wide adoption of Industry 4.0, the degree of adoption signifi cantly varies across geographies and industries. The major factors which contribute towards varying degrees of uptake include differential investment in technology, degree of stringency of regulatory structure for cyber security coupled with workforce skills and management mindset.

This landscape presents both opportunities and challenges. It is therefore crucial for large and small to medium sized enterprises to quickly determine their position and readiness towards this digital transformation.

The survey on Industry 4.0 aims to gauge the industry's preparedness towards adoption, determine barriers and under stand the regulatory support required to effectively integrate Industry 4.0 technologies in the system.

About **DMSCA**

Diverse Manufacturing Supply Chain Alliance (DMSCA) works to create an environment of collaboration and trust between manufacturers and suppliers.

This includes providing education and training opportunities, helping to foster communication between the two sides, and facilitating the development of new, innovative services. This includes the development of supplier and manufacturer relationships through strategic planning, the use of industry best practices, and the fostering of innovation and creativity.

DMSCA is dedicated to improving supplier and manufacturer relationships in the age of Industry 4.0.

With the emergence of new technologies, such as the Internet of Things (IoT), Artificial Intelligence (AI), and the Industrial Internet of Things (IIoT), the way manufacturers and suppliers interact is rapidly changing. As a manufacturer's supplier development organization, DMSCA focuses on helping small- to medium-sized businesses and suppliers create long-lasting, mutually beneficial relationships.

Objective
of *the Survey*

The aim of the survey is to gain holistic understanding of the status of the adoption of Industry 4.0 among enterprises, identifying key challenges and determining areas of support. It intends to provide an overarching stance of the stakeholders towards the Industry 4.0

This will help DMSCA to frame their future strategies and programs for the members. The survey probes the members on the following themes to arrive at a current state analysis.
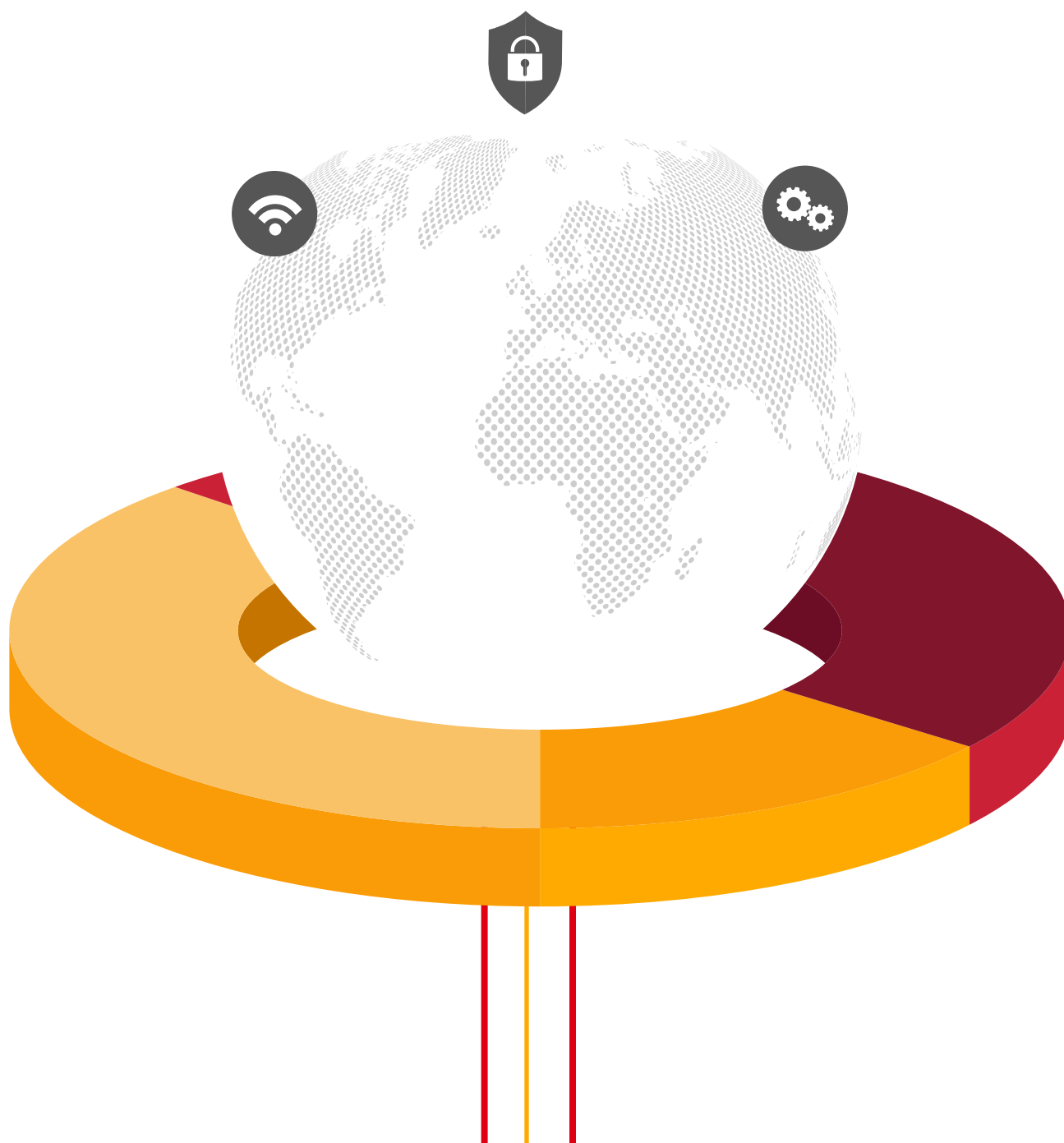
Evaluating Level of adoption

Evaluating the Industry 4.0 technology integration by assessing how IoT, AI, and IIoT are currently being utilized in manufacturing operations

Identifying Barriers and Challenges

Identifying challenges hindering the adoption of Industry 4.0 technologies such as (but not limited to) financial constraints, lack of technical expertise and organizational resistance

Evaluating Technology and Supply Chain Relationship

Analyzing the impact of Industry 4.0 technology adoption on the dynamics between suppliers and manufacturers specifically in terms of collaboration, communication and supply chain efficiency

Understanding People and Businesses

Understanding the culture and hence the specific educational and training needs required to implement Industry 4.0

Methodology and
Demographics

Survey Design

The survey design makes a holistic assessment of an organization's readiness for Industry 4.0. It addresses the multidimensional aspects of global digital transformation. The dimensions are further detailed into sub-dimensions which delve into specific aspects of implementation. It is expected to yield valuable insights for organizations which are looking to navigate through the complexities of Industry 4.0 adoption

Literature Review → Frame work Design → Questionnaire Design → Pilot Questionnaire

Final Questionnaire → Data Collection → Data Validation → Data Analysis → Benchmarking → Recommendation & Insights

Literature Review

Conducted a comprehensive review of 50 + academic journals, industry reports, and case studies related to industry 4.0

Indentified key themes, trends, and gaps in the existing literature, particularly focusing on the six dimension of readiness.

Consolidated findings to define the scope and key metrics for each dimension and sub-dimension.

Questionnaire Design for *In-Depth Industry 4.0 Readiness* Assessment

Tailored to 7 Dimensions

Mixed-Method Approach

Sub-Dimensions Explored

Pilot Testing for Precision

Maturity Levels Degined

User-Centric Design

7 Dimensions

Expertly crafted questions aligned with each of the 7 dimensions to cover the full spectrum of Industry 4.0 readiness

Sub-Dimensions Explored

Comprehensive coverage with 54 sub-dimensions to ensure a granular analysis of all critical aspects.

Maturity Levels Defined

Each question designed to evaluate maturity across 4 levels, from nascent to optimized practices, providing clear growth pathways.

Mixed-Method Approach

Combination of quantitative and qualitative questions to capture both statistical data and nuanced insights.

User-Centric Design

Questions crafted for clarity and accessibility, ensuring meaningful responses from a diverse range of industry participants

Pilot Testing for Precision

Extensively pilot-tested to refine question phrasing, structure, and flow, enhancing the reliability of collected data

Strategic Data Collection for Comprehensive Industry 4.0 Assessment

Data collected through our online platform and personal interviews

Diverse Data Sources:
Leveraged a mix of primary and secondary data sources to ensure a rich and varied data pool for analysis.

Case Studies:
Incorporated case studies to benchmark against best practices and understand the practical application of Industry 4.0 Technologies.

Targeted Surveys:
Deployed tailored surveys across multiple industry sectors to capture specific insights into the 7 dimensions and 54 sub-dimensions of readiness.

Data Quality Assurance:
Implemented rigorous data verification and validation processes to maintain high standards of accuracy and reliability.

Data Analysis Techniques for **Insightful Industry 4.0** Readiness Evaluation

Multi-Dimensional Analysis:
Employed advanced analytical methods to dissect data across 7 dimensions and 54 sub-dimensions, ensuring a nuanced understanding of readiness levels.

Clustering analysis was used Segmentation of Companies, Pattern identification in sub dimension.

K means and hierarchical clustering was used for analysis. Methods like the Elbow Method, Silhouette Score, or Gap Statistics to determine the optimal number of clusters for the data.

T-Test, ANNOVA, Chi- Square test and regression analysis was used to test hypothesis

Maturity Level Mapping Mapped companies' capabilities to 4 distinct maturity levels for each sub-dimension, providing a clear roadmap for progression.

Cross-Sectional Synthesis: Synthesized data from diverse sources and formats to construct a holistic view of Industry 4.0 readiness across sectors and geographies

Actionable Recommendations: Translated complex data into actionable recommendations, enabling companies to pinpoint strategic areas for improvement.

Tools used: Survey platform, SPSS, R, Python, SQL

Respondent *Profile*

A total of 42 respondents responded to the survey. The respondent profile in the survey comprises diverse industry groups with significant representation from Aerospace and Defense and Consumer Product/Packaged Goods sectors.

The mix of suppliers have varied manufacturing capabilities and supply chain models including Make-to-Stock and Make-to-Order models.

The respondent profile is evenly spread out across the size of the companies which is represented by employee brackets. Executive/CEO positions have dominated the respondent roles which indicate high-level involvement in Industry 4.0 adoption decisions.

This diverse profile offers intrinsic insights into Industry 4.0 adoption trends across all facets of adoption

Percentage Share of Respondents by sector

IGC01: Aerospace and Defense

IGC04: Chemicals

IGC05: Consumer Product/Packaged

IGC06: Heavy Construction

IGC07: Electronics and Semi-

IGC10: Industrial, Office, Institutional

0%   10%   20%   30%   40%
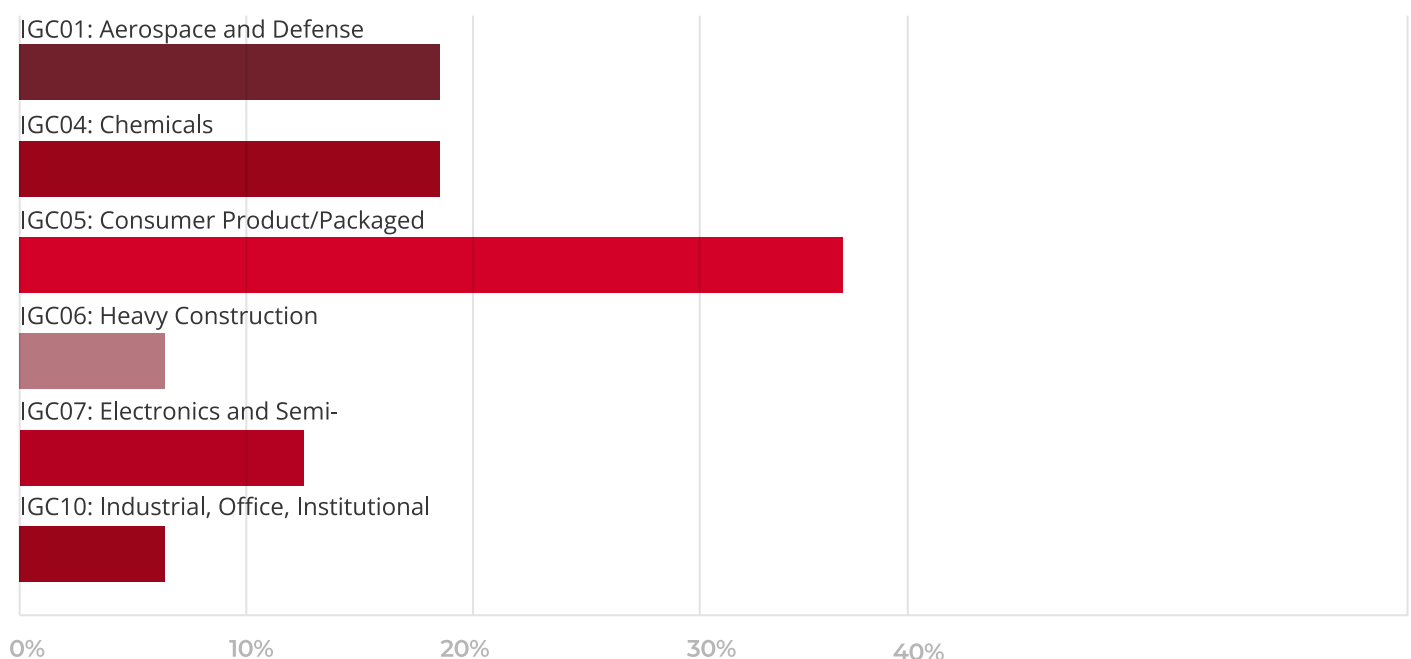
Percentage Share of Supplier Types

Manufacturing Type (MT):

MT1: Discrete fabrication/forming

MT2: Discrete assembly

MT3: Fabrication & assembly

MT4: Continuous process

MT6: Batch process

MT7: Packaging

MT8: Packaging plus batch or

| 0% | 10% | 20% | 30% |
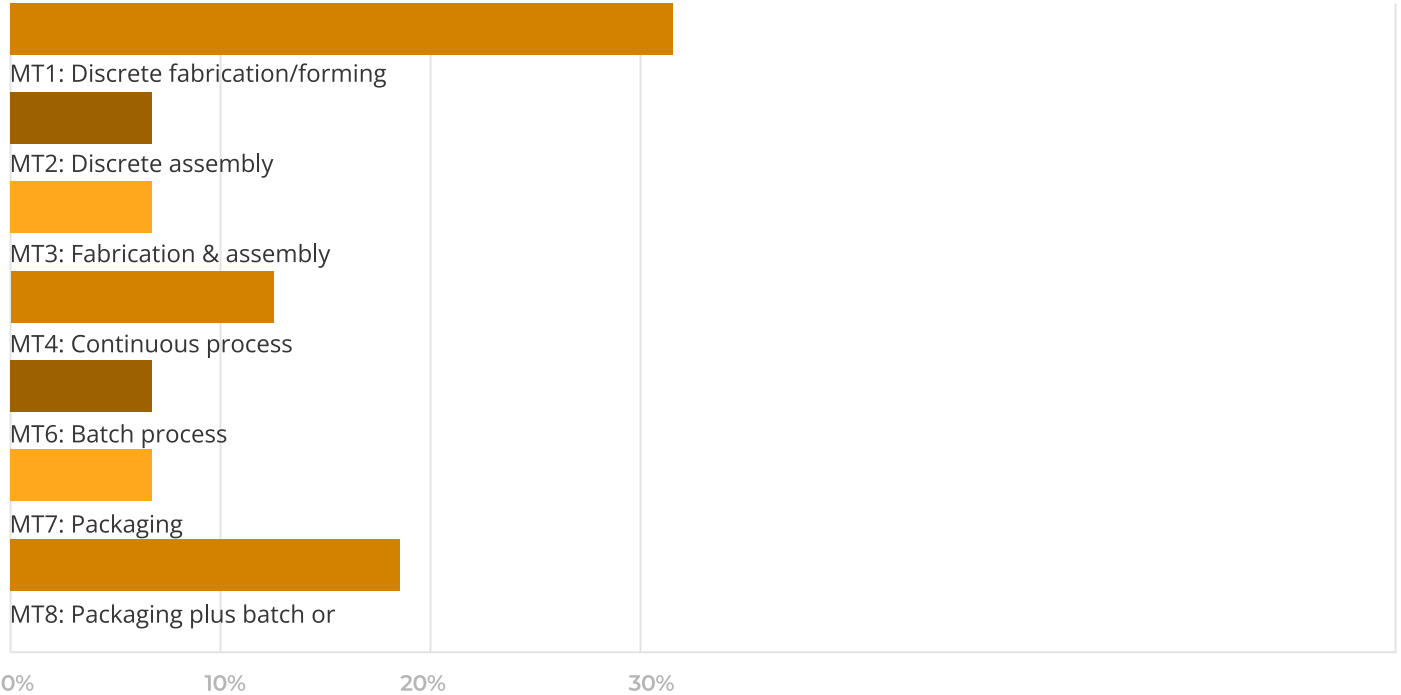
Split of Respondent Profile by Company Size

- 101+ employees
- 11-50 employees
- 201-1000 employees
- 51-200 employees
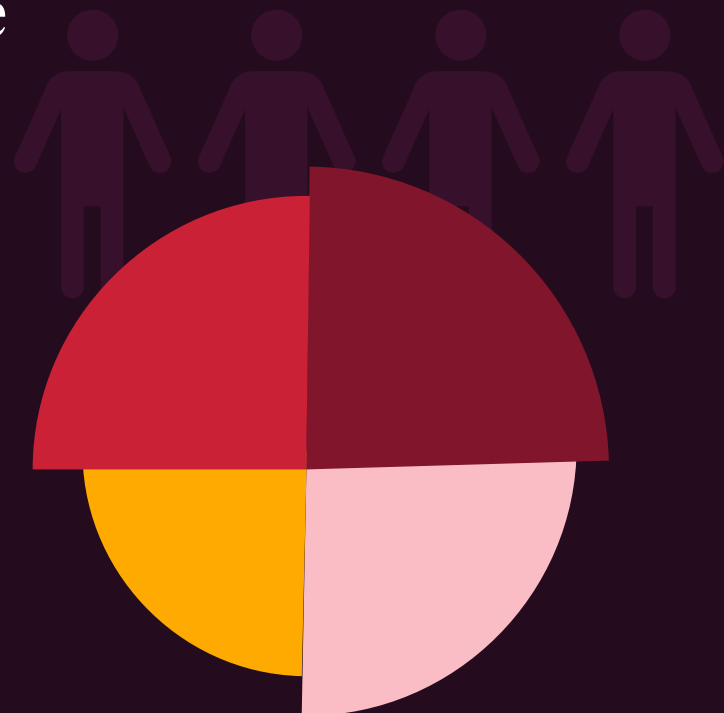
A Multidimensional Analysis of Global ReadinessAnalysis –
Key Findings and Insights

In this comprehensive analysis, we delve into seven key dimensions:

STRATEGY & ORGANIZATION

PRODUCTS & SERVICES

MANUFACTURING & OPERATIONS

SUPPLY CHAIN

DATA & TECHNOLOGY

LEGAL & GOVERNANCE

PEOPLE AND CULTURE

Each of the seven key dimensions encompasses vital sub-dimensions. Designed with four response levels for each sub-dimension, the questionnaire captures all vital aspects. Our survey evaluates the readiness of industries worldwide for the transfor mative era of Industry 4.0. A detailed analysis of each of the 7 dimensions offers a strategic lens on the evolving industrial landscape.

Product and Operation

Products & Services

Supply Chain

Manufacturing & Operations

Industry Framework

Industry Framework

Infrastructure and Culture

- Data & Technology
- People and Culture

Business and Operation

- Strategy & Organization
- Legal & Governance
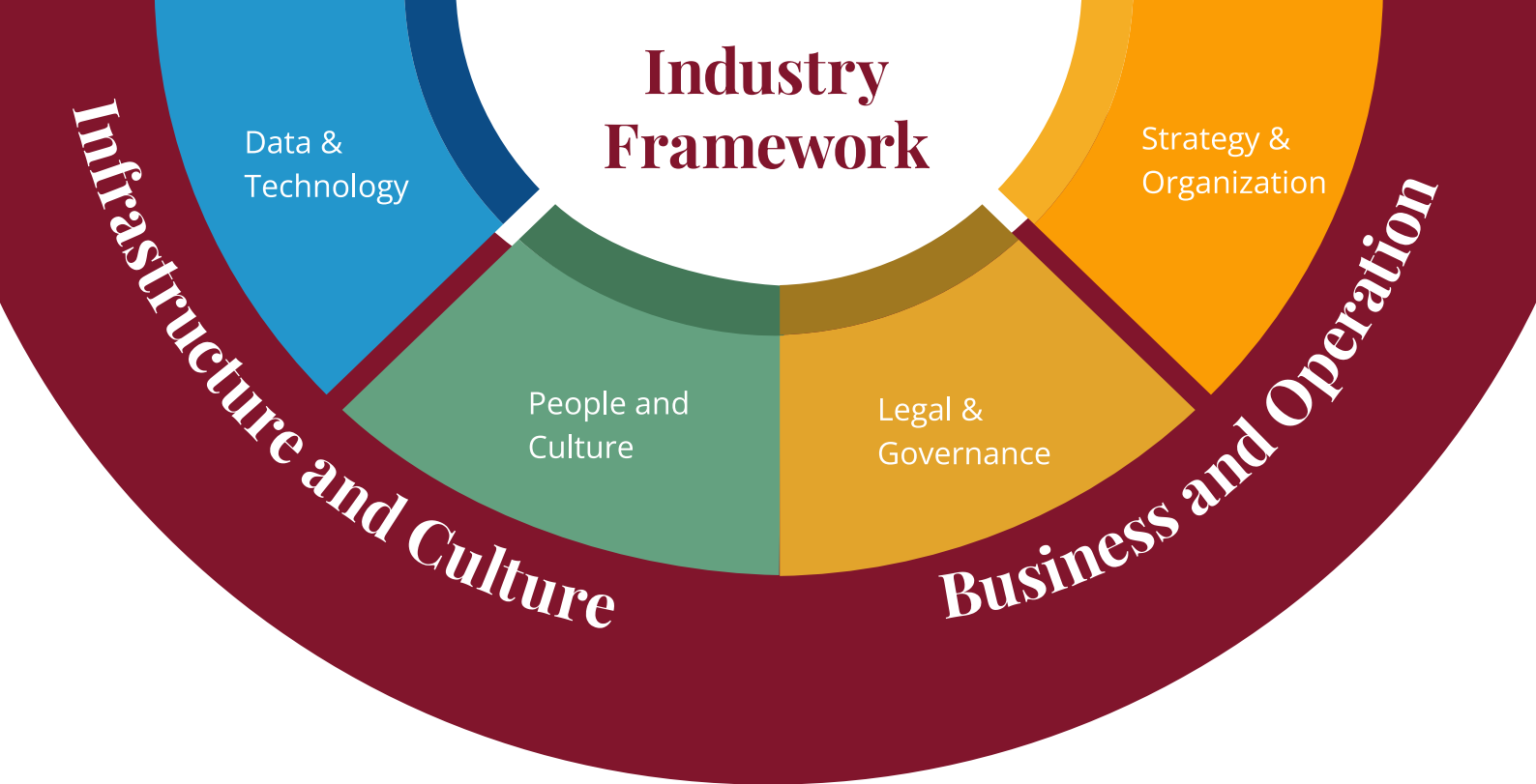
In-depth Sub-Dimension Analysis:
Diving deeper, we assessed 54 sub-dimensions, enabling a granular examination of each area's maturity and capabilities.

Defined Maturity Levels:
Each sub-dimension is evaluated through a 4-level maturity scale, ranging from Level 1 (Initial) to Level 4 (Optimized), providing a clear path for progression and improvement.

Customizable and Scalable Approach
The framework is designed to be adaptable, allowing for customization to specific industry needs and scalability for companies of different sizes.

Actionable Insights and Benchmarks:
By categorizing maturity into distinct levels, we offer actionable insights and bench marks for companies to strive towards, facilitating targeted strategies for advance ment.

Foundation for Continuous Improvement
This structured approach not only assesses current readiness but also serves as a road map for continuous improvement and innovation in the Industry 4.0 landscape.

Strategy and Organisation

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
1	Degree of strategy implementation	Assesses the transformation at departmental level to its full integration across the business
2	Measurement	Focuses on the evolution from lack of specific Industry 4.0 KPIs to comprehensive metrics which impact both business reporting and personal development
3	Investments	Evaluates the progression from investments in a single business area to comprehensive financial commitment spanning all business operations
4	Collaboration	Assesses the shift from functional silos to cross-departmental and cross-company collaboration
5	Leadership	Gauges the leadership evolution from lack of recognition of Industry 4.0's value to company wide support and strategic investment in these initiatives
6	'As a service' business model	Assesses the awareness and implementation of 'as a service' models, from initial awareness to full implementation and customer offering

The survey underscores a dynamic shift towards Industry 4.0, with organizations actively striving to bridge leader ship and collaboration gaps to spearhead a transformative integration of advanced practices

Collaboration and Leadership have the highest degree of maturity which indicates that there exists a high degree of inclination for adoption and aligning with the new technological change. More than 50 to 75% of the respondents have indicated Level 3 and Level 4 degree of maturity for these two parameters. This also hints at the conviction of the top leadership to embrace the change

The status of Industry 4.0 adoption within the organization reflects a diversified managerial approach. Though the concept is being acknowledged in specific departments, there exists a gap in fully integrating these principles into the overarching organizational strategy.

Despite this, there is progress in incorporating structured business metrics that include key drivers of Industry 4.0. These changes in how we intend to evolve our organizational strategy requires dedicated investments which may not necessarily reap short term benefits.
Hence, organizations need to develop an exploratory mindset for investments.

There has been an uptake in investments focused towards advanced business areas, indicating a strategic intent on innovation and technological advancement.

The status of Industry 4.0 adoption within the organization reflects a diversified managerial approach. Though the concept is being acknowledged in specific departments, there exists a gap in fully integrating these principles into the overarching organizational strategy.

A vital aspect of strategy, collaboration, across departments is encouraged reflecting a readiness to leverage cross-functional expertise in driving Industry 4.0 initiatives. This aspect will be instrumental in elevating industry wide adoption.

The leadership is demonstrating an active interest in exploring its potential benefits of Industry 4.0, signaling a commitment to staying abreast of emerging trends and opportunities. Although there is awareness of the concept and initial plans for development, there is room for improvement in integrating online and offline channels seamlessly, a crucial aspect of maximizing the potential of Industry 4.0 strategies.

Strategy & Organisation –
Response Across

Level 1   Level 2   Level 3   Level 4

	0%	25%	50%	75%	100%
Degree of strategy Implemetation					
Measurements					
Investments					
Collaboration					
Leadership					
"As a Service" buisness model					
Integrated Marketing Channels					
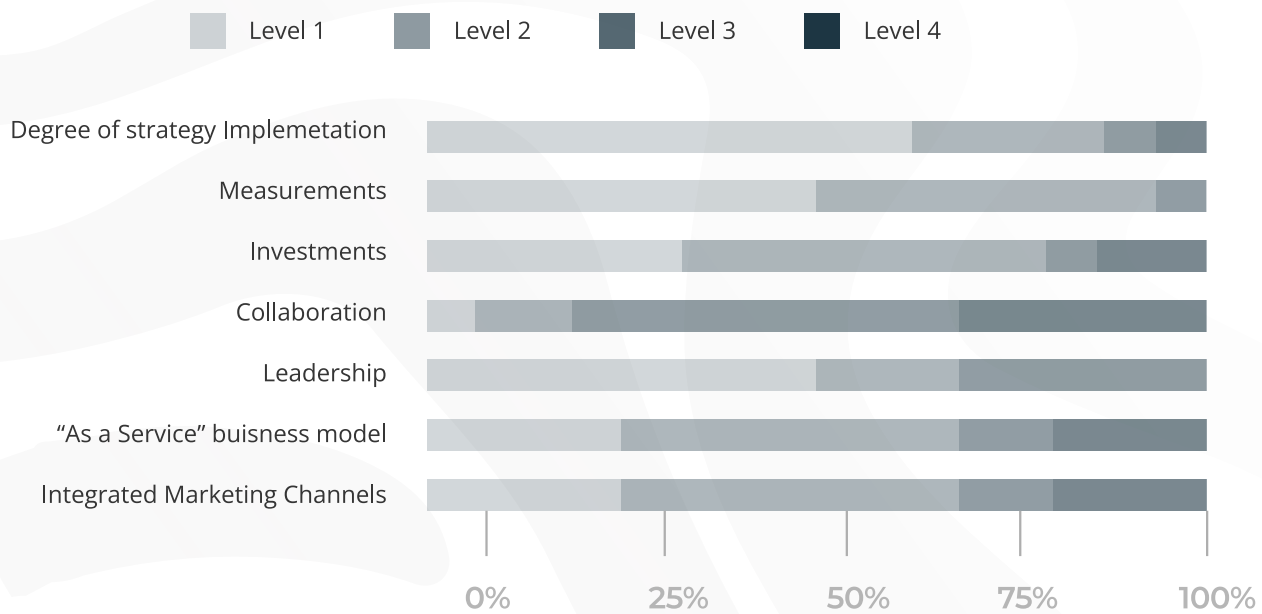
Products and Services

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
1	Product Customization	Range of product customization from lack of individualization to the availability of real time differentiation
2	Digital Features of Products	Evolution of product value starting from physical value to an overall value proposition entailing digital features and intellectual property licensing value
3	Level of Product Data Usage	Extent of data utilization in product development and improvement from no data usage to using more than 50% of collected data

The survey unravels a rather cautious approach towards product customization and digital integration. Significant share of respondents focused on physical attributes and moderate data usage, highlighting untapped potential in digital features and analytics.
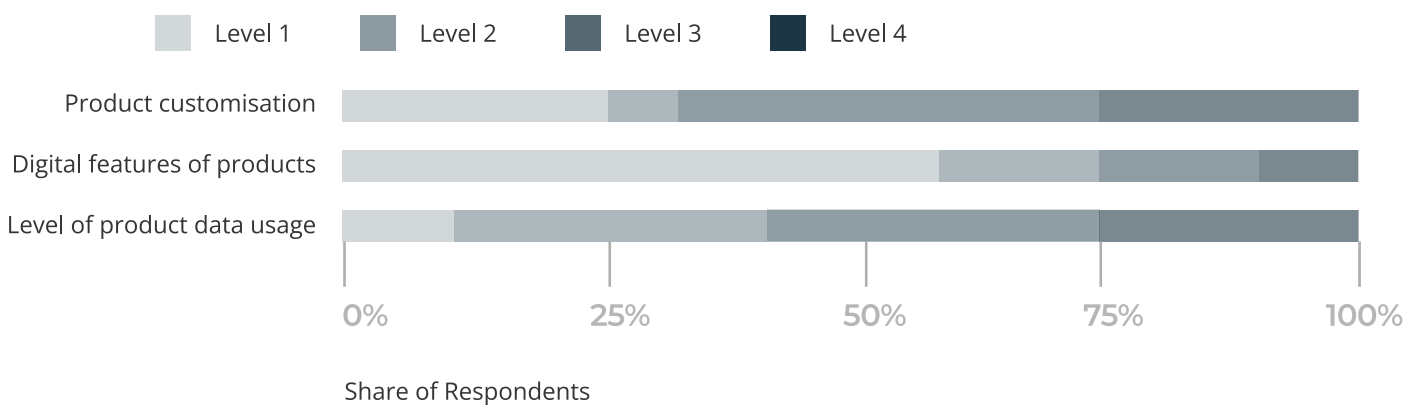
The current status of Industry 4.0 adoption suggests a nuanced approach to product customization and digital integration. Close to 60% of the respondents have indicated Level 3 and Level 4 degree of maturity in Product Customisation though only 25% of the respondents have indicated Level 4 (50% of the data utilization is used). This hints at the fact that while there are significant efforts for product customization, data is not being fully leveraged to indicating room for growth in fully capitalizing on data to drive customization efforts. This presents huge opportunity for data monetization

Product customization is a well established concept in the manufacturing industry. However, process standardization to ensure efficiency and consistency in production processes is still evolving. Also product customization has not been leveraged for enhancing digital capability capabilities and rather focuses on physical attributes.

Despite organizations focussing on collecting product related data, utilization of the data is very low. This highlights a potential area for improvement in harnessing the full potential of data-driven insight. The data can be utilized to optimize production efficiency, enhance product functionality and meet evolving consumer demands in the era of Industry 4.0.

Product & Services –
Response Across

Level 1   Level 2   Level 3   Level 4

Product customisation

Digital features of products

Level of product data usage

0%   25%   50%   75%   100%

Share of Respondents

Manufacturing and Operations

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
1	Automation	Level of automation from a limited machine control to complete automation of machines and systems
2	Machine and operation system integration (M2M)	Extent of M2M interoperability ranging from no capability to full integration
3	Equipment readiness for Industry 4	State of equipment ranging from over haul requirements to complete future-readiness
4	Autonomously guided workpieces	Assesses the usage of autonomously guided workpieces from non-use to advanced automation in handling materials
5	Self-optimizing processes	Uptake of self-optimization processes from nil usage to extensive application leading to process intelligence
6	Digital modeling	Digital modeling usage from nil application to complete integration across all relevant processes exhibiting the digitized manufacturing

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
7	Operations data collection	Operations data is being collected ranging from manual to automatized digital collection reflecting the level of digitization
8	Operations data usage	Operational data usage in merely routine processes to usage in comprehensive process control and decision-making applications
9	Human-Machine Communication	Delves into the interaction between humans and machines from no exchange to the use of mobile devices for monitoring and control reflecting enhanced human-machine interface
10	Flexibility of Equipment and Production System	Production agility from rigid systems to modular and plug-and-produce capable equipment
11	Avoidance of Errors	Effectiveness of error detection ranging from prevention to include quality control sophistication
12	Predictive maintenance	Maintenance strategies from reactive to proactive predictive maintenance using data analytics
13	Production Capacity utilization	Level of production capacity utilization
14	Do you track energy consumption by machines?	Assesses at the level of energy efficiency and sustainability efforts

The survey reflects a nascent yet evolving Industry 4.0 landscape, with organizations embracing automation and digital tools at varying degrees, yet still reliant on manual processes for quality control and maintenance, highlighting a blend of traditional practices and modern technological adoption.

Machine and systems integration, Human to Machine communication and Operations data collection exhibits a high degree of maturity with at least 50% of the respondents indicating Level 3 and Level 4 of maturity. This indicates a strong foundation in these critical Industry 4.0 areas, suggesting that businesses are increasingly capable of sophisticated technological integration and leveraging data for operational decisions.

This is however in stark contrast to the fact that only 19% of the respondents have level 4 maturity in Flexibility of Equipment and Production System. Additionally almost 80% of the respondents have relatively low levels of maturity while tracking energy consumption in machines. 50% are either not tracking energy consumption by the machines .This indicates a pronounced gap in sustainability practices

This landscape of technological integration and automation is gradually inching towards a completely new arena of automation which is programmable, flexible and integrated. While most machines and system infrastructures can be controlled through automation, they are still not fully integrated with limited opportunities for further upgrades. This presents a significant challenge because upgrading is key to product customization.

Autonomously guided workpieces and self-optimization processes which can significantly reduce operational defficiencies are not yet implemented. These are indicating areas for future development.
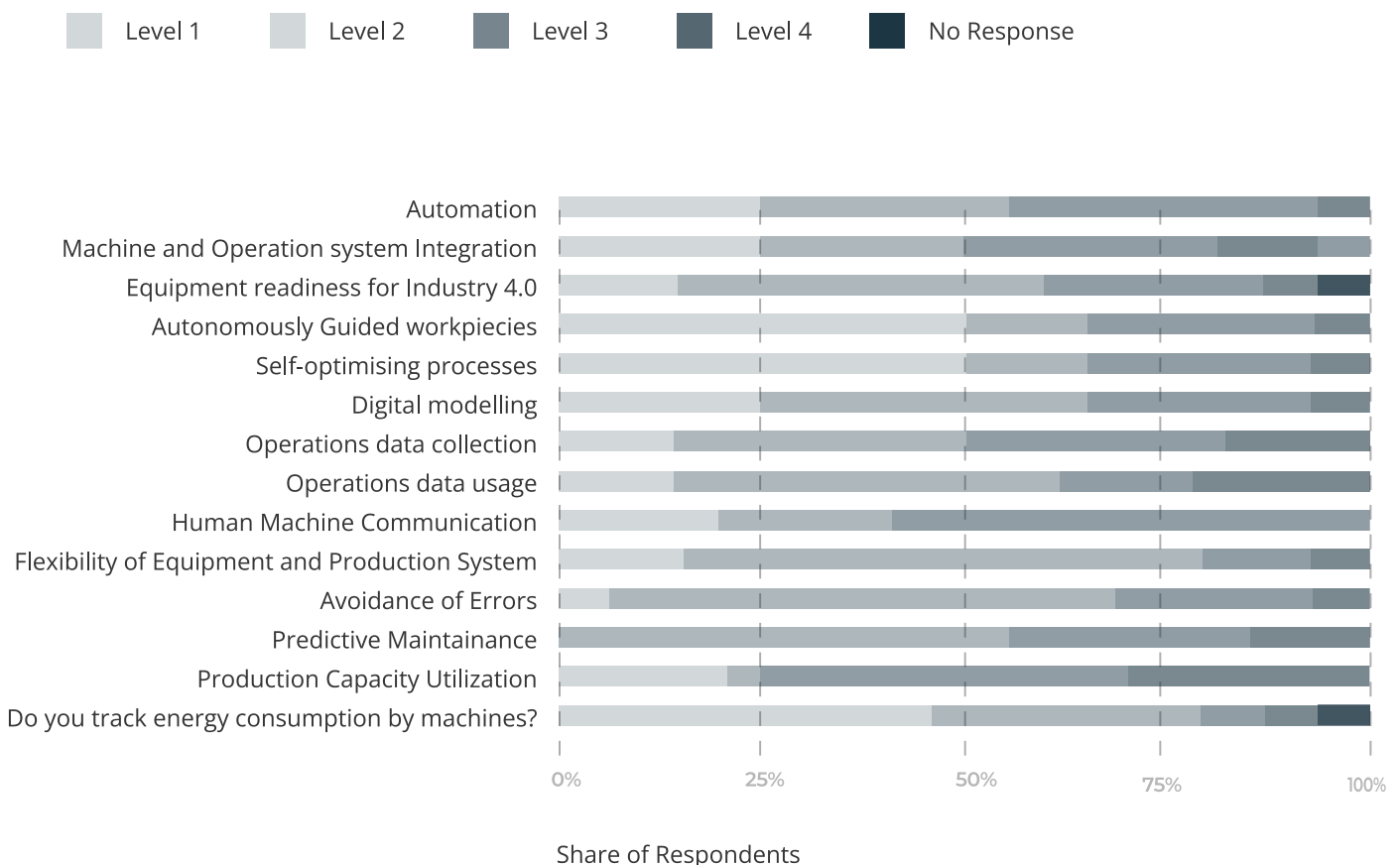
Utilization of mobile devices for display and input enhances operational flexibility, while equipment flexibility allows for the product customization and production process agility.

Select processes are utilizing digital modeling with digital data collection specific applications only. There are efforts towards comprehensive data collection across multiple domains but it is a long way ahead.

Quality defect detection primarily relies on employee visual or manual inspection, with maintenance scheduled based on elapsed time or usage.

Although production capacity utilization ranges from 50% to 70%, energy consumption monitoring and associated data collection remains virtually absent across all categories. These observations underscore the organization's progress in Industry 4.0 adoption while highlighting areas for further advancement and optimization.

Manufacturing and Operations
Response Across

Level 1　Level 2　Level 3　Level 4　No Response

| | Automation |
| Machine and Operation system Integration |
| Equipment readiness for Industry 4.0 |
| Autonomously Guided workpiecies |
| Self-optimising processes |
| Digital modelling |
| Operations data collection |
| Operations data usage |
| Human Machine Communication |
| Flexibility of Equipment and Production System |
| Avoidance of Errors |
| Predictive Maintainance |
| Production Capacity Utilization |
| Do you track energy consumption by machines? |

0%　　25%　　50%　　75%　　100%

Share of Respondents

Supply Chain

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
1	Inventory control using real-time data management	Graduation from base level understanding of inventory levels to real-time database updates through smart devices
2	Supply chain integration	Integration with stakeholders ranging from ad hoc and sporadic communication to integrated and streamlined systems for real-time planning
3	Supply chain visibility	Visibility and transparency across the supply chain from no or low integration to real-time visibility and optimization
4	Supply chain flexibility	Responsiveness to market changes from slow to immediate response reflecting supply chain agility
5	Lead times	Analyzes lead time management
6	Interaction between Production, Quality and Logistics	Information sharing efficiency from manual to fully automated real-time interaction
7	Tracing	Functionality of traceability systems with internal and external information as a core functionality

Supply Chain

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
8	Tracking	Measures the extent of tracking along the supply chain through autonomous real-time interaction with planning systems
9	Use of Standardized Load Carriers	Standardization of load carriers from product and supplier-specific carriers intelligent carriers
10	Exchange of Planning Information	Level of data exchange within the Global Production Network (GPN) for an optimized business process integration

There is an evolving blend of digital technologies and supply chain connectivity. Select aspects are still tethered to manual processes for critical data management coupled with persistence of manual database updates

Use of Standard load carriers and Tracing has a high degree of maturity with 70% of the respondents having level 3 and level 4 maturity. High maturity in these areas are the foundation for adoption of Industry 4.0 technologies. This also indicates that organizations are moving towards are more collaborative approach for integrated and cooperative supply chain models

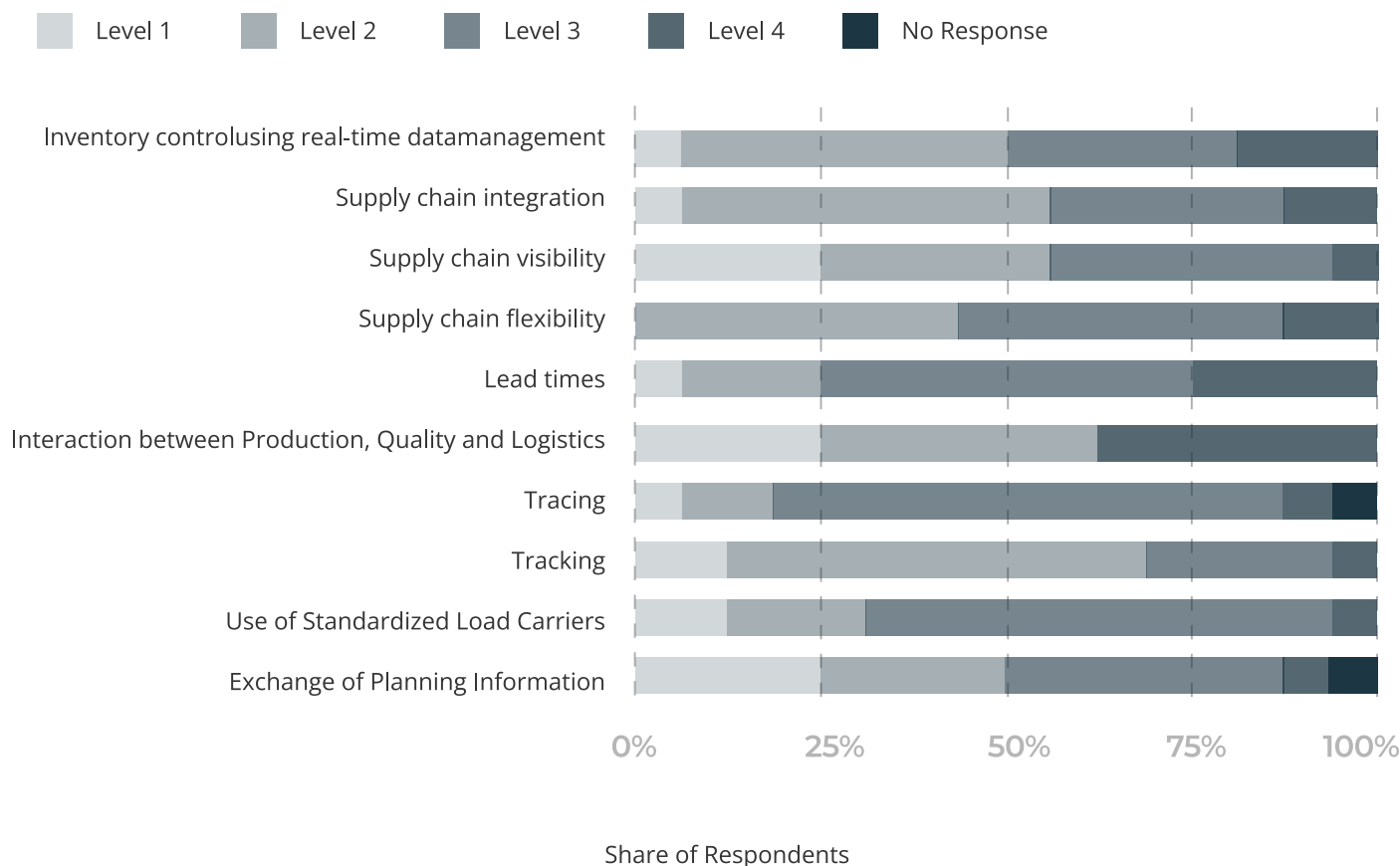There has been a progressive integration of select technologies in the supply chain. These are largely focussed on traceability and flexibility. Lead times have a high degree of maturity with Inventory control using real time data management has peaked

There is minimal exchange of planning information with either "No data exchange within the GPN" or "Manual exchange of data by e-mail or telephone on request". This requires a proactive approach towards increase in sharing of planning information with GPN

Computer database and manual updates are still required and continue to serve as foundation of communication
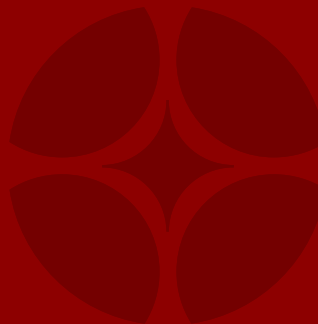
Supply Chain –
Response Across

| Level 1 | Level 2 | Level 3 | Level 4 | No Response |

Inventory controlusing real-time datamanagement
Supply chain integration
Supply chain visibility
Supply chain flexibility
Lead times
Interaction between Production, Quality and Logistics
Tracing
Tracking
Use of Standardized Load Carriers
Exchange of Planning Information

0%   25%   50%   75%   100%

Share of Respondents

Data & Technology

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
1	Cloud solution usage	Extent of cloud integration from nil usage to multiple solutions implemented across the business
2	IT and data security	Efficacy of IT security in terms of scope of implementation from planning to all relevant business processes
3	IT supported business	Extent of IT support to fundamental business processes
4	Big data Analytics	Utilization and integration of big data analytics in business innovation and strategy
5	ERP/MES	Implementation of Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES)
6	Remote Monitoring of products	Product monitoring from no or spotwise monitoring to comprehensive remote monitoring and control
7	AI/GenAI Adoption	AI adoption from exploratory stage to AI being core to organizational transformation

| S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
8	Data driven decisions	Level of data informed or data driven decisions within the organization
9	Are your digital technologies primarily in-house or outsourced	Approach to technology development and management by the provision of digital technologies in the organization

The industry has witnessed amalgamation of advanced solutions to enhance operational facets. This includes progressive integration of ERP systems and AI technologies. There are ongoing integration efforts balancing in-house development with strategic outsourcing. However huge gap exist with respect to uptake of AI/GenAI products.

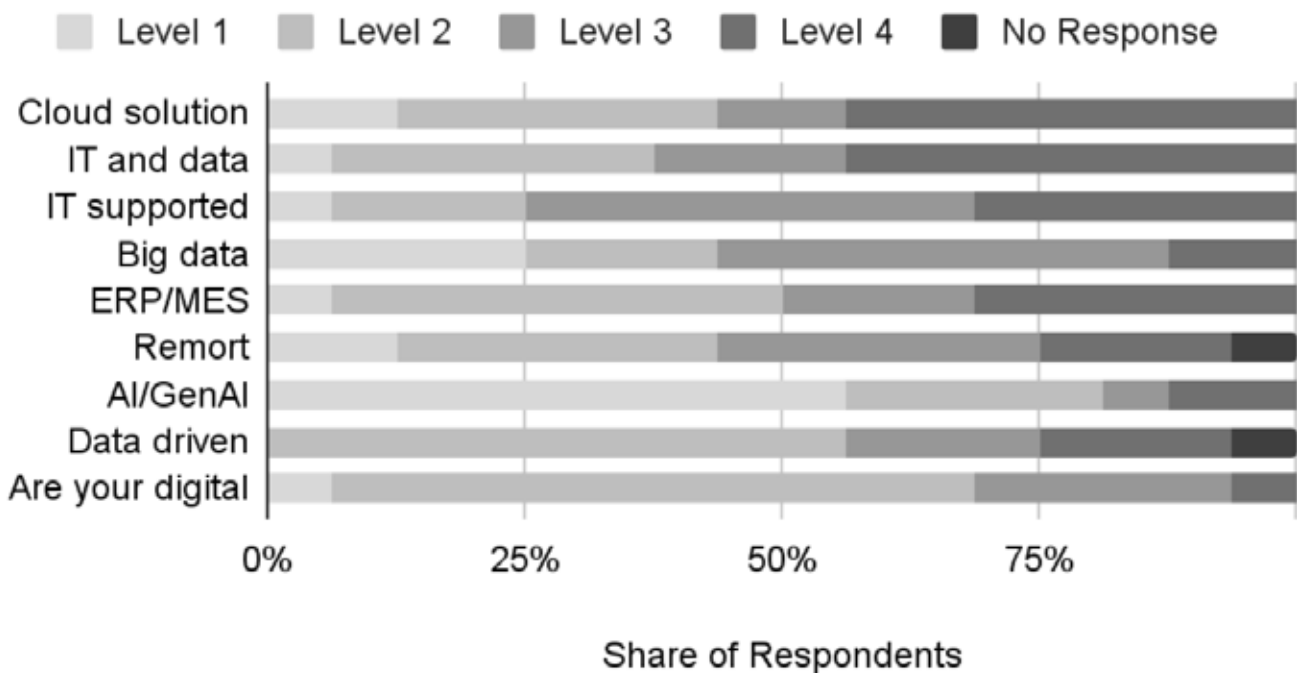**56% percent** of the respondents have indicated Level 1 (Exploratory) maturity for GenAI. 56% percent of respondents are at Level 2 (Some data is analyzed and featured in key business reports to review performance) maturity of Data Driven decisions. Both the above imply a hug gap in data monetization and an opportunity to be leverage data in critical decisions especially when the leadership has a progressive mindset
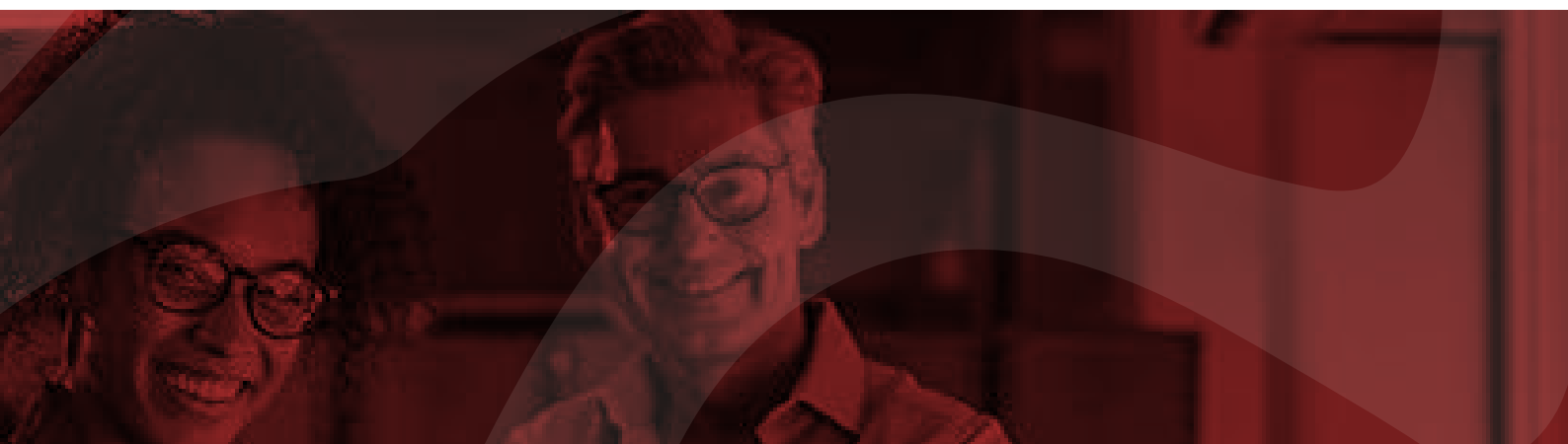
There has been a marked update of IT solutions and processes though full integration is still work in progress. Organizations are investing in ensuring compliance, preliminary safeguarding against cyber risks and other grass root level digital necessities.

There has been a headway in adoption of big data analytics for organizational growth though it is still not a core function driving innovation and strategy for most organizations

Data & Technology –
Response Across

Legend: Level 1, Level 2, Level 3, Level 4, No Response

Categories: Cloud solution, IT and data, IT supported, Big data, ERP/MES, Remort, AI/GenAI, Data driven, Are your digital

X-axis: 0%, 25%, 50%, 75%

Share of Respondents

Legal Considerations

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
1	Contracting models	Evolution of contracting models from unchanged linear processes to behavioral models aimed at optimization
2	Risk	Organization's approach to risk mitigation from no identification and assessment to a detailed risk profile
3	Data protection	Strength of data protection policies and compliance with General Data Protection Regulation
4	Intellectual property	Level and strength of intellectual property in new offerings

Organizations require a proactive understanding of digital transformation challenges to assess the gaps in risk mitigation and GDPR compliance. Formal legal safeguards are pending with an imminent need enhanced regulatory alignment and protection measures

75% of the respondents have a "Good understanding with robust policies and procedures but haven't updated for General Data Protection Regulation"

An organization's progression towards Industry 4.0 is driven by its alignment to contracting processes. This is critical because of evolving operational dynamics with sectors.

Organizations understand that robust technological process need compliance and updates but still do not have updated compliance with General Data Protection Regulation (GDPR)

Legal Considerations –
Response Across

Share of Respondents
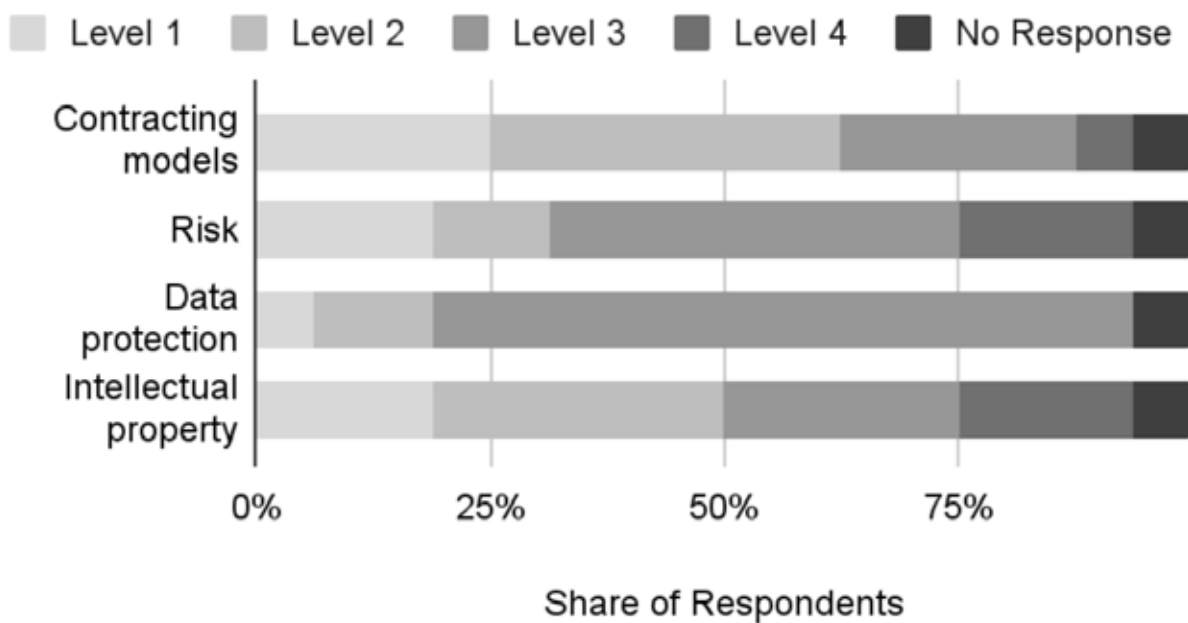
People & Culture

S.NO	SUB-DIMENSION	INDUSTRY 4.0 ASSESSMENT SCOPE
1	People capabilities	Workforce skills ranging from little or no digital technologies capability to advanced data analytics skills
2	Access to Information for Employees	Extent of information access ranging from no direct access to a personalized user interface
3	Culture of innovation	Innovation embodiment within the company and integration with daily operations and strategy
4	Adaptability to new digital tools and practices	Extent of responsiveness and receptivity to new digital practices

Negligible share of employees achieve the highest training level for Industry 4.0 reflecting a huge upskilling gap. With decreased access to information at upper proficiency levels, there is a critical need for preparedness and continuous adaptation strategies
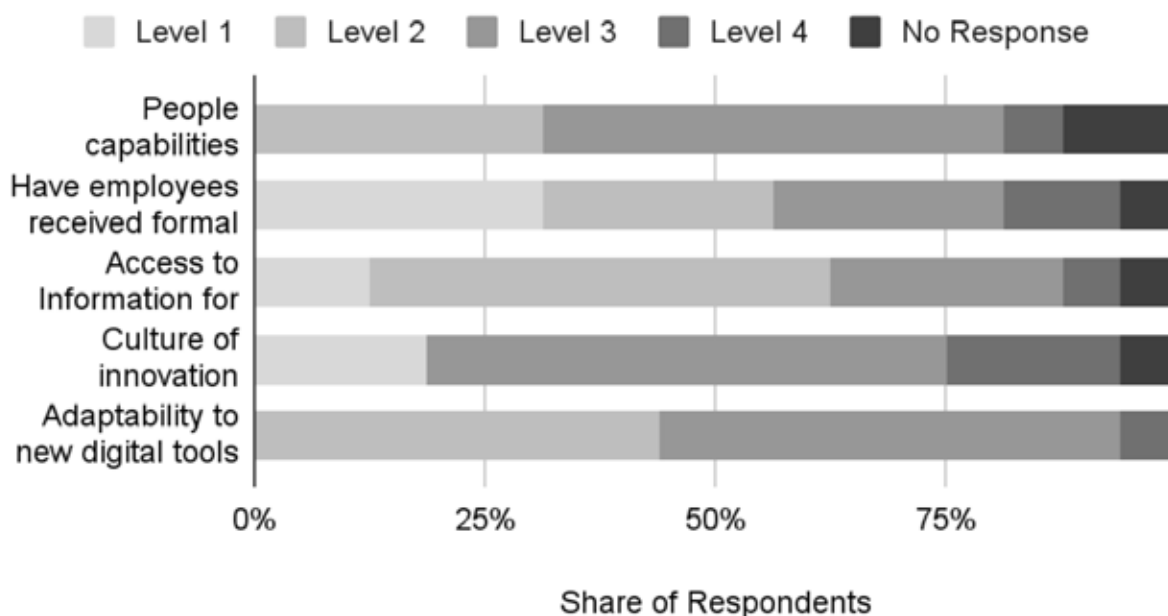
There exists a low level of maturity on training with basic or no formal training on Industry 4.0. However there exists a high inclination for innovation. 75% of the respondents have level 3 and level 4 maturity for uptake of Innovation. This indicates strategic intent for growth and adoption of Industry 4.0 . This gap can be fulfilled with tailor made training programs

The adoption of Industry 4.0 technologies will impact several aspects of human resources. It will alter the way organizations view human capital management. Industry 4.0 core technologies on automation reduce the requirement for manual labor thereby affecting both skill requirement and labor pricing.

These technologies are likely to cause an iterative impact on talent agglomeration. It will create the need for specialized skills and expertise in areas such as analytics, automation and other digital technologies. This specific need will lead to concentration of skill in geographic areas which are hot spots for these opportunities.

There will be further concentration of skill because of the collaborative nature of industry 4.0 technologies which will attract skilled professionals, innovators, researchers towards a concentrated and well aligned professional cluster.

People & Culture –
Response Across

Level 1   Level 2   Level 3   Level 4   No Response

People capabilities
Have employees received formal
Access to Information for
Culture of innovation
Adaptability to new digital tools

0%   25%   50%   75%

Share of Respondents

Comparison of Maturity Levels Across Dimensions

Highest Maturity levels (Top 2 across each Dimension)
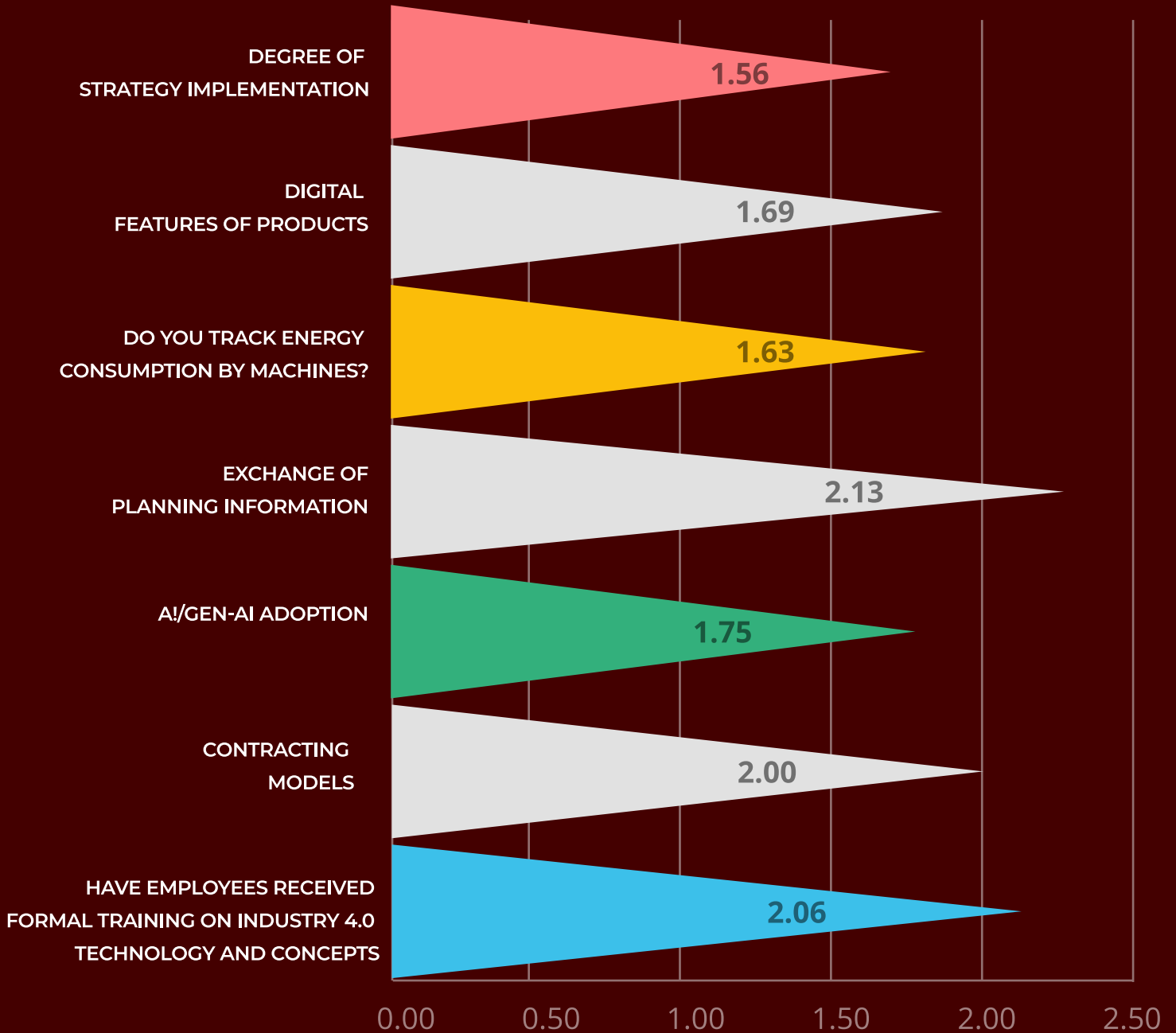
Dimension	Value
Sub Dimension Collaboration	3.06
Leadership	2.69
Level of product dat...	2.81
Product customisation	2.69
Production Capacity...	3.13
Predictive maintaina...	2.56
Machine and operati...	2.44
Lead times	2.94
Supply chain flexibility	2.69
IT and data security	3.00
IT supported business	3.00
Data protection	2.56
Risk	2.50
Adaptability to new...	2.63
Culture of innovation	2.63

0.00   1.00   2.00   3.00   4.00

Maturity Level (1- Lowest, 4- Highest)

Lowest Maturity level across Sub-Dimensions

Sub-Dimension	Maturity Level
DEGREE OF STRATEGY IMPLEMENTATION	1.56
DIGITAL FEATURES OF PRODUCTS	1.69
DO YOU TRACK ENERGY CONSUMPTION BY MACHINES?	1.63
EXCHANGE OF PLANNING INFORMATION	2.13
A!/GEN-AI ADOPTION	1.75
CONTRACTING MODELS	2.00
HAVE EMPLOYEES RECEIVED FORMAL TRAINING ON INDUSTRY 4.0 TECHNOLOGY AND CONCEPTS	2.06

0.00 0.50 1.00 1.50 2.00 2.50

Maturity Level (1- Lowest, 4- Highest)

Reasons for
Low industry 4.0 Adoption

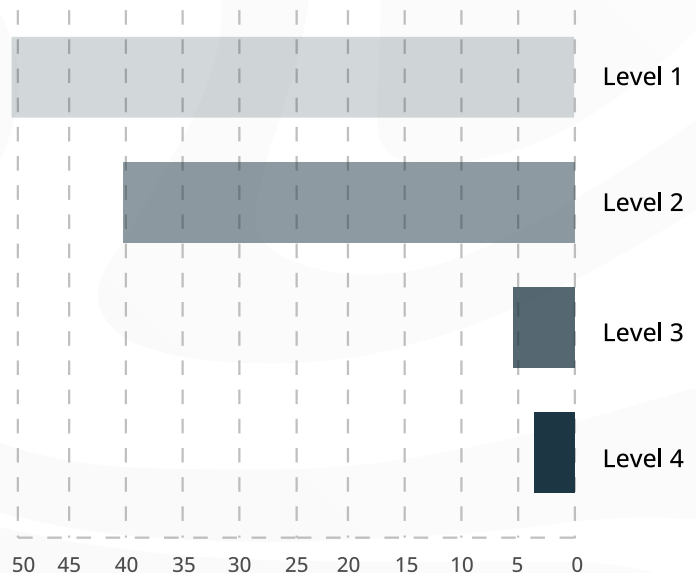**LOW INVESTMENT IN INDUSTRY 4 FOR BUSINESS AREAS**
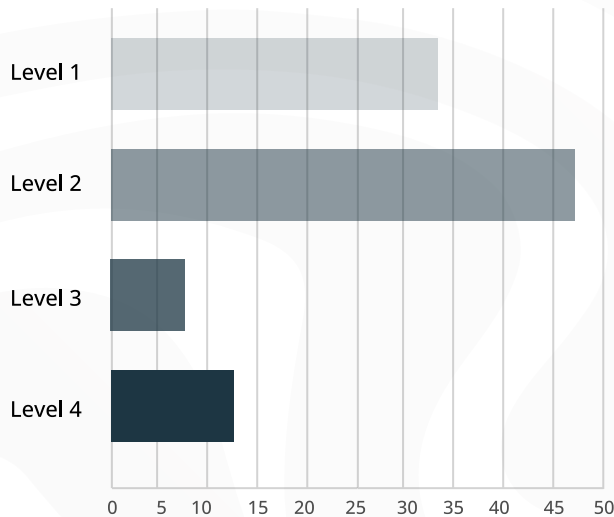
70%
More than 70% have low investment to wards industry 4.0 areas
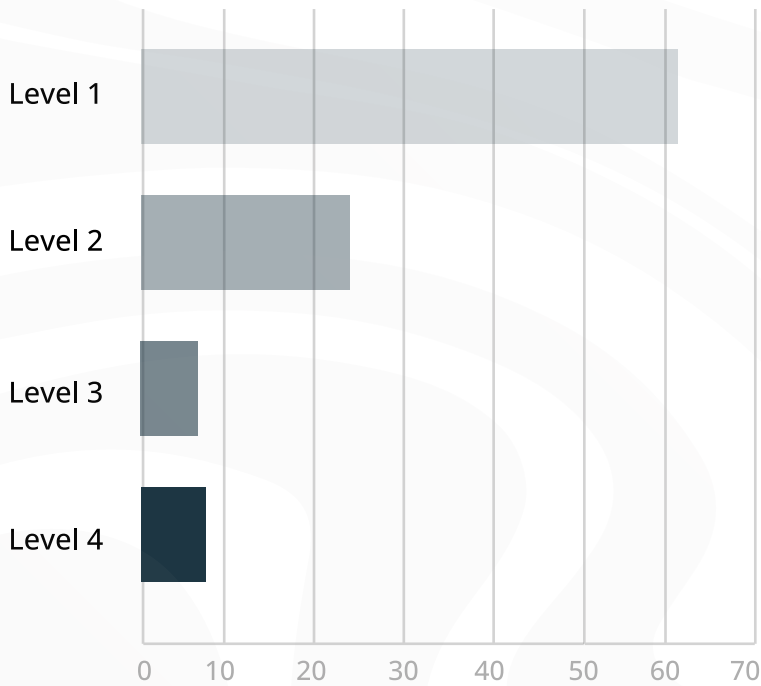
BUSINESS KPIS NOT STRUCTURED TO INDUSTRY 4

90%
More than 90% surveyed organizations 90% don't have business KPIs aligned to Industry 4

*Level 1 represents lowest maturity level and Level 4 highest maturity level

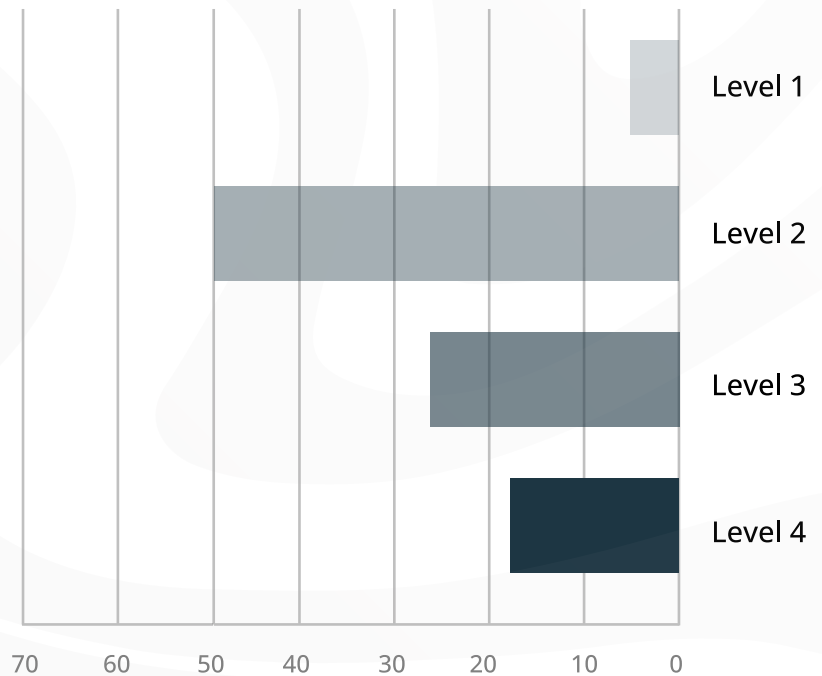## INDUSTRY 4 FULLY INTEGRATED INTO THE OVERALL STRATEGY

Level 1	
Level 2	
Level 3	
Level 4	

0 10 20 30 40 50 60 70

80%
More than 80% of the organizations do not have Industry 4 integrated to the strategy

LEADERSHIP TEAM IN WAIT AND WATCH MODE

50%
50 % of leadership team in wait and watch mode

70 60 50 40 30 20 10 0

	Level 1
	Level 2
	Level 3
	Level 4

* Level 1 represents lowest maturity level and Level 4 highest maturity level

Leading the Digital Frontier:

Industry 4.0 Technologies at the Forefront of Global Manufacturing

Select technologies are responsible for driving Industry 4.0's transformative impact on global manufacturing. These range from intelligent automation to data-driven decision-making themes. These technology trends can be viewed in isolation or in conjunction with other technologies.

Multiple aspects of technologies often intersect and amplify each other's capabilities leading to innovative solutions. As Industry 4.0 continues to evolve, such intersections are bound to impact offerings from technology service providers.

S.NO	TECHNOLOGY	MAJOR THEMES
1	Internet of Things (IoT) and Industrial IoT (IIoT)	Smart Sensors and Devices Connected Systems
2	Artificial Intelligence (AI) and Machine Learning	Predictive Maintenance AI in Quality Control
3	Robotics and Automation	Collaborative Robots (Cobots) Advanced Automation
4	Big Data Analytics and Data-Driven Decision Making	Data Analysis for Efficiency Real-Time Monitoring
5	Cyber-Physical Systems (CPS)	Integration of Physical and Digital Worlds Smart Factories
6	Blockchain for Supply Chain Transparency	Enhanced Traceability Secure Transactions
7	Edge Computing	Data Processing at the Source Reduced Dependency on Centralized Cloud
8	Digital Twins	Virtual Replicas Predictive Modeling
9	Sustainability through Tech Integratio	Energy Efficiency Sustainable Processes
10	Additive Manufacturing (3D Printing)	Rapid Prototyping Customized Production

Unveiling Regional Dynamics in
Industry 4.0 Adoption

The readiness for Industry 4.0 varies significantly across different regions of the world, influenced by factors such as technological infrastructure, government policies, workforce skills and economic development.

Overall, the readiness for Industry 4.0 is highly differentiated across regions. These differences highlight the need for region-specific strategies in the global transition to Industry 4.0.

S.NO	REGION	NUANCES
1	North America (U.S. and Canada)	High Technological Adoption with private players such as Tesla, GE leading the way Heavily invested by US Government with variation in policy support across states Strong focus on upskilling and reskilling but gaps in advanced manufacturing technologies persist
2	Europe	Strong Policy Support with substantial investments in R&D High degree of Collaboration between industry, academia, and government Sustainability focus as seen in companies like Siemens and Bosch
3	Asia-Pacific (APAC)	Rapid Adoption in Leading Economies Significant Variability Across the Region Investment in Innovation through companies like Samsung and Toyota which have invested heavily into robotics and automation

4	Latin America	Emerging Adoption with countries like Brazil and Mexico making gradual progress Challenges in Infrastructure and Skills Focus on Specific Sectors such as automotive manufacturing in Mexico
5	Middle East and Africa (MEA	Diverse Levels of Readiness with Gulf countries like the UAE investing in smart city projects, while many African countries are still developing basic industrial infrastructure Resource-Driven Economies Diversifying Potential for Leapfrogging for certain African countries

Sectoral Dynamics

The readiness across different sectors is influenced by factors such as complexity manufacturing processes, specific regulatory structure, product lifecycle and customer demand centricity.

Technologically driven industries like automotive, aerospace and electronics are front runners while traditional sectors like construction and textiles are adopting these technologies at a slower pace. Different sectors navigate the challenges and embrace the opportunities at their own specific pace leading to varied levels of adoption and implementation.

1.

SECTOR: AUTOMOTIVE INDUSTRY

Nuances:

High readiness and leader in adoption with extensive use of automation, robotics and digital twins technology

Examples/Highlights:

Tesla has revolutionized manufacturing with highly automated factories while BMW and Volkswagen have also implemented smart factory concepts extensively

2.

SECTOR: AEROSPACE AND DEFENSE

Nuances:

Advanced adoption due to requirement of precision in highly complex aerospace manufacturing process

Examples/Highlights:

Boeing and Airbus use IoT and AI for predictive maintenance and improvement of manufacturing efficiency

3.

SECTOR: ELECTRONICS AND SEMICONDUCTOR

Nuances:

Rapid innovation with a focus on miniaturization, automation and smart manufacturing

Examples/Highlights:

Intel and Samsung are known for their highly automated and sophisticated semiconductor fabrication plants

4.

SECTOR: CHEMICALS AND PHARMACEUTI-CALS

Nuances:

Moderate to high readiness adoption process largely for optimization and regulatory compliance

Examples/Highlights:

Pfizer and Bayer have implemented digital technologies for process optimization and quality control

5.

SECTOR: OIL AND GAS

Nuances:

Varied adoption though there is increasing use of IoT, big data and AI for exploration, predictive maintenance and operational efficiency

Examples/Highlights:

Shell and BP are utilizing digital twins and AI for exploration and predictive maintenance

6.

SECTOR: FOOD AND BEVERAGE

Nuances:

Increasing Adoption for supply chain traceability, quality control and efficiency in production

Examples/Highlights:

Nestlé and PepsiCo are utilizing smart sensors and data analytics to optimize production

7.

SECTOR: TEXTILE AND APPAREL

Nuances:

Emerging Adoption particularly in areas like supply chain management and customization

Examples/Highlights:

Adidas's concept of "Speedfactory" has implemented automation and product customization

8.

SECTOR: HEALTHCARE AND MEDICAL DEVICES

Nuances:

Focused adoption around precision, quality control and regulatory compliance

Examples/Highlights:

Siemens Healthineers utilizes advanced manufacturing technologies for producing high-precision medical devices

9.

SECTOR: CONSTRUCTION

Nuances:

Slow adoption with interest from areas such as building information modeling (BIM) and modular construction

Examples/Highlights:

Companies like Caterpillar are integrating IoT and AI into their construction machinery for better efficiency

10.

SECTOR: RETAIL

Nuances:

Customer-centric adoption for supply chain optimization and customer experience

Examples/Highlights:

Amazon's use of robotics and AI in logistics and warehousing is a model

The Way Forward – Overcoming Complexities and Paving the Path to *Digital Transformation*

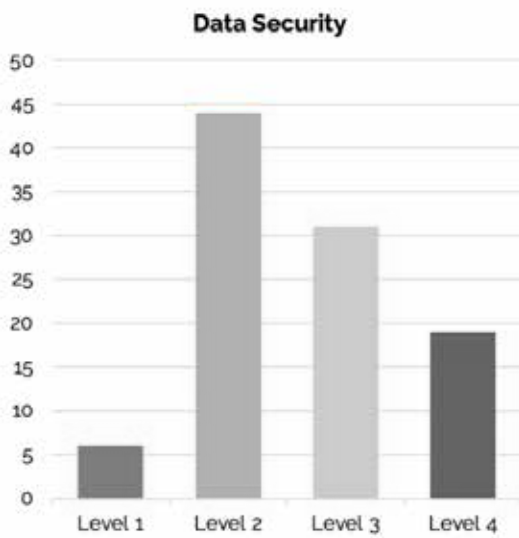| S.NO	COMPLEXITY	CRITICAL ASPECTS
1	Digital Transformation Challeng Workforce Readiness and Skill Gapses	• Integrating with new age technologies • Upgrading or replacing legacy systems • Developing training programs which are effective, timely and scalable. • Shortage of skilled workers proficient in new digital technologies
2	Cybersecurity Risks	• Enhanced connectivity leads to increased exposure to cyber threats. • Developing robust cybersecurity protocols
3	Supply Chain Complexity	• Global supply chains are exposed to numerous vulnerabilities. • Implementing smart supply chain technologies can be complex and resource-intensive
4	Regulatory Compliance and Standards	• Staying compliant with international standards and regulations • Varying global data protection laws is critical and complex
5	Sustainability and Environmental Concerns	• Implementing sustainable manufacturing practices while maintaining efficiency and profitability is a strategic challenge • Regulatory Pressure and Corporate Responsibility
6	Cultural and Organizational Change	• Managing multilayered cultural and operational change • Creating a culture that consistently embraces innovation
7	Investment and ROI Concerns	• Onboarding stakeholders to invest in Industry 4.0 technologies can be difficult • Long-term Strategic Planning requires strategic foresight and careful planning

Building digital trust should be a top priority
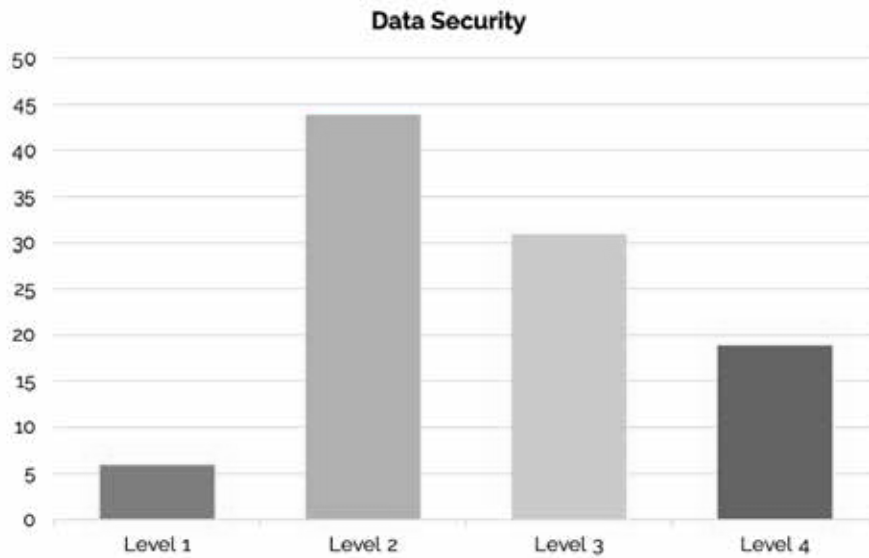
Data Security

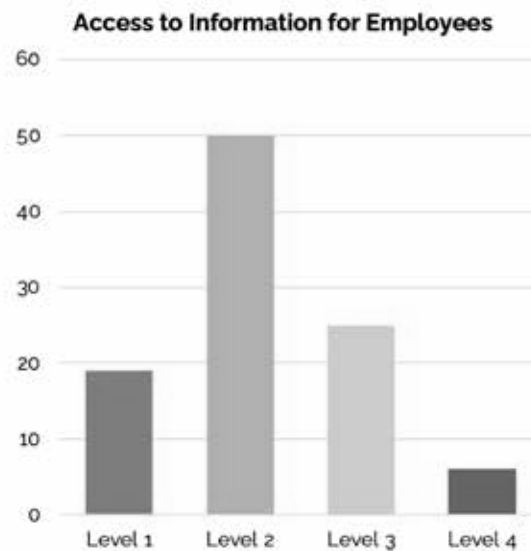| Level	Value
Level 1	6
Level 2	44
Level 3	31
Level 4	19

*Level 1 represents lowest maturity level and Level 4 highest maturity level

40% More than 40% organization have maturity level 2 in data security

Most important concern was operation disruption due to data breach

Data Security

Level	Value
Level 1	6
Level 2	44
Level 3	31
Level 4	19

Access to Information for Employees

Level	Value
Level 1	19
Level 2	50
Level 3	25
Level 4	6

*Level 1 represents lowest maturity level and Level 4 highest maturity level
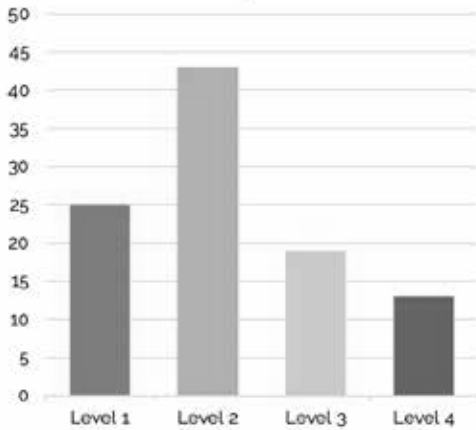
40% More than 40% organization have maturity level 2 in data security

70% More than 70% organization have maturity level 1 &level 2 in accessing information
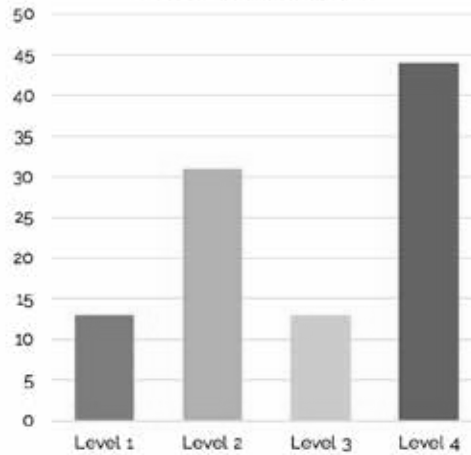
Companies need to expand their **use of big data**

Organization need to expand Big data foot print

Level	Value
Level 1	25
Level 2	43
Level 3	19
Level 4	13

Cloud Solution Usage

| Level	Value
Level 1	13
Level 2	31
Level 3	13
Level 4	44

* Level 1 represents lowest maturity ever and Level 4 highest maturity level

50% More than 50% surveyed organizations have Level 1 & 2 maturity

Organizations will need to use data in predictive, forward-looking ways that make sense of market developments

Robust, **enterprise wide data analytics** capabilities require significant change

Low enterprise wise analytics capabilities

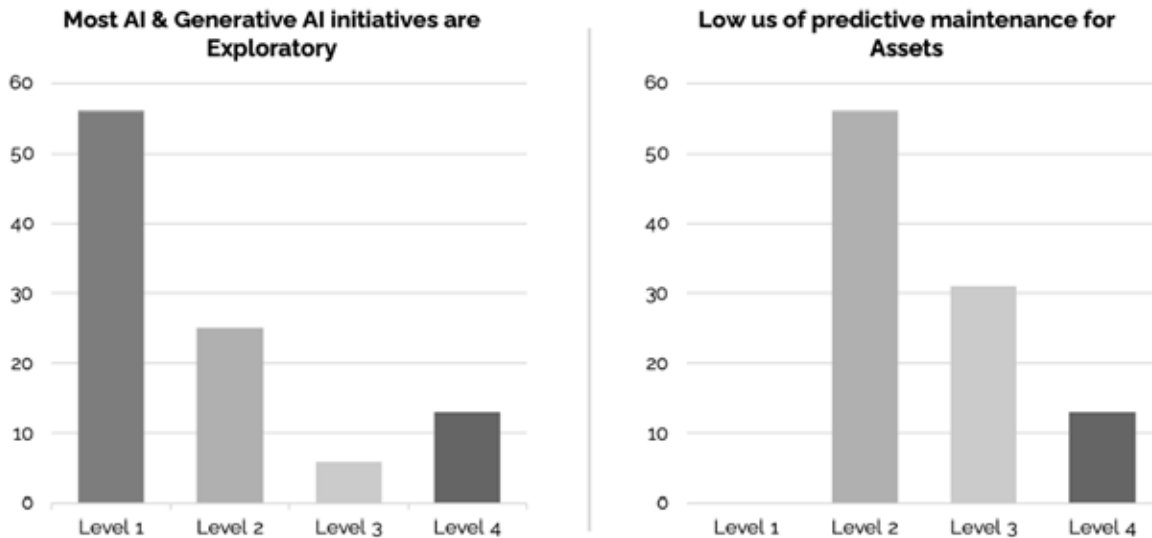| Level	Value
Level 1	6
Level 2	56
Level 3	19
Level 4	19
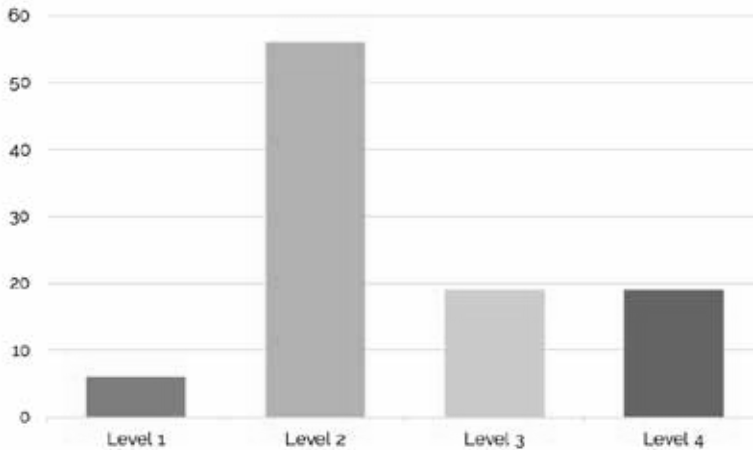
* Level 1 represents lowest maturity level and Level 4 highest maturity level

60% More than 60% surveyed organizations don't yet have mature data analytics capabilities

56% 56% percent of respondents are at Level 2 maturity of Data Driven decisions.

AI needs to be integrated into **the company strategy**

Most AI & Generative AI initiatives are Exploratory

* Level 1 represents lowest maturity level and Level 4 highest maturity level

### Low us of predictive maintenance for Assets

* Level 1 represents lowest maturity level and Level 4 highest maturity level

56% 56% percent of the respondents have indicated Level 1 (Exploratory) maturity for GenAI

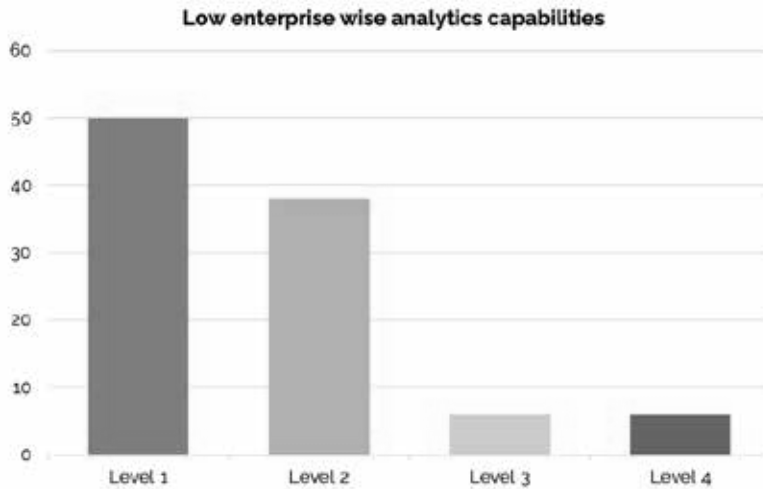**55%** More than 55% have no clear predictive maintenance plans using technology

Bridge the pronounced gap in **Sustainability Practices**

Low Employees training on Industry 4.0
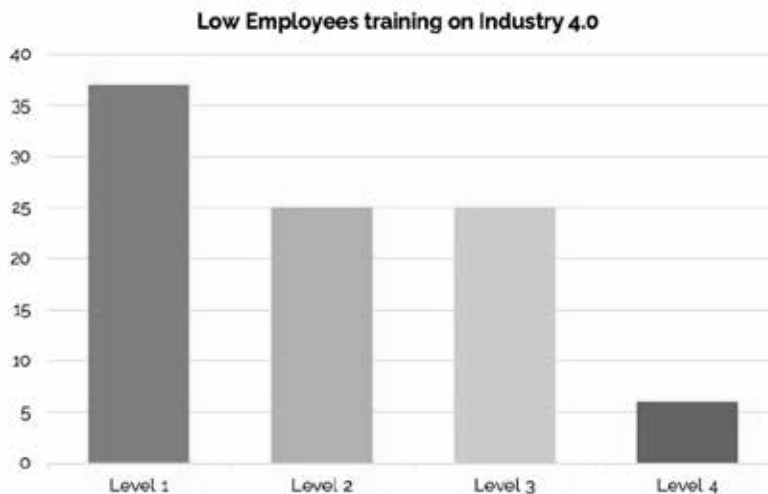
* Level 1 represents lowest maturity level and Level 4 highest maturity level

60% More the 60% have no formal training on Industry 4.0

Organizations to invest in Upskilling

Low enterprise wise analytics capabilities

Bar chart showing maturity levels:
- Level 1: 50
- Level 2: 38
- Level 3: 6
- Level 4: 6

*Level 1 represents lowest maturity level and Level 4 highest maturity level

80% 80% of the respondents have relatively low levels of maturity while tracking & reporting energy

50% 50% are either not tracking energy consumption by the machines

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Forging Inclusive Futures & Accelerating Manufacturing in the Industry 4.0 Era

Tailored Education &Training Programs
Bridging digital literacy and technical skills gaps with accessible, affordable programs tailored to minority

Collaborative Growth
Fostering Partnerships with larger corporations, technology providers, and academic insttutions

Promoting peer learning networks

Supportive Ecosystem
Developing Incubators, Accelerators, Innovation hubs

Helping leverage government and community initiatives offering funding, training

Access
Develop customised, scalable, and affordable technology solutions

Collaborating with financial institutions and government agencies

Policy Advocacy
Championing policies that foster digital transformation including advocating for government contracts and inclusion in national strategies.

Strategic Recommendations for
Industry 4.0 Readiness

Significant Investments for Significant Impact: The Moment to Pledge is Now

Allocate substantial resources to transformative technologies that promise substantial ROI and competitive advantage.

Comprehensive Data Analytics Across the Organization: Essential for Transformation

Implement comprehensive data analytics solutions across all organizational levels to unlock valuable insights and drive decision-making.

Data Analysis and Digital Trust: Fundamental Elements of Industry 4.0:

The Pillars of Industry 4.0: Build robust data management and security protocols to establish a reliable digital ecosystem, fostering innovation and efficiency.

Leveraging AI and Generative AI: Stay Ahead of the Curve: Embrace AI and generative AI tools to enhance predictability, optimize operations, and gain a competitive edge in rapidly evolving markets.

Prioritizing People and Culture:

The Heart of Transformation: Invest in people by fostering a culture of continuous learning, adaptability, and innovation, ensuring your workforce is equipped and motivated to drive and sustain transformation.

www.aimplify.tech

Annexure

References

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3. Vilnius Tech - Assessing Industry 4.0 Maturity, 2023
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6. ERIA - Industry 4.0 and Circular Economy and Industry 4.0 Assessment Tool, 2020
7. Asian Productivity Organization - Handbook, 2022

Acknowledgments and Appreciation

As we conclude this insightful journey into the transformative world of Industry 4.0 and its implications for the diverse manufacturing supply chain, we extend our deepest gratitude to all those who made this research possible.

First and foremost, our heartfelt thanks go to the Diverse Manufacturing Supply Chain Alliance (DMSCA) for commissioning this important study. Your commitment to fostering diversity, innovation, and excellence within the supply chain ecosystem serves as a beacon of inspiration for the industry.

We are equally grateful to Aimplify.tech, our esteemed research partner, whose expertise and innovative approach have been instrumental in navigating the complex landscapes of Industry 4.0 technologies. Your collaboration has not only enriched this research but also set a new standard for excellence.

To all the survey participants, your invaluable contributions have provided the cornerstone for our findings. Your perspectives and experiences have brought to light the challenges and opportunities that lie ahead for the industry. We thank you for your time, your honesty, and your commitment to advancing the manufacturing sector.

We also extend our appreciation to the team of researchers, analysts, and contributors who worked tirelessly behind the scenes. Your dedication, expertise, and attention to detail have been pivotal in bringing this report to fruition.

Lastly, but by no means least, we thank our readers and the broader industry community for your interest and engagement. It is our hope that this report not only informs but also inspires action and collaboration towards a more inclusive, efficient, and innovative future for manufacturing.

As we look to the horizon, let us carry forward the insights and recommendations from this report with a shared commitment to embracing the potential of Industry 4.0. Together, we can pave the way for a more diverse, resilient, and prosperous manufacturing landscape.

DMSCA
DIVERSE MANUFACTURING SUPPLY CHAIN ALLIANCE
ALIGN · COLLABORATE · ACCELERATE

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