LTIMindtree

Whitepaper

Impact of Generative AI in Transforming Industrial Manufacturing

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Industry 5.0: An Opportunity for Manufacturers

Industry 5.0 will leverage the strengths of both human and machine to improve manufacturing processes. With the advent of Industrial IoT, machines today are generating few Petabytes of data every second which is expected to grow into few Zettabytes of data by 2030. Approx 29.5 billion [1] IoT devices are expected to be available by 2030.

The amount of data which will be available will be beyond comprehension of any human being. It will be extremely difficult for any human being to use Analytics engines to gain insights from such a huge volume of data without the use of any advanced AI capabilities. It is also to be noted that all data which the machines will generate will not be good data. We would need very high computing power to identify the good data vs bad data and cleanse and enrich the data to generate insights from it.

For Industry 5.0 to function properly and to leverage such a huge volume of data, along with functioning of people and to add resilience and sustainability goals it will be imperative to embark on next gen data and analytics capabilities who wants to make fast decision to augment the manufacturing process to cater to ever changing customer & business needs.

To leverage true Industry 5.0 not only analytics systems, need to be capable of analyzing & processing large volume of data, but also person at the ground level should be capable of generating insights from these data sets to take on-the ground instantaneous decisions without using complex analytics tools to enhance the productivity of manufacturing process for a quick turnaround.

What is required to make Industry 5.0 a Success?

Industry 5.0 will require technology which can leverage the power of humans and machines.

Generative AI bridges this gap by analyzing large sets of data using LLM and by providing insights to enhance productivity and reduce cost. The stakeholders in the manufacturing process will be able to gain insights based on textual input and take instantaneous real time decisions & actions to enhance shop floor productivity which will have direct / indirect impact on optimizing costs.

According to MarketResearch.Biz, the Generative AI in Manufacturing Market is projected to surpass around USD 6,398.8 Million by 2032, and it is poised to reach a registered CAGR of 41.06% from 2023 to 2032. [2]

In 2022, the global generative AI in Manufacturing Market was worth USD 223.4 Million, which will be an increase of 28X in Market size in 9 years.

Global AI market size is expected to become approximately $1.84 trillion by 2030 [3], as the Global market grows, companies will leverage the AI tools and find new ways to solve complex problems and drive innovation.

Why an Industrial Manufacturer should be interested about Generative AI

The main utilization of Generative AI will be in the spheres of Product Designing, Predictive Maintenance, Prototyping & Quality control. The usage of Generative AI will also be helpful for Supply chain team to optimize end to end supply chain based on the changing customer demands without waiting for insights to come from market.

Generative AI, when utilized effectively, can revolutionize, and positively influence every stage of the production process, from initial design to final product.

Industrial Manufacturers who adopt Generative AI will experience a significant gain in productivity, innovation & efficiency.

The end-to-end manufacturing process generates huge amount of data with multiple variables which becomes extremely difficult for individuals to analyze and create insights, however Machine Learning along with Generative AI will help with easy prediction of extremely complex scenarios and to predict for any incident occurrence based on actual data points.

How Generative AI can be beneficial to increase the productivity & reduce cost

We have observed that in the manufacturing value chain, there are many bottlenecks/optimization opportunities due to which organizations lose revenue or fail in optimizing cost.

The below diagram shows various challenges faced by organizations in their value chain due, which it becomes an opportunity loss.

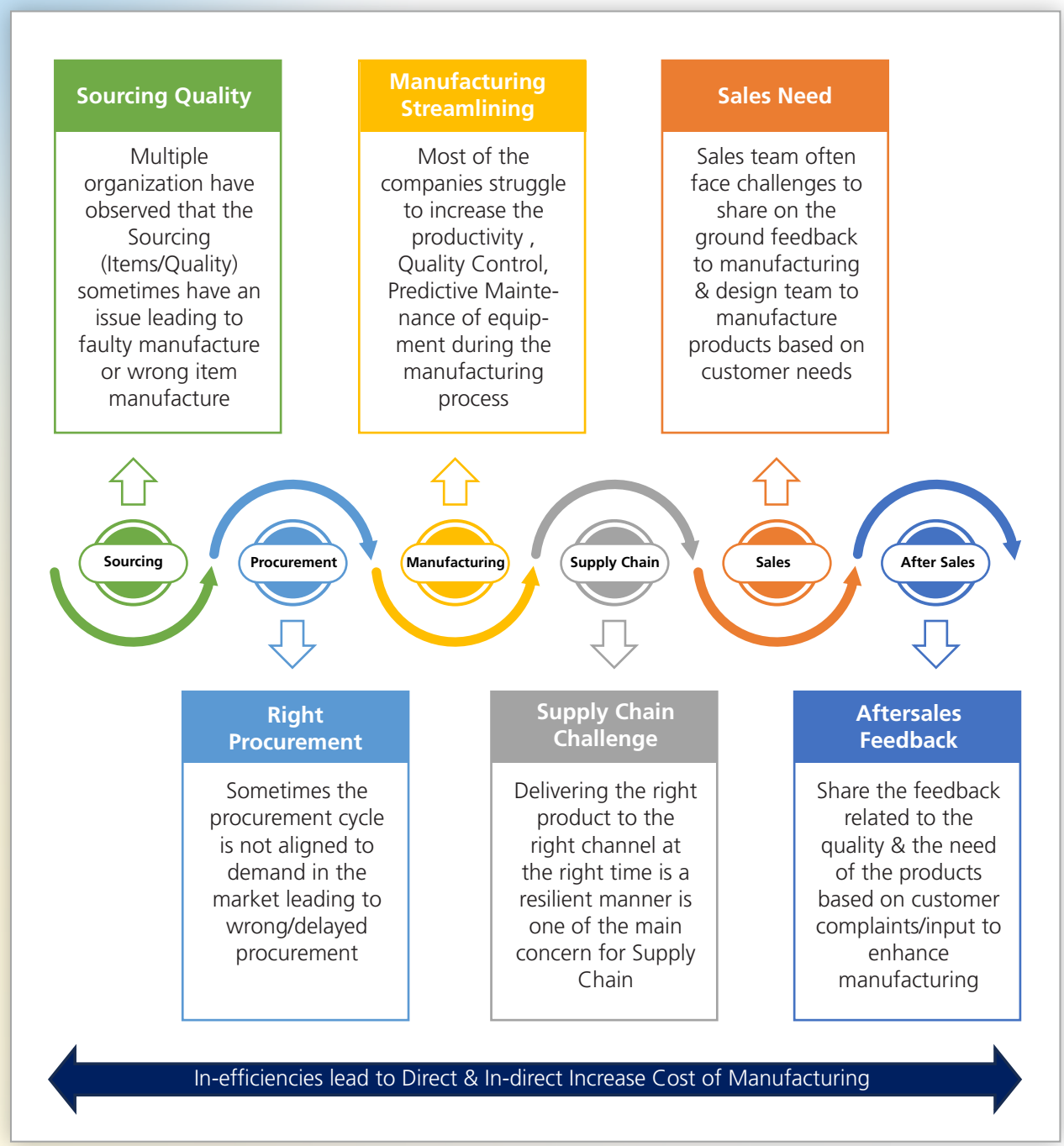

Fig 1. Challenges Faced by Companies in their Value Chain

Generative AI in tandem with Machine learning algorithm can work across the value chain to provide insights to the manufacturing unit to optimize / reduce cost and increase productivity.

Generative AI assumes a central role in the vital components of Production, orchestrating a synergy of innovation and efficiency across the entire manufacturing landscape.

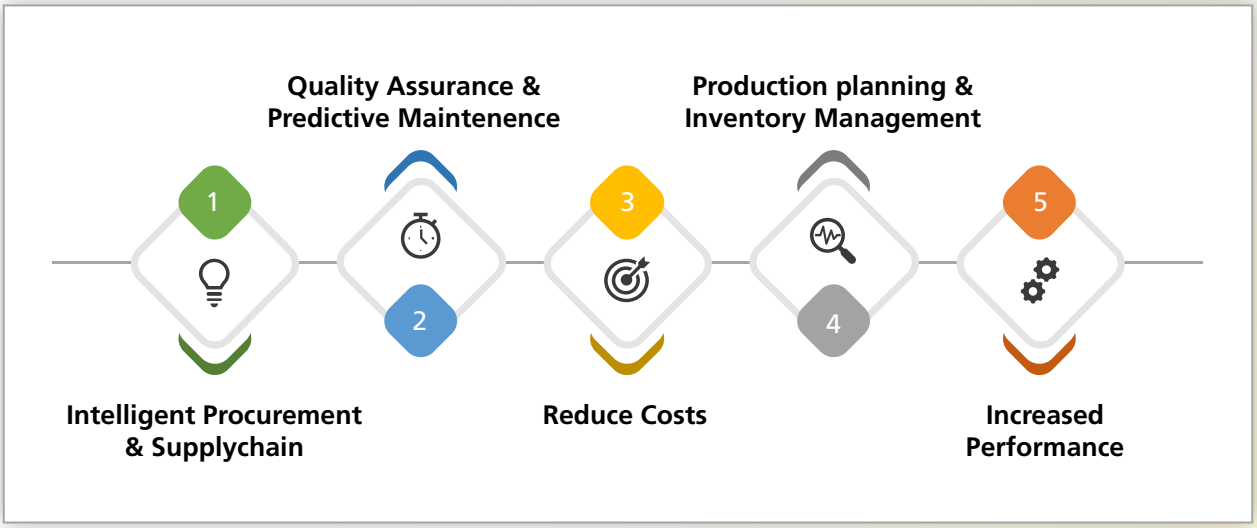

Fig 2. High Level uses cases of GenAI in Manufacturing

Implementation of Generative AI will have a positive impact on all the Use cases.

Based on our experience here is a list of Use cases across all value chains which any manufacturer can look at while implementing Generative AI. In the ensuing sections, we shall delve into the intricacies of implementing Generative AI applications, offering guidance on how to successfully integrate these cutting-edge technologies into your organization's operations.

Note – This list of use cases is a representative list and not an exhaustive list.

Sourcing Quality

- Regulatory compliance assurance
- Rapid material discovery for advanced production materials
- Supplier quality assessment and selection
- Quality prediction for raw materials to enhance sourcing decisions

Right Procurement

- Product design optimization
- Material composition optimization
- Demand forecasting and inventory management
- Warranty claims prediction through product usage analysis
- Smart material selection for lightweighting and cost savings
- Predictive analytics for identifying potential vendor disruptions

Manufacturing Streamlining

- Assembly sequence planning
- Toolpath optimization
- Virtual prototyping
- Rapid prototyping
- Production scheduling
- Automated inspection planning
- Pro-active Defect detection
- Predictive maintenance
- Production line balancing for efficiency
- Process visualization through AI-generated graphics
- Root cause analysis of production issues
- Continuous improvement identification
- Material waste reduction
- Tool wear prediction for efficient tool replacement planning
- Facility layout optimization
- Real-time quality control and defect sorting in production lines
- Production yield optimization
- Real-time equipment performance monitoring and anomaly detection
- AI-generated real-time dashboards for production status tracking
- Simulation-based workforce

Supply Chain Challenge

- Supply chain management optimization
- Simulation for process optimization
- Supply chain visibility in real-time
- Inventory management optimization
- Packaging design optimization for cost-effective shipping
- Real-time tracking of work-in-progress inventory
- Data-driven optimization of supply chain routes for cost reduction

Sales Need

- Automated documentation generation
- AI-generated process flowcharts for training and documentation

Fig 3. Representative List of Use Cases of GenAI in Manufacturing across

All of the mentioned use cases have an impact on the manufacturing. Generative AI will be instrumental in informing strategic decisions across a spectrum of applications that either directly or indirectly influence the manufacturing process, or which have a significant bearing on production costs.

Through the below example of "Day in a Life of a Manufacturing Unit Head" you will get to understand how Generative AI will help in day-to-day decision making for cost effective & better manufacturing process.

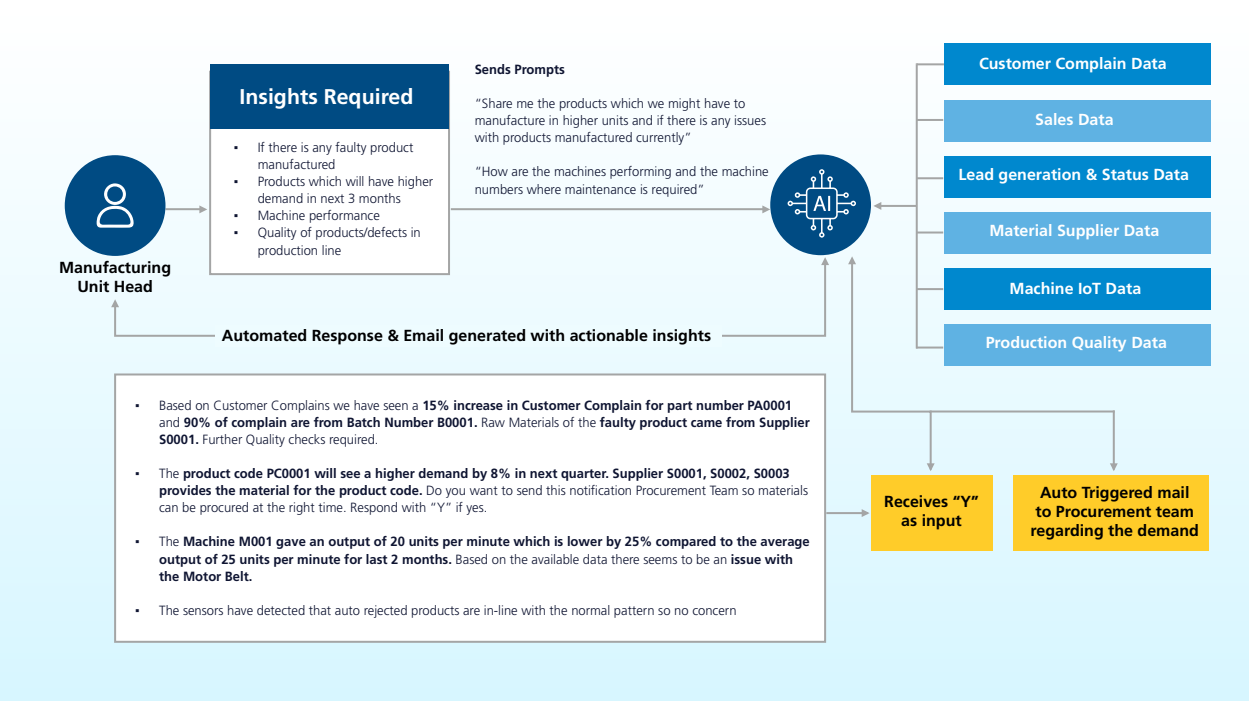

Fig 4. Day in a Life of a Manufacturing Unit Head

The implementation of Generative AI not only provides the output based on multiple data points, but also provides insights and actions which become difficult or time consuming with current analytics engines. Also, with a single prompt from the Manufacturing Unit Head, the Generative AI engine is capable of analyzing large sets of structured and unstructured data quickly and provides an output.

This easily comprehendible, fast output will help people across the industrial manufacturing value chain to take decisions faster and in an efficient manner.

How manufacturers can prepare themselves to use Generative AI

The landscape of Generative AI is quickly changing with new foundation models being developed every day. It's imperative to say that Data is the bedrock of Generative AI Models to pretrain. Bad data will lead to bad training and hence unusable outcomes. Apart from the availability of Data the major concerns that most organization voice out is related to Adoption due to low or lack of trust and in terms organization wide deployment. There are apprehensions among the organization related to Use Cases and determining RoI for Generative AI initiatives.

In this section we will discuss how you need to prepare yourself for implementing Generative AI, the maturity model that you need to look at and the pitfalls that you need to be careful about. During our interactions with multiple clients across multiple domains. The most common questions that we get during various phases of implementations are:

I. Conceptualization Phase

a. What specific task will Generative AI tackle which can't be done now?
b. What kind of value will Generative AI provide to the end users?
c. What data sources will be used to train the AI Model?
d. How will the data be pre-processed and cleaned to make it suitable for training?
e. Which generative AI model architecture is most suitable?
f. How will the system handle increased usage & scaling requirements?
g. What performance matrix will be used to evaluate GenAI output?
h. How will you ensure the security of data?
i. What is the budget for developing and maintaining this Gen AI system
j. What is the expected RoI for the implementation?
k. How will the feedback be gathered from users and incorporated for improvements?

II. Socialization & Use Case / User Story creations

a. What quality of data is required to use it in the model?
b. What ethical considerations are associated with the use of AI in this context of use case?
c. How the biasness and fairness will be handled in the AI system?
d. How will the users interact with the generative AI model?
e. How will the Generative AI enhance the user experience?
f. How the user privacy or how will the data be used and processed to comply with regulatory requirements?
g. How can the user help in fine-tuning the model based on the on-the-ground requirements?
h. How will Generative AI provide unique value?
i. How will the Generative AI fit into boarder long term business requirements?

III. Implementation

a. What will be the training method which will be used?
b. Is the model pre-trained or custom-trained for use case?
c. What hyperparameters and training techniques will be used?
d. How data moderation will be done to anonymize it?
e. What are the prompt engineering options?
f. Which foundation models and framework will be used?
g. What tool will be used to implement end-to-end observability?
h. What technologies or components will be used to implement strong access control?
i. Custom experiences we can build on top of GenAI?

None of the answers to the question above has any standard answers as it depends on organization to organization based on the data maturity level.

Before we embark on the journey of adapting Generative AI, it's imperative to understand how it is different from Traditional ML Models

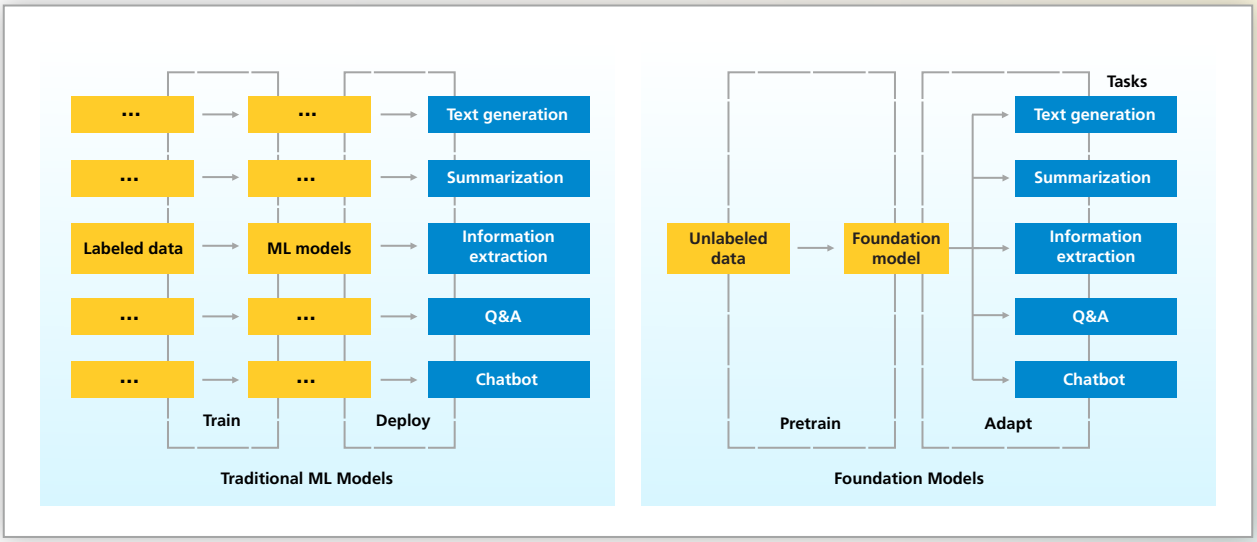

Fig 5. Difference between Traditional ML Model vs Foundation

Traditional ML models rely on Labelled data; however, the Generative AI foundation models rely on unlabeled data, The models need to be pre-trained with these Unlabeled data and this is one of the most important aspects of deploying Generative AI.

If an organization wants to realize fast returns, they can start with off the shelf Foundation models, These Foundation models need to be customized and trained with their own data to support their specific use cases.

Initiatives that an organization needs to take now to jumpstart the journey.

Manufacturers need a detailed planned approach to implement Generative AI. Here are the suggestive key stages which a manufacturer needs to follow to harness the full potential of GenAI and to make it future proof in terms of implementation.

1. **Generative AI Literacy:** The first and foremost requirement is organizational level GenAI literacy involving all functions like Business, Finance etc. so to make them aware of the art of possibilities and what is possible and not possible in GenAI. Workshops, online courses or training from experts help in bridging the gap for GenAI.

2. **Data Collection & Curation:** Data is the bedrock for implementation of Generative AI models. Data can make or break the initiative. Hence it becomes extremely important for a manufacturer to collect and curate relevant data from various sources. A detailed data exploration engagement needs to be performed to understand the available sources of data and the data needs for Generative AI. Data needs to be cleansed and enriched and standardized before the use for GenAI models.

3. **Data Preprocessing:** If we want to reduce biased or inaccurate results then we must pre-process the data to reduce noise and perform data normalization.

4. **Use Case Identification:** This is one of the key points for a successful Generative AI engagement. Since Generative AI has a wide range of applications, it is important for a manufacturer to choose the right use cases to start with. We recommended selecting 3-5 use cases and training the model and extract output and stabilize it before trying to implement a wide range of use cases.

5. **Tool Selection:** Basis the use cases the right tools, AI frameworks, libraries need to be selected after a detailed due diligence. This is an extremely critical point as if wrong tools/frameworks/libraries are selected the output that will be generated will be wrong and it might have a huge impact on outcome based decisioning. While choosing the tools one needs to be ensure that it should align with the organization's technical capabilities and future goals.

6. **Model Development:** Developing effective Generative AI models involves choosing appropriate architectures. VAEs (Variational Autoencoders), GANs (Generative Adversarial Networks), and other models can be explored based on the specific use case. Manufacturers might need to collaborate with AI experts or hire AI talent to develop these models.

7. **Security and Privacy Considerations:** Handling sensitive manufacturing data requires robust security measures. Manufacturers must implement encryption, access controls, and other cybersecurity measures to protect their data and comply with regulations like GDPR and HIPAA.

8. **Training and Optimization:** Training Generative AI models requires significant computational resources. The models learn patterns and generate outcomes based on the input data during this phase. Manufacturers should experiment with hyperparameters, model architectures, and training algorithms to achieve the desired results.

9. **Validation and Testing:** Validation and testing ensure that the Generative AI models produce accurate and meaningful outcomes. Manufacturers need to establish metrics for evaluating model performance and conduct thorough testing using both real-world and synthetic data.

10. **Integration and Deployment:** Once validated, Generative AI models should be integrated into the manufacturing process. This could involve developing APIs or integrating the models into existing software systems. Seamlessly integrating the AI-generated insights ensures a smooth transition from theory to practice.

11. **Monitoring and Maintenance:** Generative AI models are not static; they require continuous monitoring and maintenance. Manufacturers need to monitor the performance of the models in real-world scenarios and update them as needed to adapt to changing requirements.

Generative AI technology is dynamic and evolving. Manufacturers must stay adaptive and open to incorporating advancements to ensure their solutions remain cutting-edge. Embracing a culture of continuous improvement facilitates innovation and long-term success.

In conclusion, Generative AI presents manufacturers with a powerful toolkit to innovate, optimize, and create. By adhering to a well-defined strategic blueprint that encompasses educational initiatives, data management protocols, model development, and seamless integration, manufacturers can harness the power of Generative AI to revolutionize their operational frameworks, secure a competitive advantage, and play a pioneering role in shaping the future of the industry.

How manufacturers can prepare themselves to use Generative AI

We recommend an organization to start small with basic use cases and foundational model and slowly migrate to advanced level.

Before embarking on the journey, it's extremely important for an organization to understand the appetite for implementation of Generative AI. Every organization needs to evaluate themselves on the below parameters to understand what, why and how they should embark on Generative AI journey.

This helps to mitigate any risks associated with output of GenAI and organization level acceptance of Gen AI initiatives.

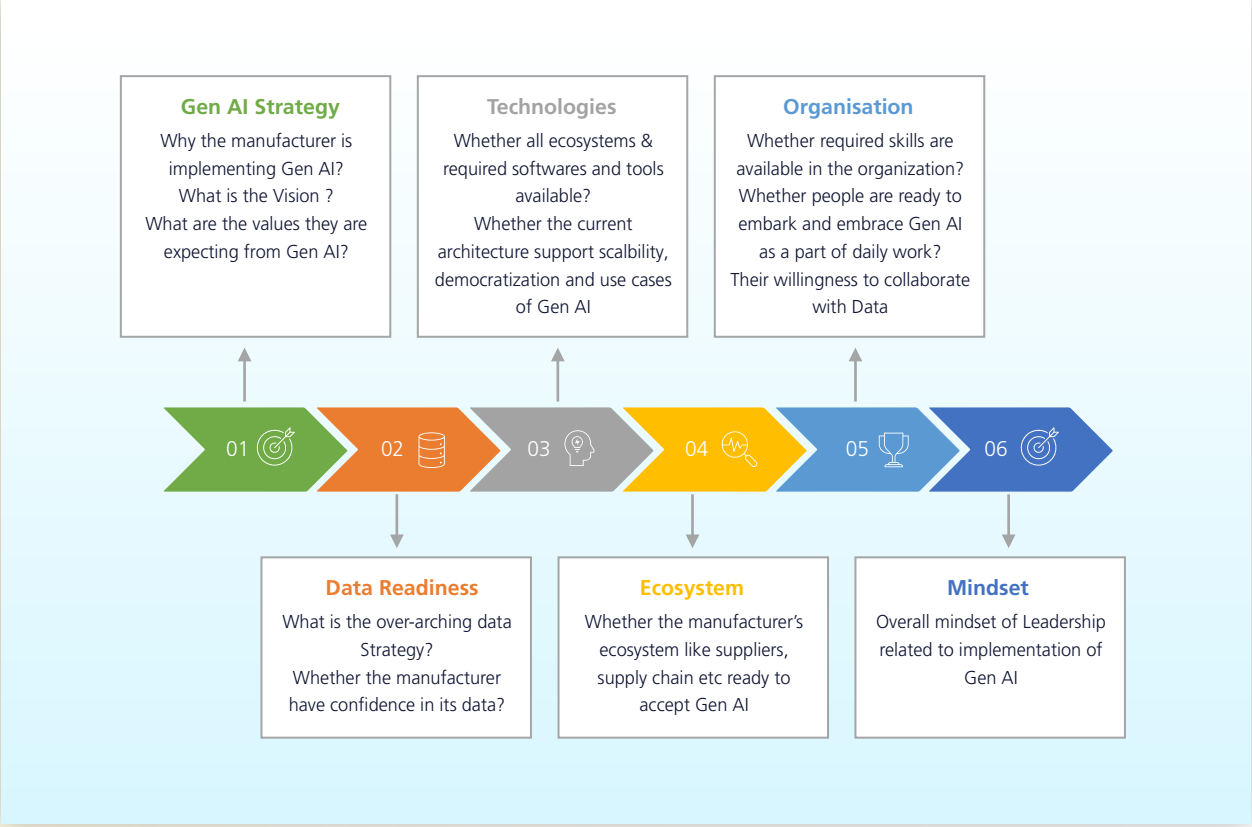

Fig 6. Basic Questions to ask before embarking on GenAI Journey

Once the industrial manufacturer understands the overall strategy, vision and value creation from implementation of Generative AI, it is extremely important for an organization to start with the exploration stage. If an organization tries to jump start with "Building" or "Innovation" stage, there are a high chance of failure.

Generative AI journey needs to be taken in small steps and then leapfrog to Innovation stage. This ensures not only the organization is aware of the value derived from this implementation but also enables the organization to stabilize the data and the model requirements.

For any industrial manufacturer to embark on a Generative AI journey, quite a considerable amount of time is required to be spent in Exploration & experimentation phase. This is a phase where an Industrial Manufacturer will not only get to learn but unlearn a lot in the process of implementation of Generative AI.

2-3 Use cases which have a major impact on a particular function/decision making process and where data is available should be picked up at first to start the journey before launching an organization wide Generative AI implementation.

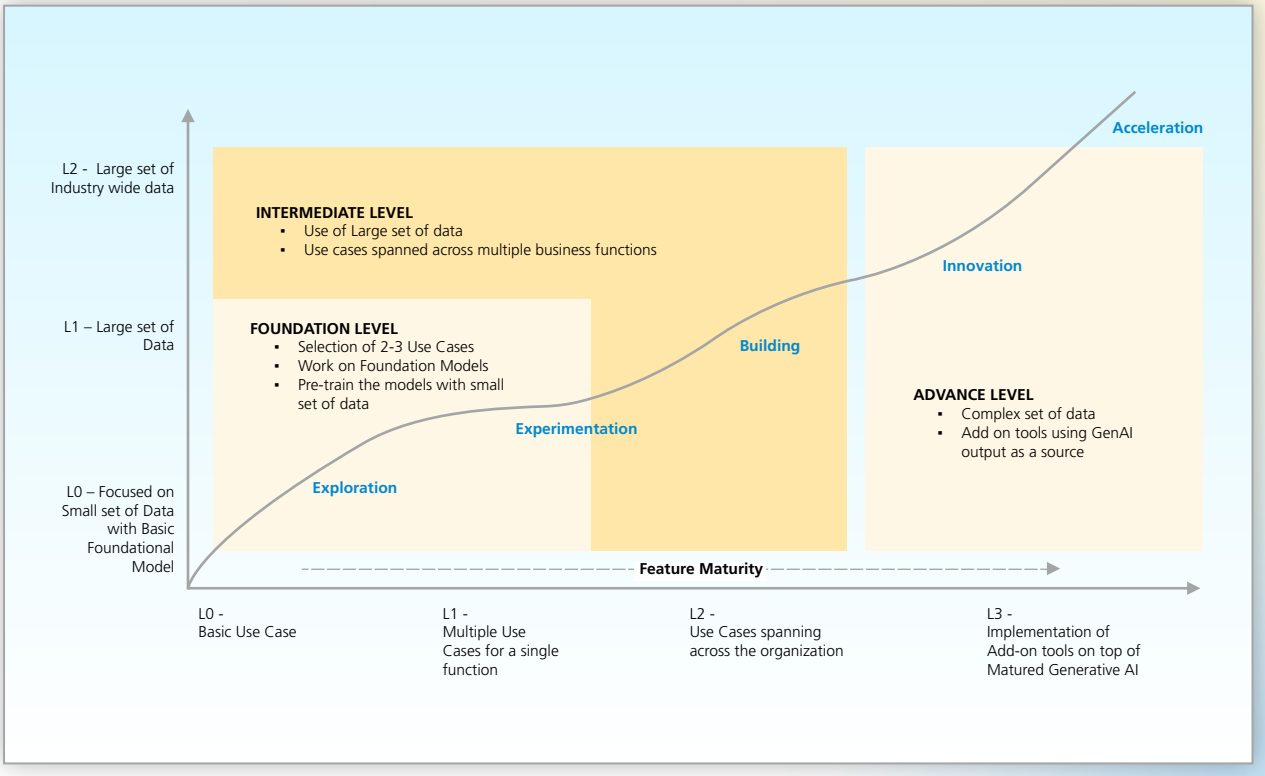

Fig 7. Suggestive Maturity Model Roadmap of GenAI Journey

Pitfalls that an organization need to be aware of in this journey of Generative AI

While implementing Generative AI can provide powerful results, if not done correctly this can be detrimental for any manufacturer. Based on our experience we believe the following are the pitfalls that a manufacturer needs to be aware of before implementing Generative AI.

1. **Data Privacy and Ethics:** Generating content using AI can inadvertently expose sensitive data or create unethical content. It's important to ensure proper data handling and adhere to ethical guidelines.
2. **Bias and Fairness:** Generative AI models can amplify biases present in training data, leading to biased or unfair outputs. Regularly assess and mitigate these biases to maintain fairness.
3. **Quality Control:** Generated content might not always meet desired quality standards. Implement mechanisms for review and control to ensure the output aligns with your organization's standards.
4. **Legal and Copyright Issues:** AI-generated content could inadvertently infringe upon copyright or intellectual property rights. Ensure the generated content doesn't violate any legal constraints.
5. **Resource Intensiveness:** The training and upkeep of Generative AI models necessitate substantial computational capabilities and infrastructure, owing to their inherently complex and data-intensive nature. Be prepared for the associated costs and technical requirements.
6. **Lack of Understanding:** A lack of comprehension regarding the capacities and constraints of the technology can engender exaggerated anticipations and suboptimal deployments, ultimately leading to disappointing outcomes.
7. **Security Concerns:** Poorly implemented AI systems might become vulnerable to attacks, leading to security breaches. Ensure robust security measures are in place.
8. **User Acceptance and Perception:** Users might be uncomfortable or uncertain about content generated by AI. Gradually introduce the technology and provide clear communication about its use.
9. **Overreliance on AI:** A dearth of familiarity with the technology's capabilities and limitations can culminate in unreasonable expectations and inefficient execution, ultimately leading to ineffective results.
10. **Changing Landscape:** AI technology is evolving rapidly. What works today might become obsolete or require frequent updates in the near future. To navigate these pitfalls successfully, it's crucial to have a well-defined strategy, involve experts in AI ethics and technology, and maintain a proactive approach to addressing challenges as they arise.

How Canvas AI can help to jumpstart the Journey

Canvas.ai of LTIMindtree is among the first-of-its-kind platforms designed to help enterprises jump start and scale generative AI capabilities, bolstering business innovation and engineering productivity.

Leveraging a well-architected framework and sound governance measures, Canvas.ai effectively manages proprietary and industry-specific data, while factoring in its ethical use, sustainability, privacy, and security. The platform-based architecture of Canvas.ai caters to the business requirements of three key personas – creators who build the generative AI solutions, admins who manage, and users who consume governed generative AI solutions.

Canvas.ai guarantees up to 40-50% reduction in time and effort for app modernization and cloud migration programs. Canvas.ai comes with Tools & Accelerators which helps power the Generative AI Journey.

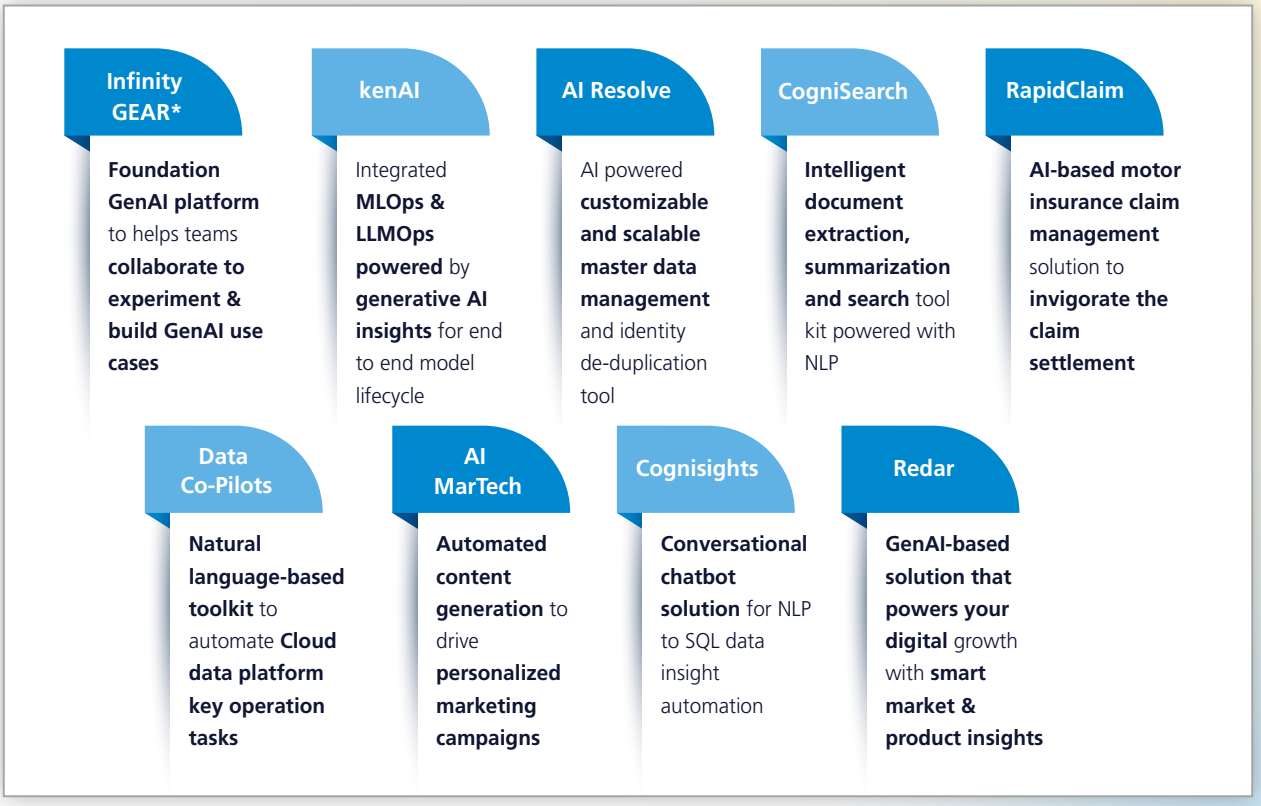

Fig 8. Key Tools & Accelerators Powered by GenAI

With the help of Canvas.ai, LTIMindtree can help any organization to jump start the journey of implementing Generative AI with minimum effort.

Conclusion

Generative AI will transform how industrial manufacturers look at Data in the coming years. Though the technology is at a nascent state the Generative AI models will become more robust providing the exact output. It's evident for any manufacturer to start the journey of Generative AI now to get first mover advantage.

We at LTIMindtree believe that we have all the right skills, tools & accelerators to make this Data & Analytics transformation journey as seamless as possible.

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Arnab Basu has 19+ years of industry experience across manufacturing, banking, travel and hospitality domains. He is experienced in implementing multiple large digital transformation programs, including DW, analytics, Master Data domain and cloud platforms across global clients. As a Senior Director at LTIMindtree he helps customers with their digital transformation journeys. He partners with clients to keep them ahead of competition and to deliver data driven business solutions. He leads large-scale accounts delivering technology solutions for clients and drive business, revenue and people growth for organization that deliver measurable results like improved sales and time-to-market.

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About LTIMindtree

LTIMindtree is a global technology consulting and digital solutions company that enables enterprises across industries to reimagine business models, accelerate innovation, and maximize growth by harnessing digital technologies. As a digital transformation partner to more than 700 clients, LTIMindtree brings extensive domain and technology expertise to help drive superior competitive differentiation, customer experiences, and business outcomes in a converging world. Powered by 82,000+ talented and entrepreneurial professionals across more than 30 countries, LTIMindtree — a Larsen & Toubro Group company — combines the industry-acclaimed strengths of erstwhile Larsen and Toubro Infotech and Mindtree in solving the most complex business challenges and delivering transformation at scale. For more information, please visit https://www.ltimindtree.com/.