

# Internal and External Precursors to Favorable Adoption of Industry 4.0 Technologies

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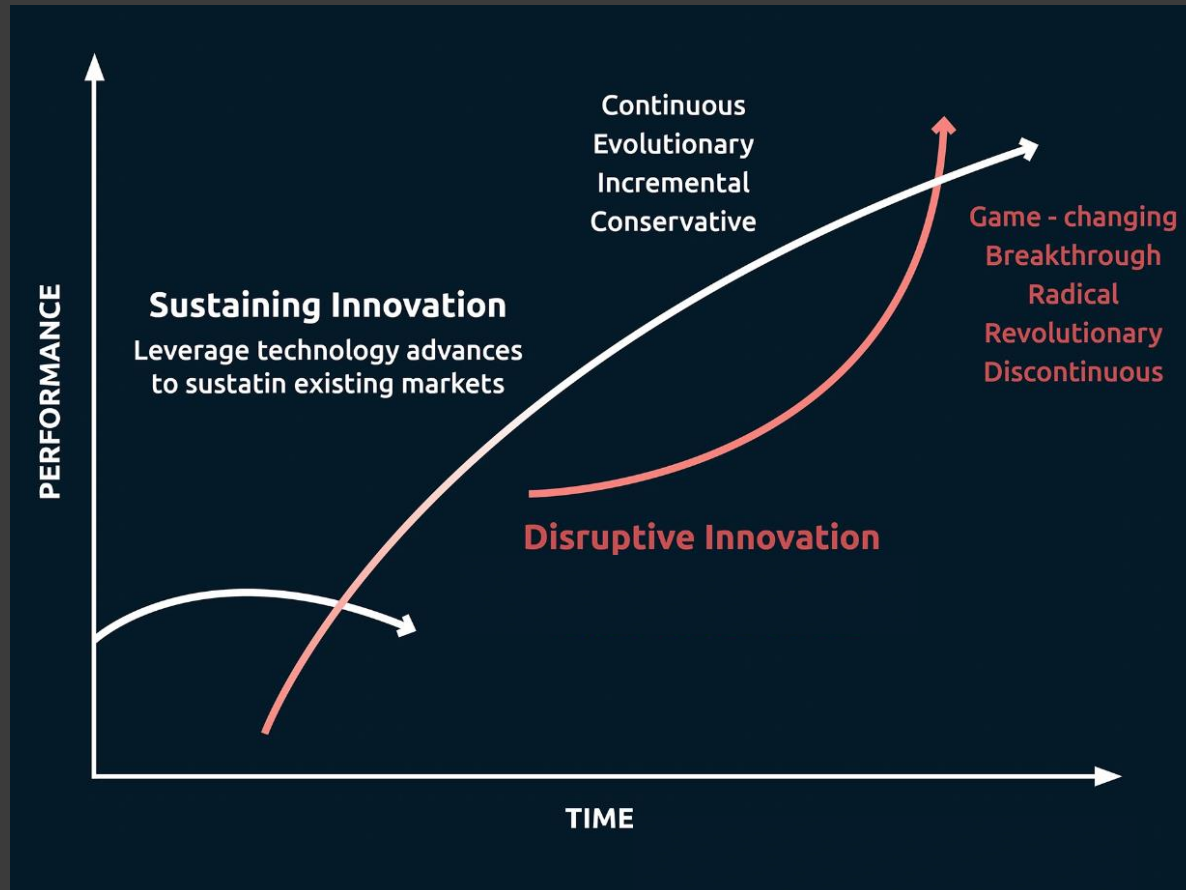
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# Approach to Analysis

1. Due to the recency of Industry 4.0 introduction, the concept is first defined and distinctly characterized
2. Literature is examined to pinpoint the properties, advantages, and drawbacks of Industry 4.0
3. Adoption patterns are examined
4. Factors for adoption considerations are assessed in relation to:
  - A. Urgency
  - B. Importance
5. Based on this, a matrix relating the urgency and importance of factors is created
6. Action plans for Industry 4.0 are examined from a strategic perspective
7. Implications for Industry 4.0 implementation are derived

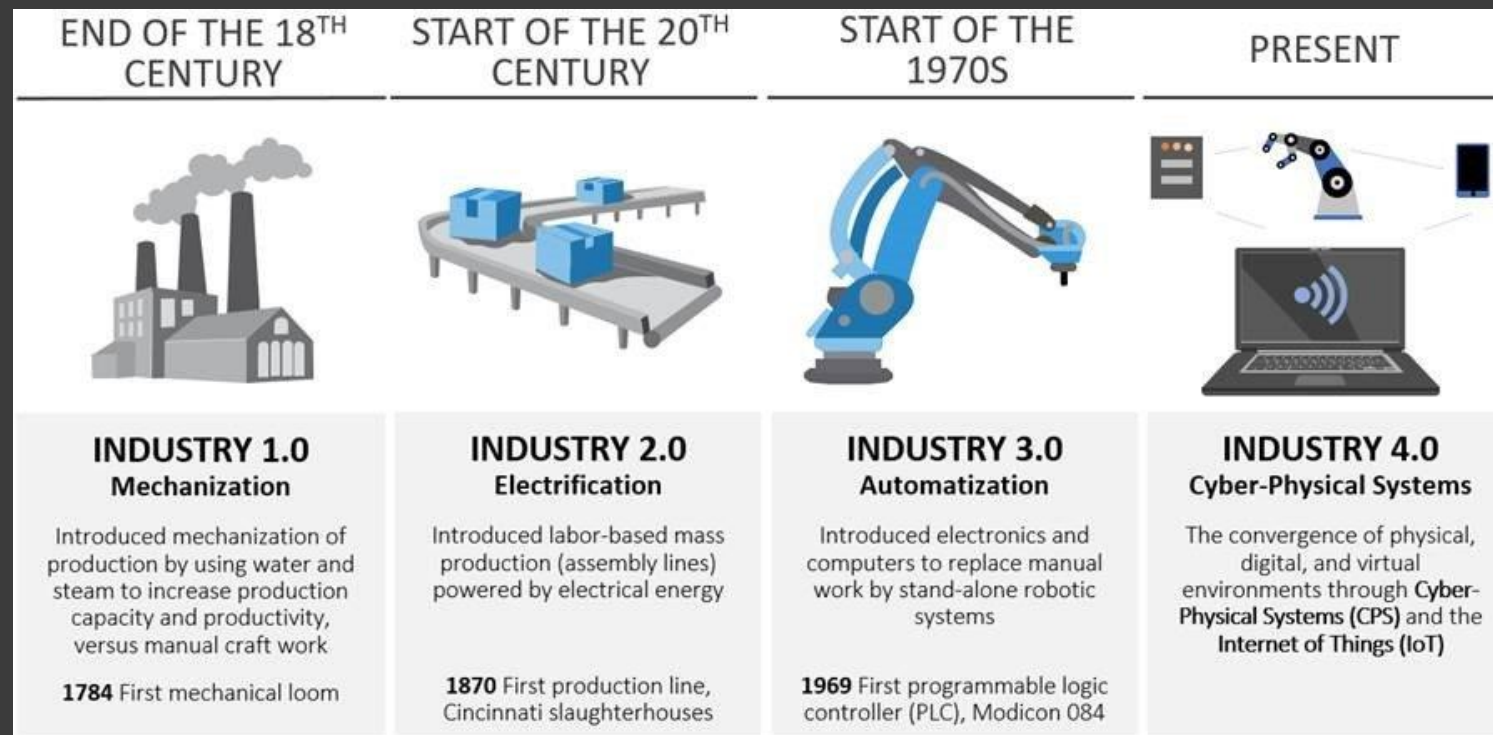
# Patterns in Technological Innovation

- Innovation does not manifest as a slow, methodical process
- The disruptive nature causes “waves” of technological advancement over time



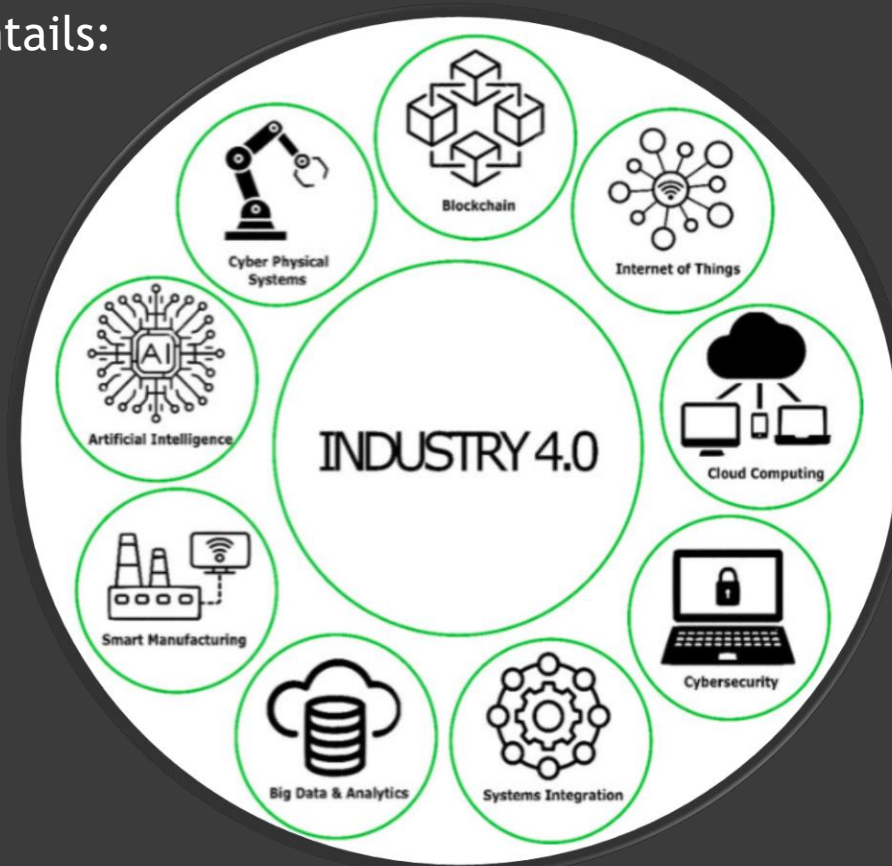
# Industry 4.0 Overview

- Industry 4.0 refers to the modern wave of new technologies
  - In some ways, Industry 4.0 expands upon automation emerging from Industry 3.0 to provide adaptive learning and decision-making capabilities
  - Initial introduction yields disruptive market effects



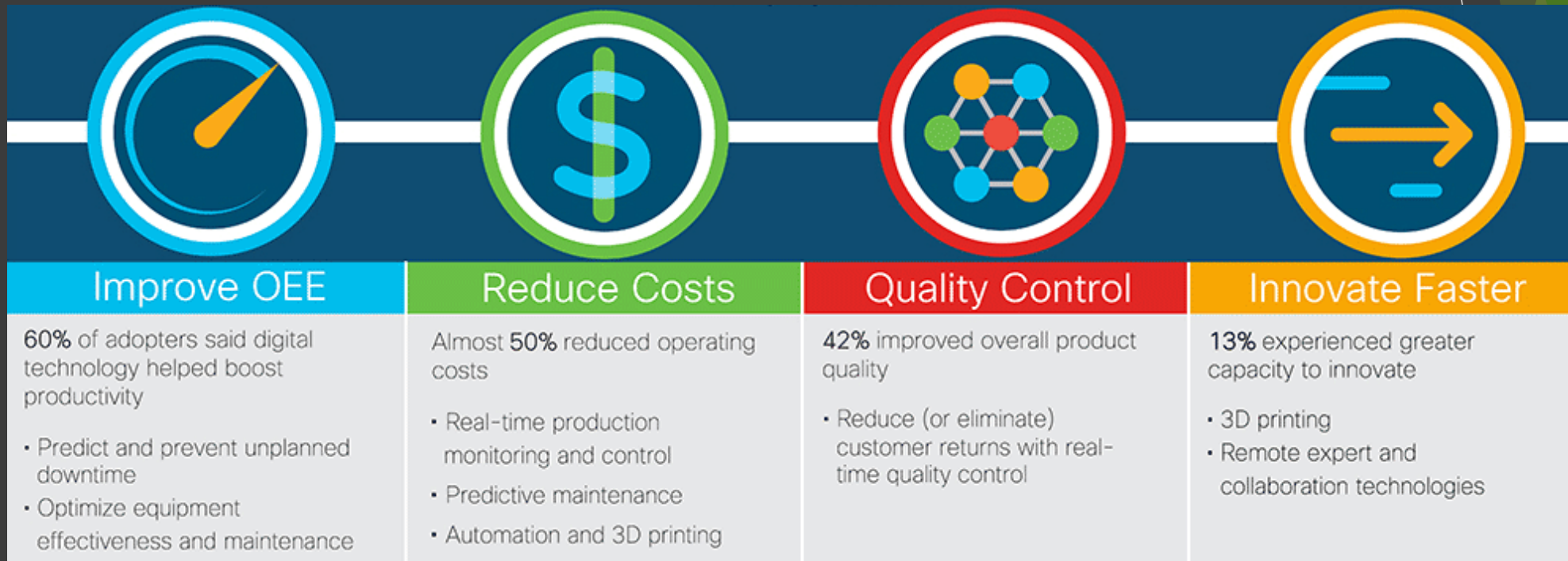
# Industry 4.0 Scope

- Broadly, what does Industry 4.0 entail?
  - Real time learning, predictive, and decision-making capabilities
- Specifically, it entails:



# Span of Industry 4.0 Benefits

- Enhanced organizational capabilities:
  - Adaptiveness
  - Efficiency and Reliability
  - Status visibility of operations



# Span of Industry 4.0 Drawbacks

- Like advantages, drawbacks vary situationally
  - Initial lag in high-level understanding of automated decision processes
    - Sophisticated technology lacks widespread transparency in understanding when initially introduced
  - Initial disruptive effect to operational practices
    - Learning curves exist with all new things
  - Risk in implementation ventures
    - Lack of transparency in outcomes
    - Lack of transparency relative to over-committing or under-committing resources



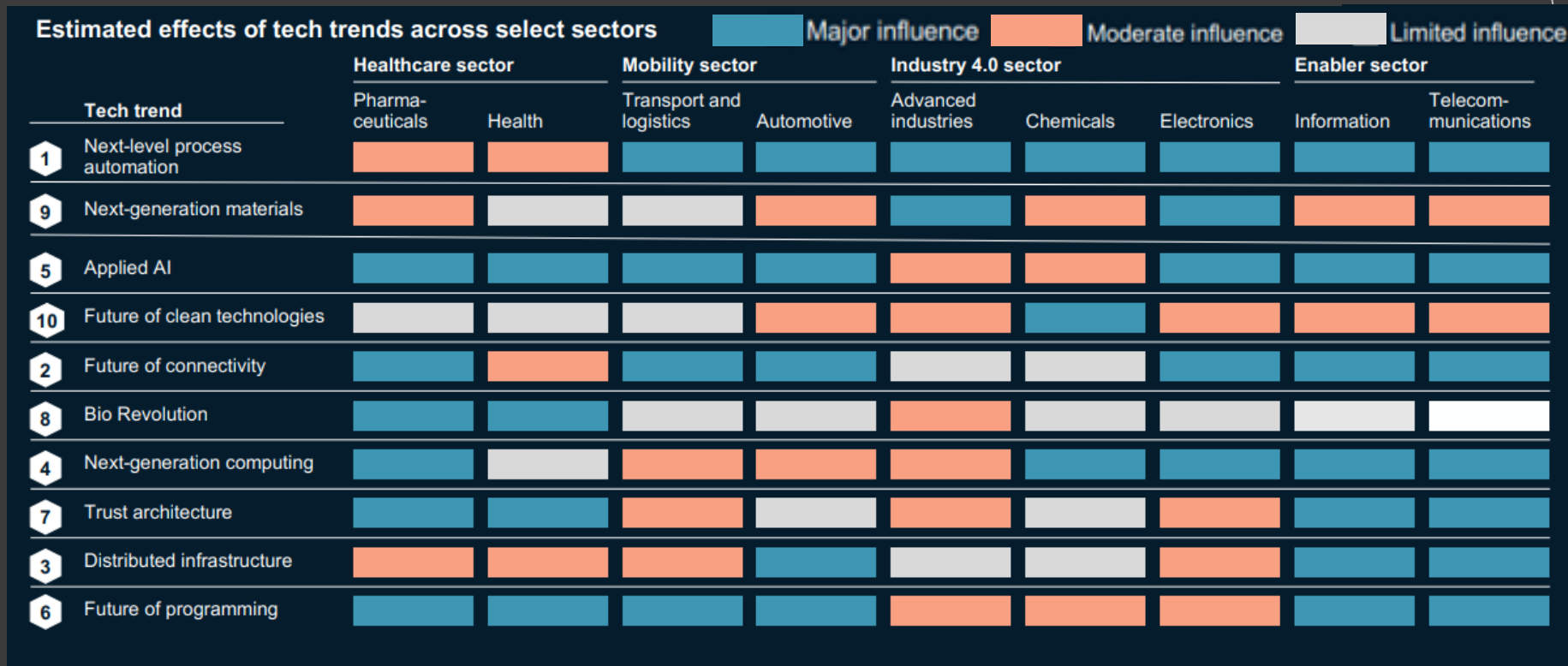
# Modern Challenges of Industry 4.0

- Challenges most strongly impact organizations with limited resources
  - Lack of talent to knowledgably implement Industry 4.0 technologies
    - Emerging technologies have a small pool of knowledgeable talent
  - Unclear value propositions
    - Situational value of technology is not very well understood
  - Unclear impacts on human labor
    - How should we accommodate human labor to ensure stability?
  - Insufficient resources to pursue change
    - Tight operational budgets limit opportunistic action



# Adoption Patterns/Tendencies

- Adoption rates most strongly correlate with company size
- Applied AI/ML shows the strongest and most widespread benefits
- Computing/programming capabilities show moderate/good benefits



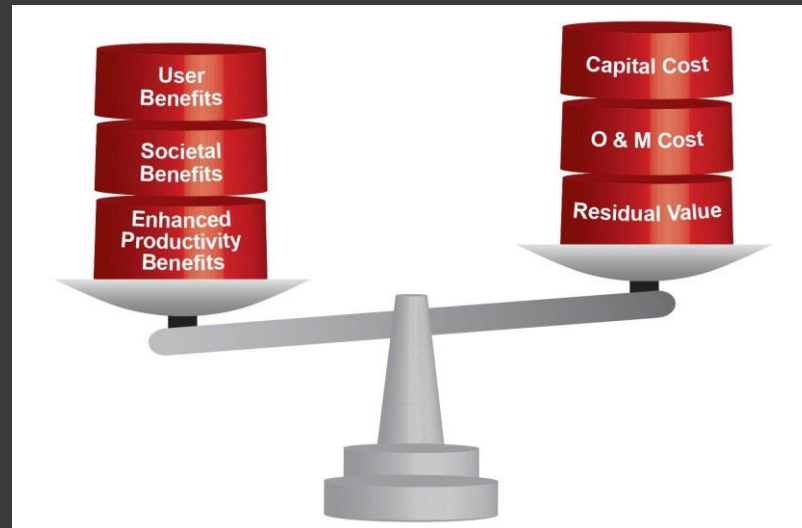
# Strategic Deficiencies

- Lack of clarity on the properties of a good Industry 4.0 strategy yields a lack of mobility towards adoption ventures



# The Cost/Benefit Dilemma

- How should companies decide whether or not to pursue implementation when:
  - The benefits are unclear
    - How should the prospect of situational benefits be communicated?
  - The costs are unclear
    - What new cost modeling and forecasting techniques are required?
    - What are the consequences of *not* implementing Industry 4.0?



# How to Shrink the Growing Divide

- How do we make Industry 4.0 accessible to all?
  - Better diagnosis of when to adopt Industry 4.0 technologies
    - What conditions best facilitate the adoption of Industry 4.0?
  - Transparency about technology implementation outcomes
    - How should organizations track implementation measures?
  - Best practices for human-technology interaction
    - How are human factors principles impacted by Industry 4.0?
  - Understanding how Industry 4.0 contributes to strategic trajectory
    - How does Industry 4.0 accelerate the strategic goals of the organization?

# Urgency/Importancy Dynamic

- Confusion arises in interpreting emerging internal and external phenomena
  - Most internal and external cues possess two predominant components:
    - A magnitude of urgency
    - A magnitude of importance
  - Filtering out “urgent” cues possessing no importance is difficult in the context of unfamiliar technology
    - What conditions distinguish urgency from importance?
  - Human bias supports:
    - A tendency to adopt technology based on popularity
    - Becoming fixated on things rather than outcomes

# Urgency/Importancy Dynamic (Internal)

- Distinguishing between salient cues (urgency) and true importance is critical

<b><u>Self Diagnosis:</u> How Important and Urgent is the Adoption of Industry 4.0?</b>	<b>Urgent</b>	<b>Not Urgent</b>
<b>Important</b>	<ol style="list-style-type: none"> <li>1. Technology capability deficiency to serve customers</li> <li>2. Widespread and ineffective scheduling or timing of operations</li> <li>3. Wasteful operational practices</li> </ol>	<ol style="list-style-type: none"> <li>1. Lack of long-term product/service feature innovation</li> <li>2. Lack of opportunistic action to improve processes</li> <li>3. Failure to sustain improvement solutions to operations</li> </ol>
<b>Not Important</b>	<ol style="list-style-type: none"> <li>1. Occasional re-centering of automated processes</li> <li>2. Trivial engineering design solutions</li> <li>3. Struggles with internal support value streams</li> </ol>	<ol style="list-style-type: none"> <li>1. Technology may not improve product/service deficiencies</li> <li>2. Technology may not improve lapses in high-level strategy</li> <li>3. If culture and not technology is the leading struggle</li> </ol>

# Urgency/Importancy Dynamic (External)

- Distinguishing between salient cues (urgency) and true importance is critical

<b><u>Self Diagnosis:</u> How Important and Urgent is the Adoption of Industry 4.0?</b>	<b>Urgent</b>	<b>Not Urgent</b>
<b>Important</b>	<ol style="list-style-type: none"> <li>1. If organizations upstream and downstream achieved full adoption</li> <li>2. If customers demand value only offered by Industry 4.0 technology</li> <li>3. Automated functions are routinely tweaked due to the environment</li> </ol>	<ol style="list-style-type: none"> <li>1. Upstream/downstream proposals to make cohesive supply networks</li> <li>2. Product operational context begins to deviate from past conditions</li> <li>3. If population skillsets shift to mental tasks and not manual labor</li> </ol>
<b>Not Important</b>	<ol style="list-style-type: none"> <li>1. If situational differences exist in capabilities compared to suppliers</li> <li>2. The prospect of improvement</li> <li>3. Routine complex solutions that cannot be replicated by technology</li> </ol>	<ol style="list-style-type: none"> <li>1. Value is delivered to the customer that only human labor can provide</li> <li>2. If human-machine interaction harms customer satisfaction</li> <li>3. If added value cannot be identified by involving new technology</li> </ol>



# When is Industry 4.0 Adoption Important?

- Situational Industry 4.0 importance typically emerges from one or more of:
  - Upstream/downstream organizations adopt Industry 4.0
  - Forecasting, adapting, and improving are frequent and manual tasks
  - Current technological capabilities become obsolete
- Real time tracking of goods yields a significant operational advantage
  - Holistically monitoring system activities has long been desired for coordination and scheduling
- How do Industry 4.0 technologies differ from pure automation?
  - AI/ML possess learning capabilities and self-improve over time
  - Automation simply performs the task and carries no awareness for improvement

# When is Industry 4.0 Adoption Urgent?

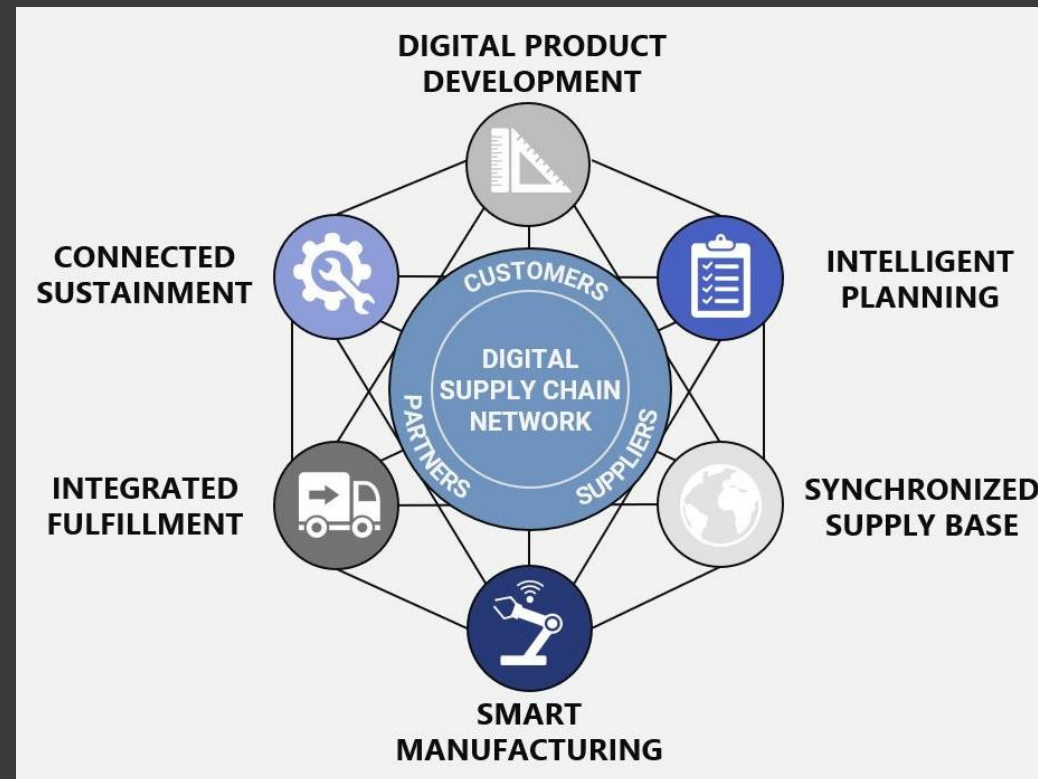
- Routine or irksome tasks may frequently urge a technical solution
  - This urgency may induce bias that inflates the perceived importance of an Industry 4.0-based solution
- Obsession over emerging popular technologies rather than outcomes
  - This inflates perceived urgency
  - Problems should be identified before solutions
- Organizational issues not rooted in technology induce urgency for change
  - Industry 4.0 technology cannot amend cultural shortfalls
  - Urgency for change should not leverage technical solutions by default

# Internal Conditions

- Primary sources of internal conditions that carry Industry 4.0 implications:
  - Organizational wastes and stagnation in processes
    - Self-improving Industry 4.0 technologies sustain gains
  - Production scheduling and coordination lapses
    - Real time tracking enhances scheduling capabilities
    - Flexibility and adaptability are enhanced with automatic data recording
  - Stagnation in product/service innovation
    - New technologies spur new ideas and capabilities

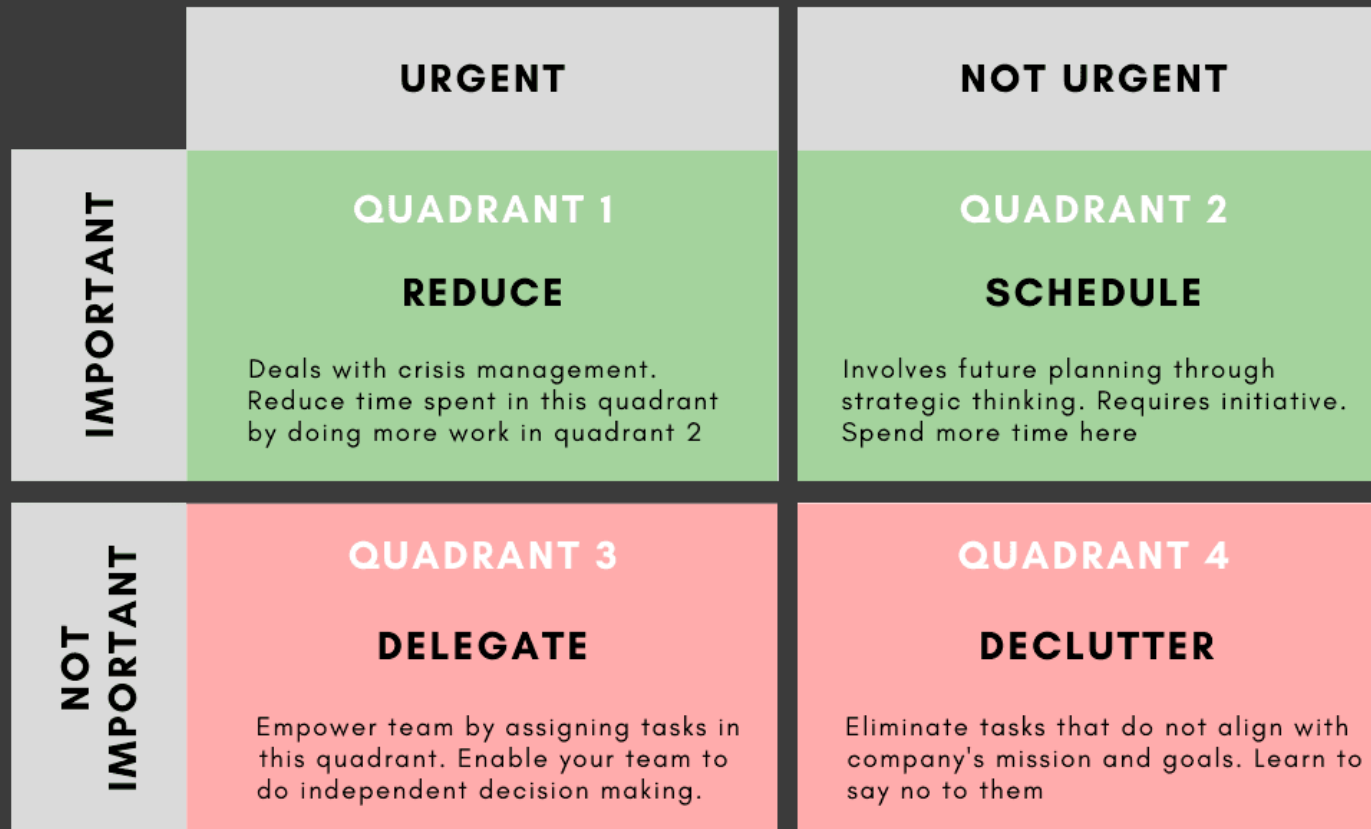
# External Conditions

- Organizations in the supply chain hold the most significant influence on Industry 4.0 adoption benefits
  - Industry 4.0 benefits are magnified when cohesive supply chains with real time tracking and scheduling are formed



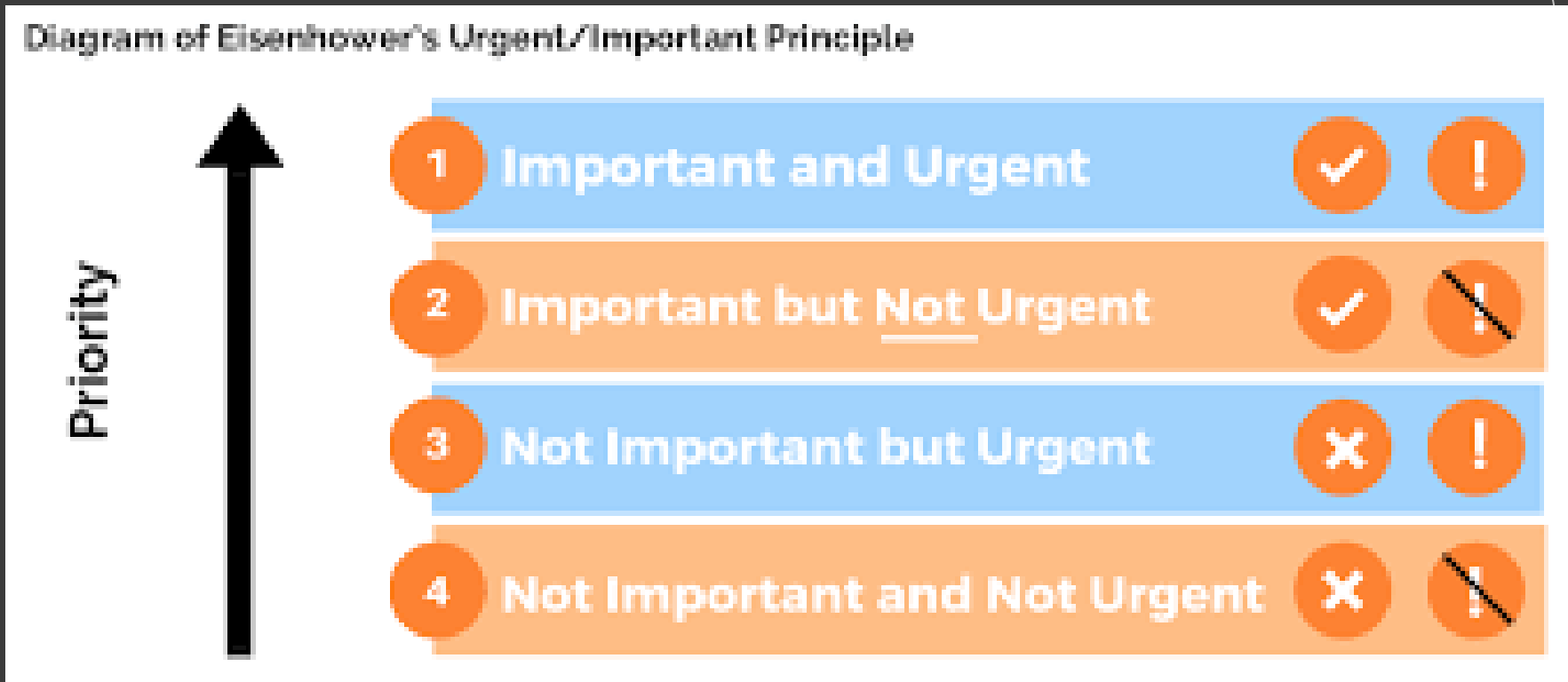
# Prioritization of Industry 4.0 Action

- The Eisenhower Matrix helps to specify the general scope of action when appropriately categorized
- Stability in long-term performance favors importance over urgency



# Prioritization of Industry 4.0 Action

- Conditions that possess importance should be prioritized over urgent conditions
- Work culture significantly contributes to how urgency is naturally handled
- Lean methodologies tend to prioritize importance over urgency



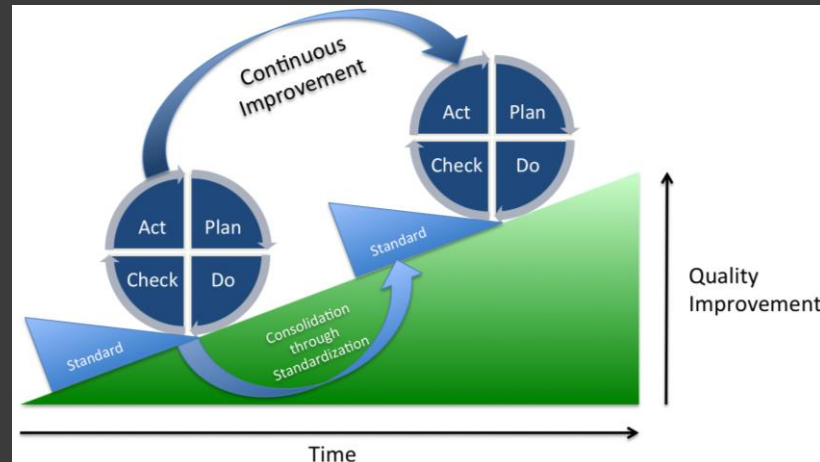
# High-Level Action Plans for Each State

- Important + Urgent Conditions:
  - Implement the necessary Industry 4.0 trajectory into short-term plans
  - Identify transitional resources to accommodate workers in a shift towards intellectual rather than tasks
  - Where possible, apply the Scrum approach
- Important + Not Urgent Conditions:
  - Search for suppliers willing to simultaneously undergo Industry 4.0 ventures
  - Alter long-term strategy
    - Self-improving technologies call for differing labor skillsets
  - Train workforce on familiarity and proficiency with new technologies



# High-Level Action Plans for Each State

- Not Important + Urgent Conditions:
  - Diagnose the root cause of the problem
    - Does the issue demand a sophisticated technical solution?
  - Construct strategies to handle urgent conditions when they arise to focus on lasting solutions rather than brief fixes
- Not Important + Not Urgent Conditions:
  - No present action is needed, but continue to monitor future conditions



# Implementation Considerations

- What should organizations consider prior to implementing Industry 4.0?
  - Usage of Lean or other systematic frameworks
    - Although Lean does not suggest Industry 4.0 adoption, but it facilitates implementation very well

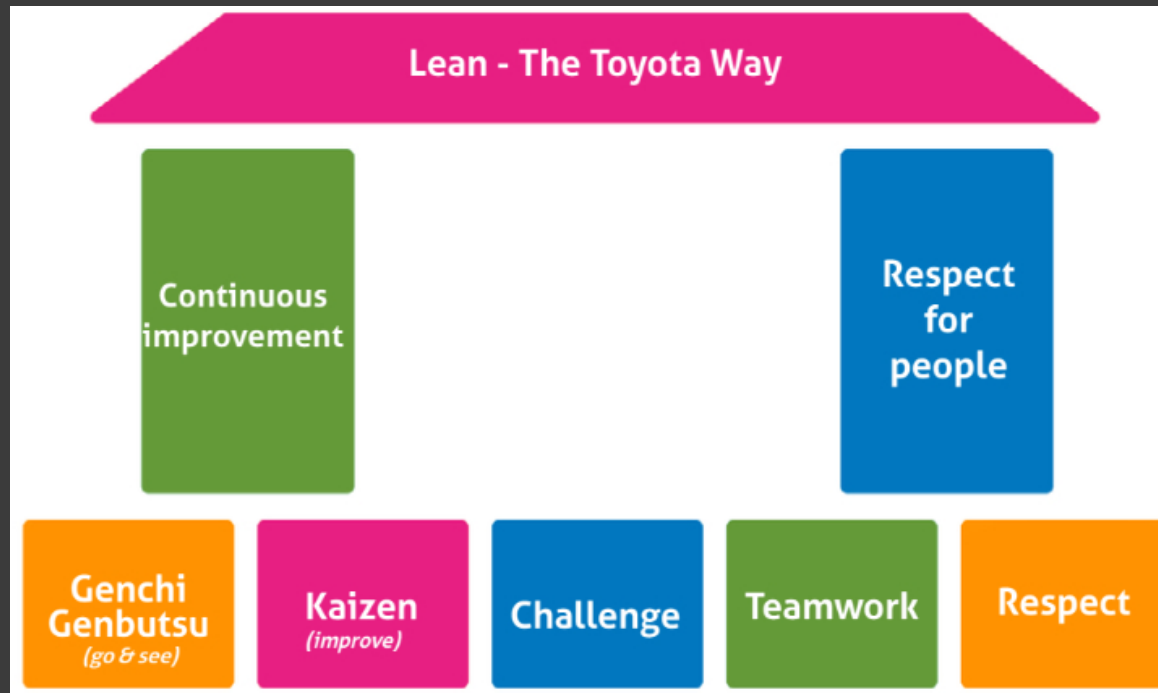


Figure 14. Lean Principles and Supporting Concepts [18].

# Implementation Considerations

- What should organizations consider prior to implementing Industry 4.0?
  - Market dynamics
    - High rates of change for product operational environments harmonizes with self-improving technologies
  - Smart technologies reduce user burden
    - Ultimately, this translates into enhanced market share



Figure 15. Market Trend Analysis [19].

# Current Vs. Future State

- These conditions help capture the current state, but how may we forecast this to draw further conclusions about the future state?
  - Internal insights:
    - Are operational/process capabilities keeping pace with competitors?
  - External insights:
    - Competitive markets are like chess games
      - Maneuvers of competing companies casts light on their strategy

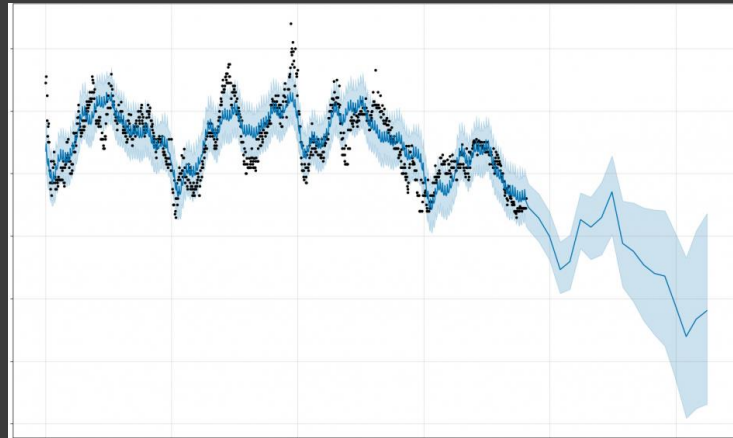


Figure 16. Confidence Bound Visualization on Predictions [20].

# Areas of Future Research

- How organizational attributes influence Industry 4.0 adoption levels
  - Surveys help, but most have regional biases
    - Findings in European markets notably differ from Western trends
  - Root cause analysis
    - Why do these attributes influence Industry 4.0 adoption tendencies?
      - What specific actions should be taken to aid accessibility to Industry 4.0 based on company attributes?
- How modern technology transition periods should accommodate human labor
  - Innovation occurs in waves
    - Which method for accommodating a workforce during transformational time periods is the most effective?

# Areas of Future Research

- In what ways does the nature of corporate culture harmonize/clash with Industry 4.0?
  - Cultural dynamics may accelerate Industry 4.0 adoption or reject it entirely
  - Customer-focus organizations are more equipped to ensure that new capabilities relate to customer requirements



Figure 17. Core Values in Organizations [21].

# Conclusions

- Industry 4.0 is emerging and possesses many uncertainties
  - Organizations need tools to diagnose whether Industry 4.0 adoption is favorable
    - The Eisenhower Matrix helps to develop action plans to address daily tasks
      - This framework can also aid Industry 4.0 action plans
  - Current conditions differ from future conditions
    - This requires continual environmental market monitoring
    - In ML, trained models do not always perform as well on test datasets (future observations) as they do training datasets (current data)
  - Organizational culture carries Industry 4.0 implications
    - This occurs for all new technology, but Industry 4.0 dynamics are unexplored



Questions?



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