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Industry 4.0: The Fourth Revolution

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Historical Context

- Revolution: instantaneous and complete shift
- First Shift: from foraging to farming (10,000 years ago)
  - Results: production, transportation, communication
  - Growth in food production, prodding of population growth
- Industrial Revolution
  - Developments of new technologies and new approaches
  - Prompts shifts in economic models and social architecture

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Historical Context

- First Industrial Revolution
  - During 1760 – 1840
  - Driver: invention of steam engine and construction of railway stimulated the revolution
  - Results: utilization of machines in production
- Second Industrial Revolution
  - During the transition from 19^{th} century to 20^{th} century
  - Driver: electricity and assembly line trigged the revolution
  - Results: mass production

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Historical Context

- Third Industrial Revolution
  - Prompted in 1960s
  - Computer or Digital Revolution
  - Driver: production of semiconductor trigged the revolution
  - Results: mainframe, personal computer, and internet

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Fourth Industrial Revolution

- Stimulated in 21st century
- Proposed to uplift German economy*
- Digital Revolution triggered the revolution
- Extensive use of ubiquitous and mobile internet
- During the revolution, sensors become cheaper, reduced in size, powerful
- Extensive use of Artificial Intelligence, Machine Learning, Cyber Physical System (CPS)

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.
Source *: Lu, Y., 2017. Industry 4.0: A survey on technologies, applications and open research issues. Journal of Industrial Information Integration, 6, pp.1-10.

Fourth Industrial Revolution

- Computers have become more sophisticated and integrated
  - Results: radical transformation of societies and global economies
- Fourth Industrial Revolution is coined as “The second Machine Age”* by Prof. Erik Brynjolfsson, MIT and Andrew McAfee, MIT
- Industry 4.0, another synonym of Fourth Industrial Revolution, is coined by Hannover Fair in 2011.

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.
Source *: Brynjolfsson, E. and McAfee, A., 2014. The second machine age: Work, progress, and prosperity in a time of brilliant technologies. WW Norton & Company

Fourth Revolution

- Scope of Fourth Revolution:
  - Smart Connected Machines
  - Smart Factories
  - Gene Sequencing
  - Nanotechnology
  - Renewables
  - Quantum Computing

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Profound and Systematic Change

- The scale and scope of innovation of Fourth Industrial Revolution defines today's acute disruption and innovation
- Airbnb, Uber, Alibaba, etc., disruptors of today, are relatively new
- Ubiquitous iPhone launched in 2007 → Billions of smart phones are being mass produced currently
- Google announced fully autonomous car in 2010 → AI-based self navigating cars are on the way

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Profound and Systematic Change

- Not only the speed of profound change, but scale of profound change is equally staggering
- Example *:
  - In 1990, industry giants in Detroit had a combined market of $36 billion capitalization, $250 billion revenues, 1.2 million employee
  - In 2014, industry giants in Silicon Valley had a combined market of $1.09 trillion capitalization, $247 billion revenues, 1,37,000 employee

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.
Source *: Manyika, J. and Chui, M., 2014. Digital era brings hyperscale challenges. Financial Times, 13.

Profound and Systematic Change

- With marginal costs, digital business creates unit of today's wealth with fewer workers
- Business, providing information goods, has virtually zero transportation and replication cost
- In the context of Industry 4.0, Instagram, WhatsApp, etc. do not require much capital to begin with, but it changes the role of capital and scaling business

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Profound and Systematic Change

- In the context of Fourth Industrial Revolution
  - Digital fabrication technologies are able to communicate with biological world
  - Designers and architects are, now, combining
    - Computational design
    - Additive manufacturing
    - Material engineering
    - Synthetic biology
  - Results: producing objects that are mutable and adaptable

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

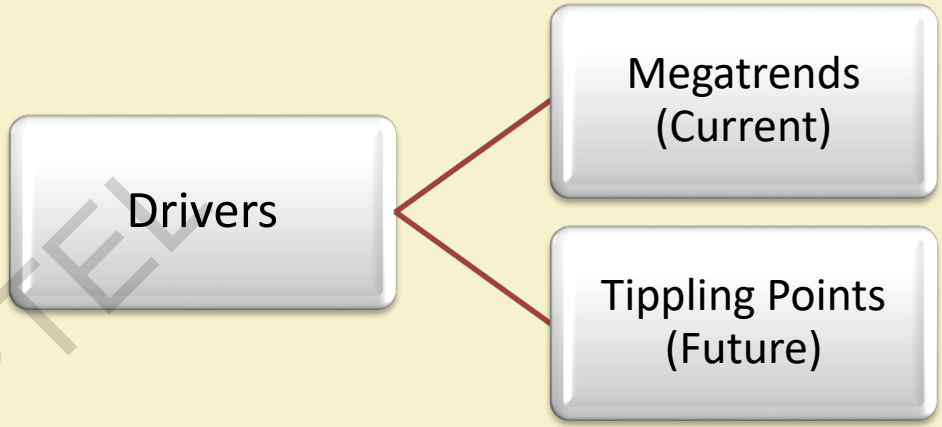
Profound and Systematic Change

- In context of Fourth Industrial Revolution
  - Use of AI
    - Self driving car
    - Virtual assessment
    - Transitional software
    - Discover new drugs
    - Prediction of cultural Interest
  - Application of Siri in Apple is one of the examples of strength of AI (Voice Search) – Also, Cortana for Windows.

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Drivers

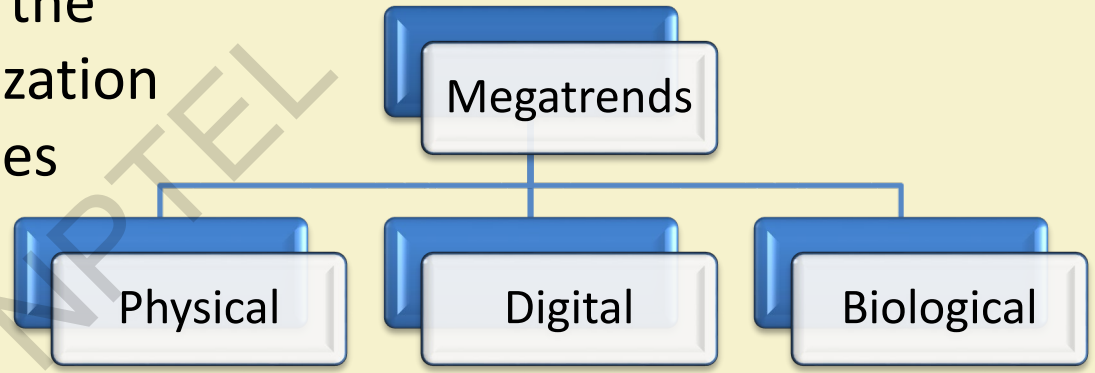
- Various aspects that drive the fourth industrial revolution
  - Scientific Breakthroughs
  - New Technologies



Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

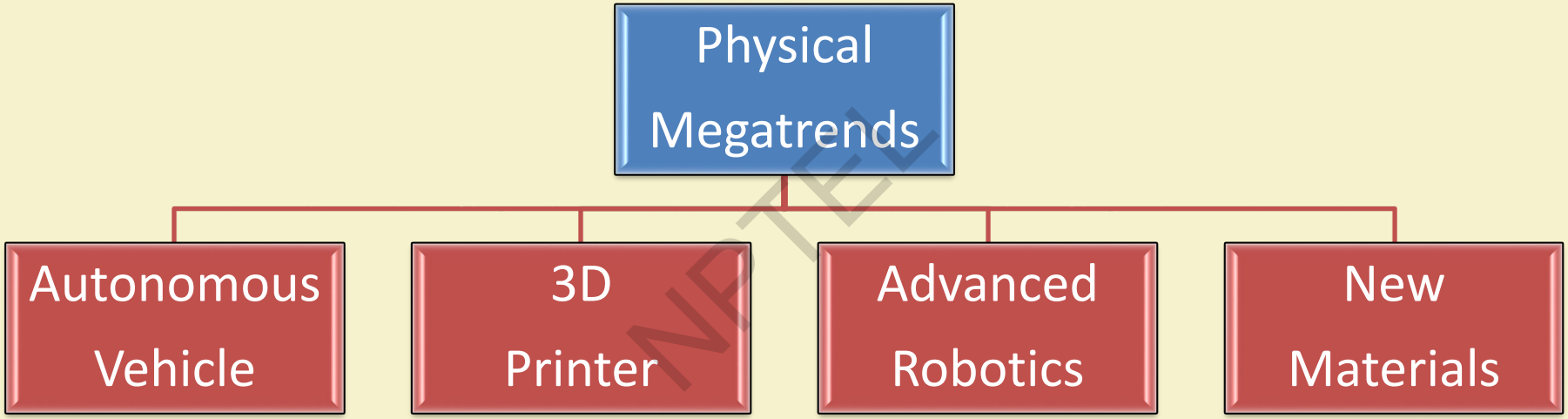
Megatrends

- All recent technologies and development that leverage the pervasive potential of digitization and information technologies



Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

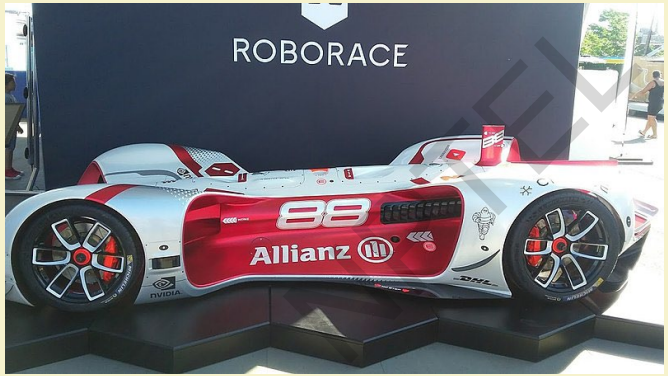
Physical Megatrends



Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Autonomous Vehicle

- Driver-less vehicles
  - Trucks
  - Drones
  - Aircrafts
  - Boats



Source: Wikipedia, By Dllu, Published: Nov 19, 2017, Online: https://en.wikipedia.org/wiki/Autonomous_car

Source: Wikipedia, By Bcschneider, Published: Jul 16, 2017, Online: https://en.wikipedia.org/wiki/Autonomous_car

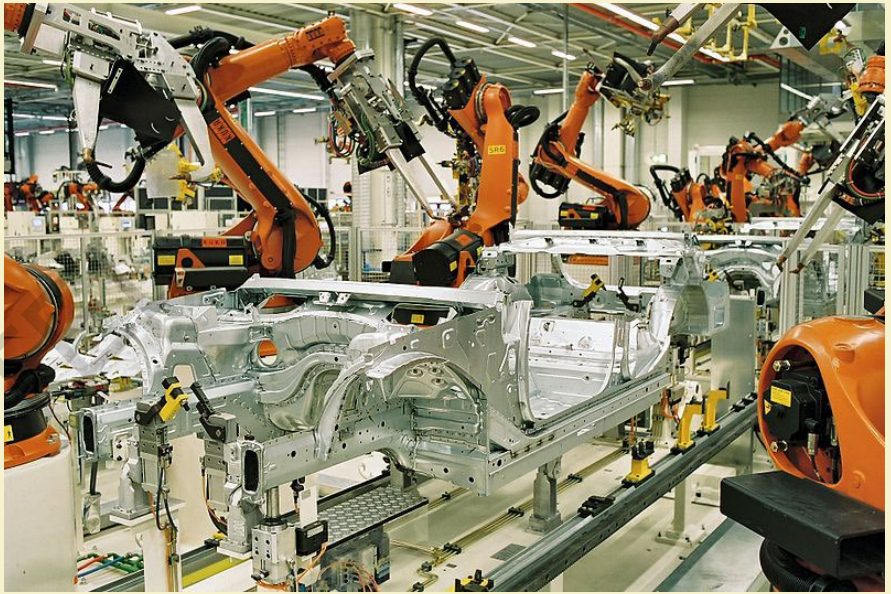
3D Printers

- Manifesting physical objects based on digital specifications
- Application
  - Wind Turbines
  - Medical Implants

Source: Wikipedia, By Tyler Caros, Published: Feb 20, 2015, Online: https://en.wikipedia.org/wiki/Airwolf_3D

Advanced Robotics

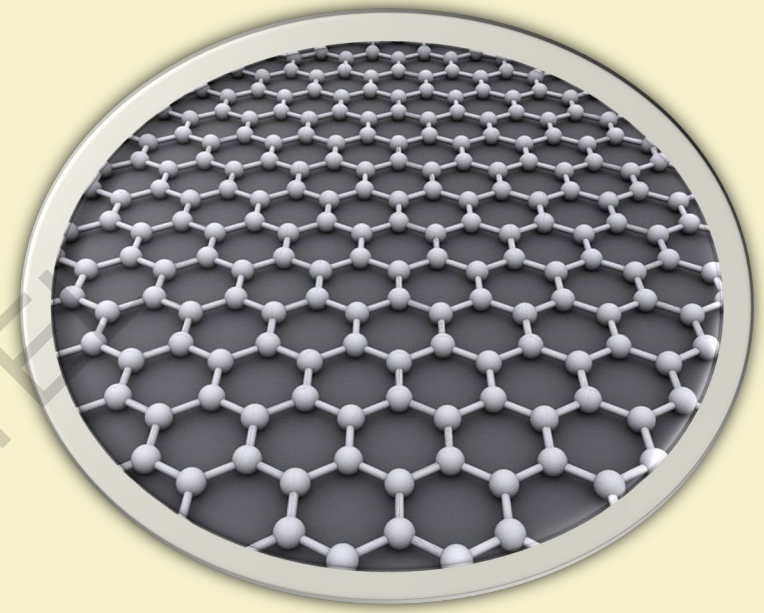
- Conventional application of robots: automotive
- Recently, robotics are used from precision agriculture to nursing



Source: Wikipedia, By BMW Werk Leipzig, Published: Jul 19, 2005, Online: https://en.wikipedia.org/wiki/Smart_manufacturing

New Materials

- Lighter, stronger, recyclable and adaptive
- Example: Thermoset plastics, Graphene



Source: Wikipedia, By AlexanderAlUS, Published: Aug 26, 2010, Online: https://en.wikipedia.org/wiki/Graphene

Digital

- Internet of Things (IoT)
- Application of IoT in Industry
  - RFID
  - Tracking of package delivery
  - Complex supply chain
  - Monitoring systems
- Bitcoin (digital currency) and Blockchain (securing bank/government transactions)
- Uber model for transportation (car pooling etc.)

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Biological

- Genetic sequencing
- DNA writing
- Recommender system (IBM Watson)
- Cell Modification
- Genetic Engineering (CRISPER)

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

Tipping Points

- Tipping points represent the radical changes in that are required in near future
- Probable tipping points in 2025
  - Clothes connected to the internet
  - Unlimited and free storage
  - 1 trillion sensors connected to the internet
  - Robotic pharmacist, etc.

Source: Schwab, K., 2017. The fourth industrial revolution. Crown Business.

References

[1] Schwab, K., 2017. The fourth industrial revolution. Crown Business.

[2] Lu, Y., 2017. Industry 4.0: A survey on technologies, applications and open research issues. Journal of Industrial Information Integration, 6, pp.1-10.

[3] Brynjolfsson, E. and McAfee, A., 2014. The second machine age: Work, progress, and prosperity in a time of brilliant technologies. WW Norton & Company.

[4] Manyika, J. and Chui, M., 2014. Digital era brings hyperscale challenges. Financial Times, 13.

[5] Isaiah, D., 2015. Automotive grade graphene. The clock is ticking. Automotive World, 26.

[6] Laskow, S., 2014. The Strongest, Most Expensive Material on Earth. The Atlantic, 23.

Thank You!!

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Industry 4.0:
Sustainability Assessment of Manufacturing Industry

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Introduction to Sustainable Industry

- Sustainability: means to continue at a fixed rate*
- Sustainable Industry provides**:
  - Energy efficiency
  - Conservation of resource
  - Low-waste production
- Example: Sustainable Manufacturing Industries

Source*: "Google Defination“
Source **:” Wikipedia”

Sustainability in Industry 4.0

- Industry 4.0 proposes inclusion of the characteristics of the previous industry revolution in more sustainable way.
- Industry 4.0 or the fourth industrial revolution
  - A comprehensive industrial revolution
  - It incorporates globalization and emerging issues.

Source Garbie, I., 2016. Sustainability in manufacturing industries: Concepts, analyses and assessments for industry 4.0. Springer

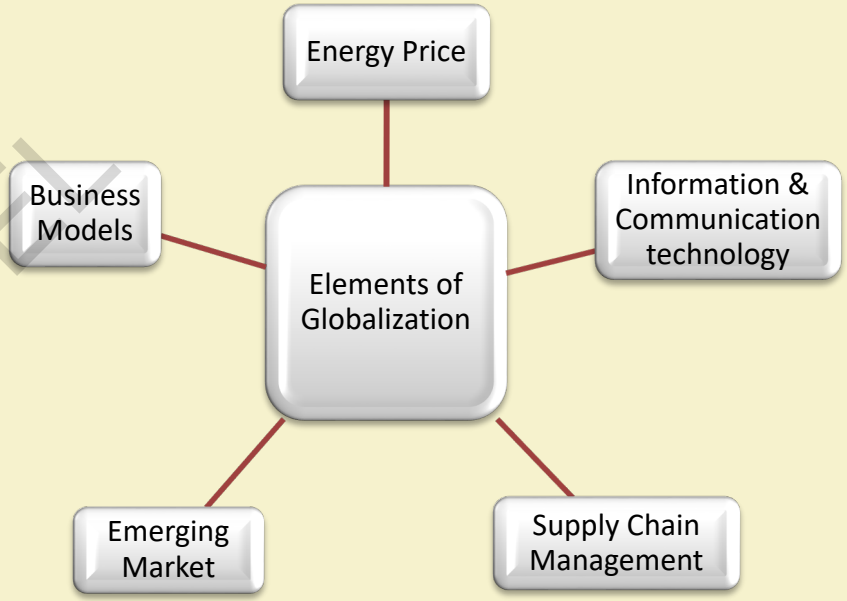
Sustainability Assessment

- Manufacturing industry is considered as
  - Base of modern industrialized society
  - Corner stone of world economy
- Strong manufacturing base stimulates other aspects of the economy of any country
- Evaluation of S/SD or sustainability assessment of manufacturing industry in Industry 4.0 incorporates evaluation of relevant issues and performance metrics

Source Garbie, I., 2016. Sustainability in manufacturing industries: Concepts, analyses and assessments for industry 4.0. Springer

Introduction to Globalization Issues

- Globalization is one of the drivers of sustainable industries
- Globalization issues affect the sustainability of any development/ manufacturing
- These issues are one of the most fundamental requirements



Source Garbie, I., 2016. Sustainability in manufacturing industries: Concepts, analyses and assessments for industry 4.0. Springer

Supply Chain Management (SCM)

- Strategic function in manufacturing industry
  - Many different stages including supplier, production system, and customer
  - Sequencing the stages for the whole system
- The most important stage in SCM is selection for outsourcing components/parts or raw material
- SCM must have environmental concerns: Climate change, contamination and resource consumption

Source Garbie, I., 2016. Sustainability in manufacturing industries: Concepts, analyses and assessments for industry 4.0. Springer

Information and Communication Technology (ICT)

- Main nervous system of any manufacturing industry
  - In absence of ICT, no communication within the enterprise
- Share information between customer, producer, and supplier
- Examples of ICT
  - Enterprise Resource Planning (ERP)
  - Wireless Communication Technology
  - Global Positioning System (GPS)
  - Radio Frequency Identification (RFID) system

Source Garbie, I., 2016. Sustainability in manufacturing industries: Concepts, analyses and assessments for industry 4.0. Springer

Energy Prices

- For enterprise, less energy consumption brings significant economic advantages
- Main issues: Energy supply at reasonable price
- Increase in energy price affects sustainability
- Reduction in energy consumption form non-renewable sources and increase in energy consumption form renewable will have significant positive effect in sustainability.

Emerging Markets

- Markets: able to meet the standards of newly developed, innovative product
- Issue: difficult to identify all of the world's emerging markets
- Emerging markets are expected to be found in developing countries

Source Garbie, I., 2016. Sustainability in manufacturing industries: Concepts, analyses and assessments for industry 4.0. Springer

Business Models

- **Mass Customization:** incorporates the knowledge including international and local cultures
- Business Models ≅ Mass Customization
- Business Model:
  - Strategic approach
  - Maximizing economic profits for an enterprises
  - Taking into account competitive benefits, promoting product value

Source Garbie, I., 2016. Sustainability in manufacturing industries: Concepts, analyses and assessments for industry 4.0. Springer

Introduction to Emerging Issues

- **Emerging Issues:** changes in manufacturing industries based on the world-wide aggressive competition
- Major aspects in case of <u>sustainable development</u> in designing manufacturing industry.

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Technology

- One of the important issues in sustainability.
- Advancement in technology facilitates manufacturing with
  - High quality products
  - Low-cost products
  - Reduces manufacturing time
- Role of technology advancement in global market
  - Converting from traditional system to automated system
  - Introducing more agility and flexibility

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Government Regulation

- Necessary to protect public and private sector
- It consists of Enterprise Requirements for achieving government purpose such as demands for better services and low cost goods
- Government Regulation
  - Prevents the manufacturing industry from unfair competition
  - Enact laws to provide suitable environments for the employees

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Government Regulation

- Employment
- Advertising
- Labor
- Environmental
- Safety And Health
- Privacy

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Government Regulation

- Employment & Labor rules represents laws
  - Concerning wages/salaries
  - Benefits (e.g. retirement plans)
  - Compliance with health and safety issue
  - Proper working condition
  - Expatriate employee issue (e.g. Visas)
  - Equal opportunity in employment (including promotion)
  - Provisioning of Authority or High ranking position

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Government Regulation

- Advertisement Regulation focuses on
  - Protection of customers
  - Firm honesty about a product
  - Information regulation publicly
  - Transparency on distribution and manufacturing process

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Government Regulation

- Environmental rules
  - Maintained by Environmental Protection Agencies(EPA)
  - Maintains clean air, reduction of chemical effects in soil, river
- Privacy Regulations
  - Safety procedure to sensitive information collected during hiring process
  - Information includes ID card, names, personal information, personal history, health condition, and banking information
  - Inappropriate disclosure of this information risks legal issues

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Government Regulation

- Safety and Health regulations
  - Ensures healthy working environment
  - Enterprise must distribute information on maintaining a healthy workplace to avoid dangerous events
  - Need to update safety regulation information due to yearly changes in Governments

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Population Growth

- Monitoring population growth is important for manufacturing industry
- It affects
  - Industry growth
  - Food supplies
  - Fertility
  - Sociology
  - Economics
  - Politics
  - Industry Location
  - Use of Available lands

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Population Growth

- Three different category of countries based on population growth
  - Developed
  - Emerging
  - Developing
- Population growth of countries (developing and disadvantaged) > Population growth of countries (developed and advantaged)

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Population Growth

- Based on the United Nations (UN) report, population growth from1950 to 2050
  - Reduced between 32 to 13 % in developed countries
  - Increased between 8 to 20 % in emerging and developing countries
- Economic view on population growth
  - Pessimistic
  - Optimistic

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Population Growth

- Pessimistic view of population growth
  - Hinders the economic growth
  - Consumes most of the economic investments in safety, need for schools, hospitals, universities
- Optimistic view of population growth
  - Dissemination of knowledge and information
  - Increases globalization issue such as trade and commerce

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Population Growth

- Despite the advantages of population growth, if there is no plan to control it, it would turn out to be disaster for any developing country
- Human capital and respective skills are one of the most important aspects of manufacturing industries.
- Example: A location of manufacturing industry requires politics and skill level provided by the local population

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Economic Crisis/Recession and Depression

- Economic crisis takes place over a duration not more than a few months
- Recession: exponential decline in economic activity
  - Commence after economic crisis arrives at the activity peak
  - Completion after economy arrives at its trough
  - Duration: more than few months but not more than two years
  - Observable on gross domestic product (GDP), actual income, employment, industrial production, and wholesale-retail sales

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Economic Crisis/Recession and Depression

- Depression: extremity of recession
  - Observed by exponential unemployment increase
  - Reduction in available credit
  - Significant reduction in trade and commerce
  - Huge number of bankruptcies
  - Volatility in currency value
  - Duration: more than two years

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Economic Crisis/Recession and Depression

- An economic crisis and recession → observing reduction in prices of few major commodities
- Increasing productivity and reduction in cost is one of the solution
- Applying same solution, it takes more time to recover form depression
- Example of avoiding crisis→ The main economy of manufacturing location should not be based only one resources

Consumption of Natural Resources

- One of the biggest issues in contrast of economically sustainable development
- As natural resources are main source of revenue in developing countries, it is one of the major source of social conflicts
  - Mining
  - Oil and Gas extraction
  - Demography shifts
  - Difficult economic situations
  - Negative societal behavior
  - Politics
  - Technology

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Consumption of Natural Resources

Renewable

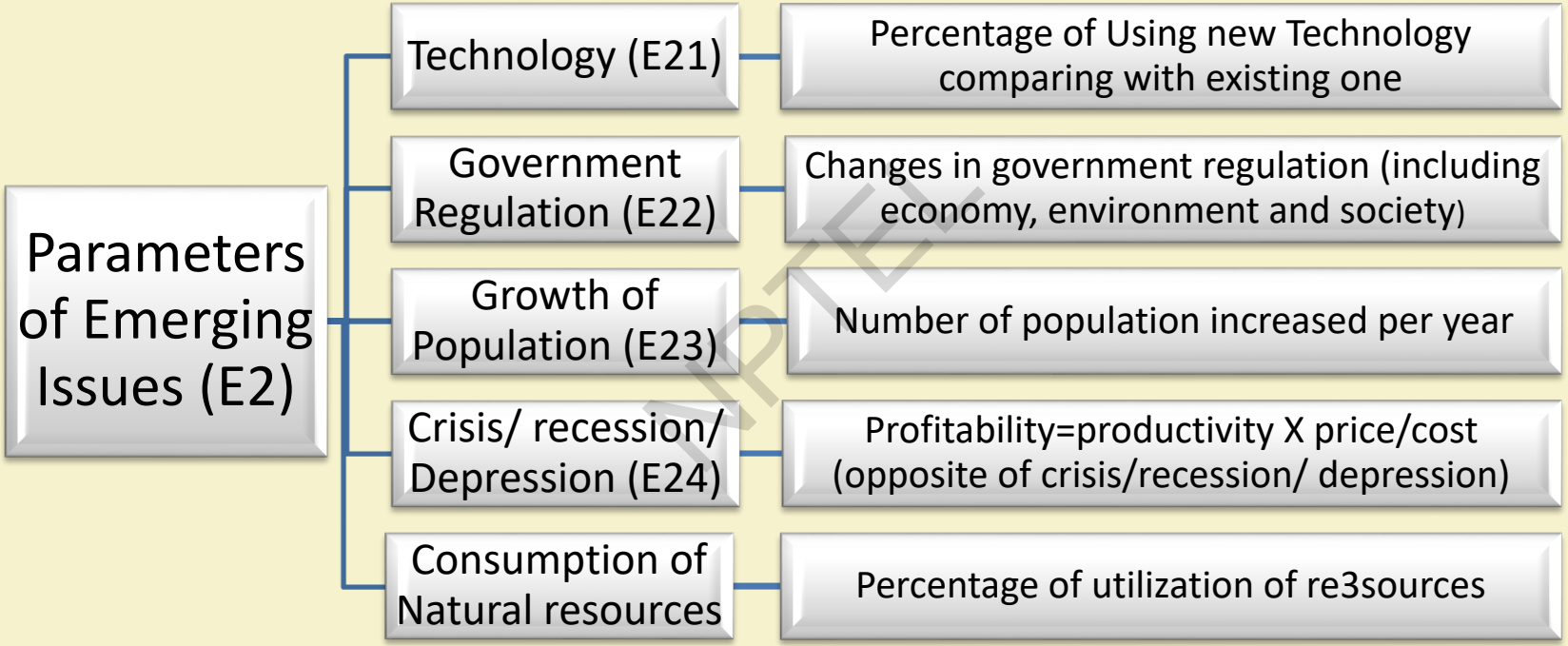
- Naturally Available
- Source: Solar, Air, Water, Wind etc.
- Renewable energies can be generated easily

Non-renewable

- Usage is selective based on the type of the industry
- Source: Coal, Oil, Gas, etc.
- Can not be recycled

Source: Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503

Sustainability Assessment of Emerging Issues



Sustainability Assessment of Emerging Issues

- Sustainability/Sustainable development
  - $S/_{SD_{E2}} = f(E21, E22, E23, E24, E25)$
  - $S/_{SD_{E2}} = \left(I_{E21}^{Y_{E21}} . I_{E22}^{Y_{E22}} . I_{E23}^{Y_{E23}} . I_{E25}^{Y_{E24}} . I_{E25}^{Y_{E25}}\right)$
  - Where $I_{E2i} = S_{E2i}/E2i$,
  - S_{E2i}= The change towards the sustainability
  - Y_{E2i}= Exponent of the change towards sustainability (S_{E2i}) of $E2i$

References

[1] Garbie, I.H., 2013. DFSME: Design for sustainable manufacturing industries (an economic viewpoint). International Journal of Production Research, 51(2), pp.479-503.

[2] Garbie, I.H., Parsaei, H.R. and Leep, H.R., 2008. A novel approach for measuring agility in manufacturing firms. International Journal of Computer Applications in Technology, 32(2), pp.95-103.

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Thank You!!

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Industry 4.0: Lean Production System

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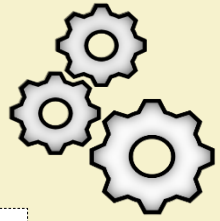
What is Lean Production System?



Finishing good inventories through eliminating wastes from processes

- Developed by **Toyota motor corporation**
- It is mainly focusses on **customer's need**

Source: Toyota Production System or Lean Manufacturing
URL: https://www.slideshare.net/haiggg/lean-production-system-tps

Lean in simple term

Lean Approach

Looks from customers perspective

Other Approach

Looks from tasks and production perspective

Source: The Origin of Lean Manufacturing
URL:https://www.coursera.org/lecture/lean-manufacturing-services/the-origins-of-lean-manufacturing-TKEXN

Lean production system established on…

Source: Toyota Production System or Lean Manufacturing
URL: https://www.slideshare.net/haiggg/lean-production-system-tps

7 Types of wastes

- **Transportation** – Excessive movements of people for materials or information
- **Waiting** – Period of inactivity of people for material or information
- **Motion** – Non value-added movement of people
- **Inventory** – Cost of inventory such as raw materials, work in process, finished goods

Source: The 7 Types of Waste, Lean U
URL: https://www.youtube.com/watch?v=8gExNBPzSJk

7 Types of wastes (Contd..)

- **Over-processing** – Doing more work in product than customer values
- **Defects** – Defects can be in products or paper works
- **Overproduction** – Producing more product sooner than the customers ready for

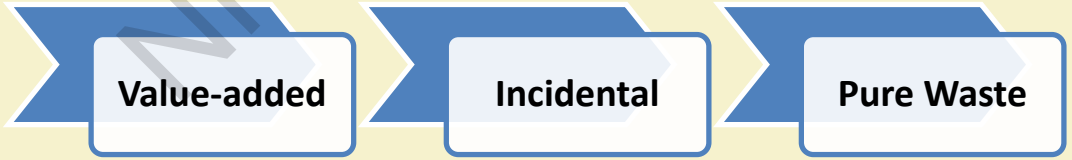
Source: The 7 Types of Waste, Lean U
URL: https://www.youtube.com/watch?v=8gExNBPzSJk

Value streams in Lean

Value streams - All the actions required for a product from order to delivery

It can be done by simply walking through the lifecycle of the product

3 types of works to be noticed ➡



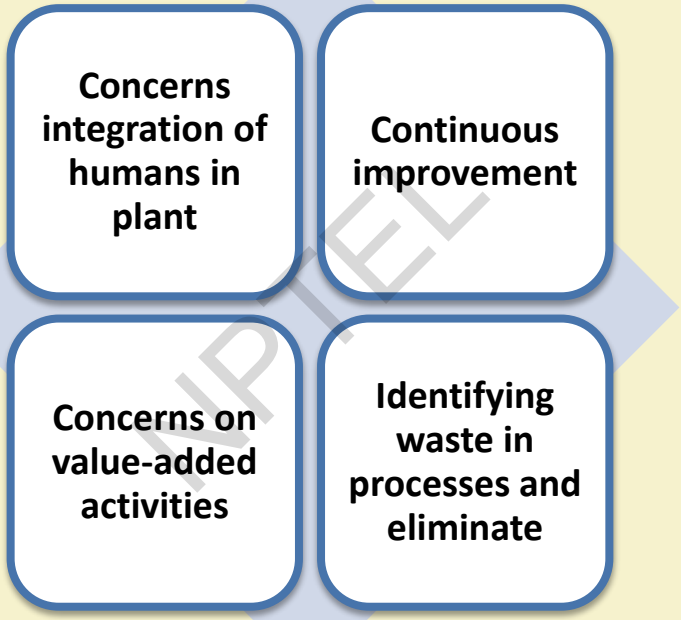
Source: Lean U - Value Streams
URL: https://www.youtube.com/watch?v=U985dxED7e4

5 steps of walk in value streams

- Focus on single value stream
- Build a leadership team
- Schedule date and time
- Walk it – Discuss value, walk together, list and prioritize ideas
- Schedule follow up

Source: Lean U - Walking a Value Stream
URL: https://www.youtube.com/watch?v=P3v5EI6EEog

Lean production in Industry 4.0



Source: Mrugalska B, Wyrwicka MK. Towards lean production in industry 4.0. Procedia Engineering. 2017 Jan 1;182:466-73.

Impacts of Lean production system

Through the elimination of waste in processes, it provides best quality, lowest cost, shortest lead time

Source: Lean Production System - TPS
URL: https://www.slideshare.net/haiggg/lean-production-system-tps

Implementation of Lean implies

Implementation of lean → implementation of full manufacturing system

- It does not only focus on lean tools
- In addition it focuses on four main areas such as business requirements, operation improvement, people management, performance governance

Source: The lean manufacturing system; Coursera
URL: https://www.coursera.org/lecture/lean-manufacturing-services/the-lean-manufacturing-system-mqbGU

Implementation of Lean implies (Contd...)

1. Business Requirements

- Set right objectives
- Clear about strategy
- Clear about contributions

Source: The lean manufacturing system; Coursera
URL: https://www.coursera.org/lecture/lean-manufacturing-services/the-lean-manufacturing-system-mqbGU

Implementation of Lean implies (Contd...)

2. Performance Management

- Refers to people management
- Should have clear **KPI** (**K**ey **P**erformance **I**ndicator) structure
- Top-down management
- Key topics to be covered-
  Productivity, **Q**uality, **C**osts, **D**elivery, **S**afety

Source: The lean manufacturing system; Coursera
URL: https://www.coursera.org/lecture/lean-manufacturing-services/the-lean-manufacturing-system-mqbGU

Implementation of Lean implies (Contd...)

3. Operation Improvement

- Company should have clear knowledge about all tools of toolbox
- Should not have massive toolbox with unnecessary tools

Source: The lean manufacturing system; Coursera
URL: https://www.coursera.org/lecture/lean-manufacturing-services/the-lean-manufacturing-system-mqbGU

Implementation of Lean implies (Contd...)

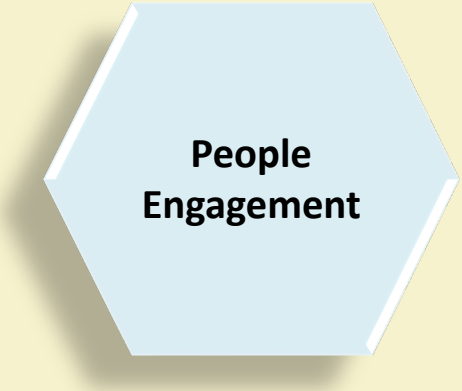
4. People Engagement

- Develop right capabilities
- Should follow **L**earn, **D**o, **T**each

Learn – Clear knowledge about tools

Do – Perform all tools

Teach – Move into role of teacher to teach about tools



Source: The lean manufacturing system; Coursera
URL: https://www.coursera.org/lecture/lean-manufacturing-services/the-lean-manufacturing-system-mqbGU

Why company should decide to implement lean?

Company should implement lean motivated by three drivers; **Cost**, **Time**, **Quality**

This leads to company's continuous improvement

Source: How Lean delivers impact in manufacturing; Coursera
URL: https://www.coursera.org/lecture/lean-manufacturing-services/how-lean-delivers-impact-in-manufacturing-S32fw?authMode=signup

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Thank You!!

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Industry 4.0:
Smart and Connected Business Perspective

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Why smart and connected products?

- Connecting the physical objects.
- Sharing the data between physical objects.
- Increasing the resource efficiency.
- Increasing the productivity.

Source: "Industry 4.0:Managing The Digital Transformation", Springer.

Benefits of smart and connected products

- Faster.
- Cheaper.
- Better usage of product.
- Improved recall process of product.
- Decreased environmental impact.
- Smart supply chain.

Source: “Why Your Products Must be Smart and Connected ”, TCS.

Medium of getting smart and connected

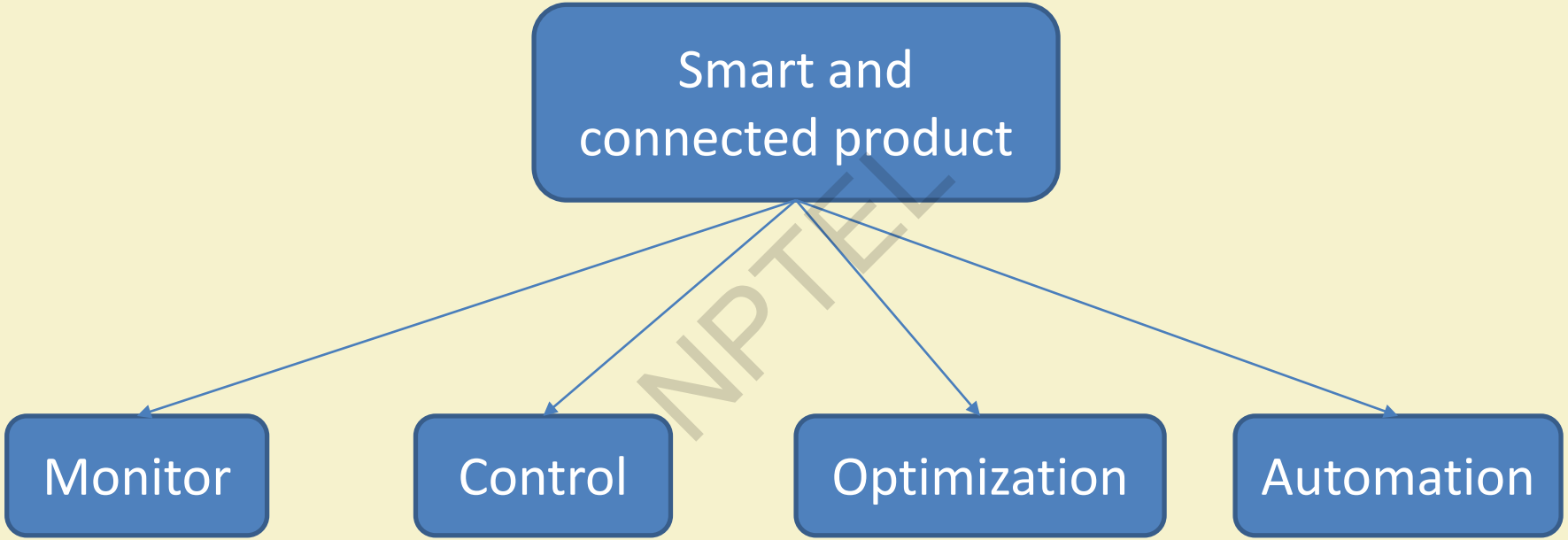
- Embedded Systems.
- Cloud computing.
- Internet of things (IOT).
- Sensors.

Source: "Industry 4.0:Managing The Digital Transformation", Springer.

Fundamental building blocks

- Customer values.
- Blueprint of profits.
- Key resources.
- Key processes.

Categorization



Monitor

- **Resource:**
  - Sensors.
  - External data sources.

- **Effects :**
  - Health monitoring of products.
  - Generating alerts.
  - Taking action against the odds.

Control

- **Resource**:
  - Custom software.

- **Effects:**
  - Controlling the products.
  - Personalization.

Optimization

- **Resource:**
  - Optimization algorithms.

- **Effects:**
  - Enhances the performance.
  - Enables remote services.
  - Assists in repairing the product.

Automation

- **Resource:**
  - Monitor, control, and optimization capabilities.
  - Software algorithms.
- **Effect:**
  - Autonomous performance of products.

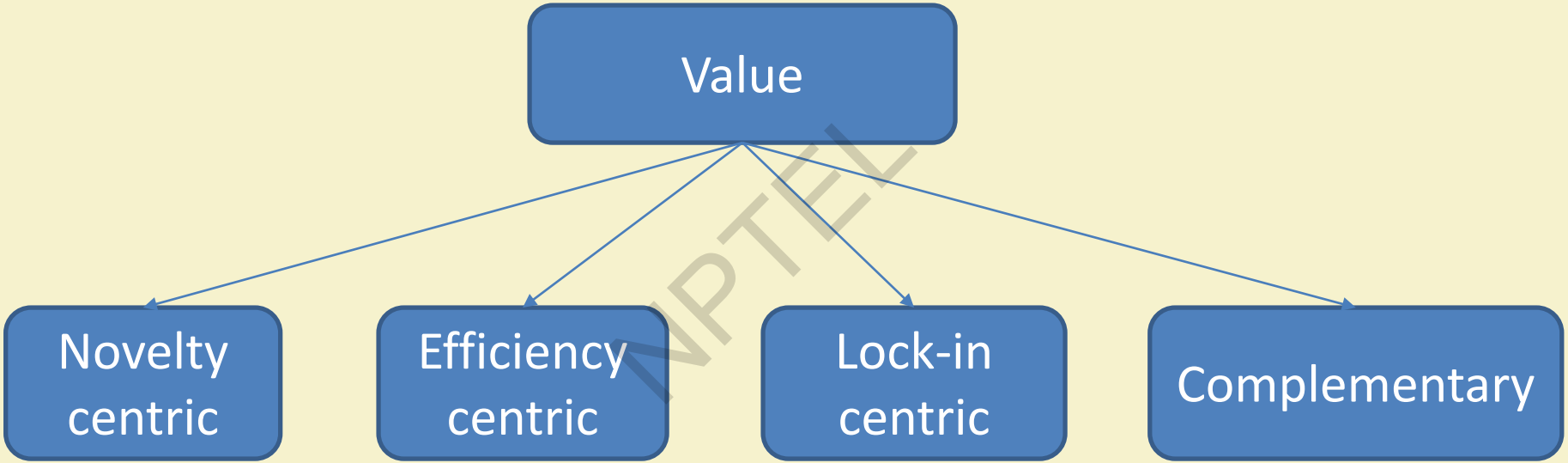
Why smart business model?

- Make the current process less costly.
- Make the process efficient.
- Meet the expected revenue.

Key attributes of smart business model

- Value proposition.
- Revenue streams.
- Technologies.

Value creation in smart business model



Value centric business model

- New market.
- New services.
- Innovation.

Efficiency centric business model

Efficiency makes the transaction –

- Faster.
- Simple.
- Transparent.
- Eliminating the errors.

Lock-in centric business model

- Prevents the customer migration.
- Switching cost.
- Building trust.

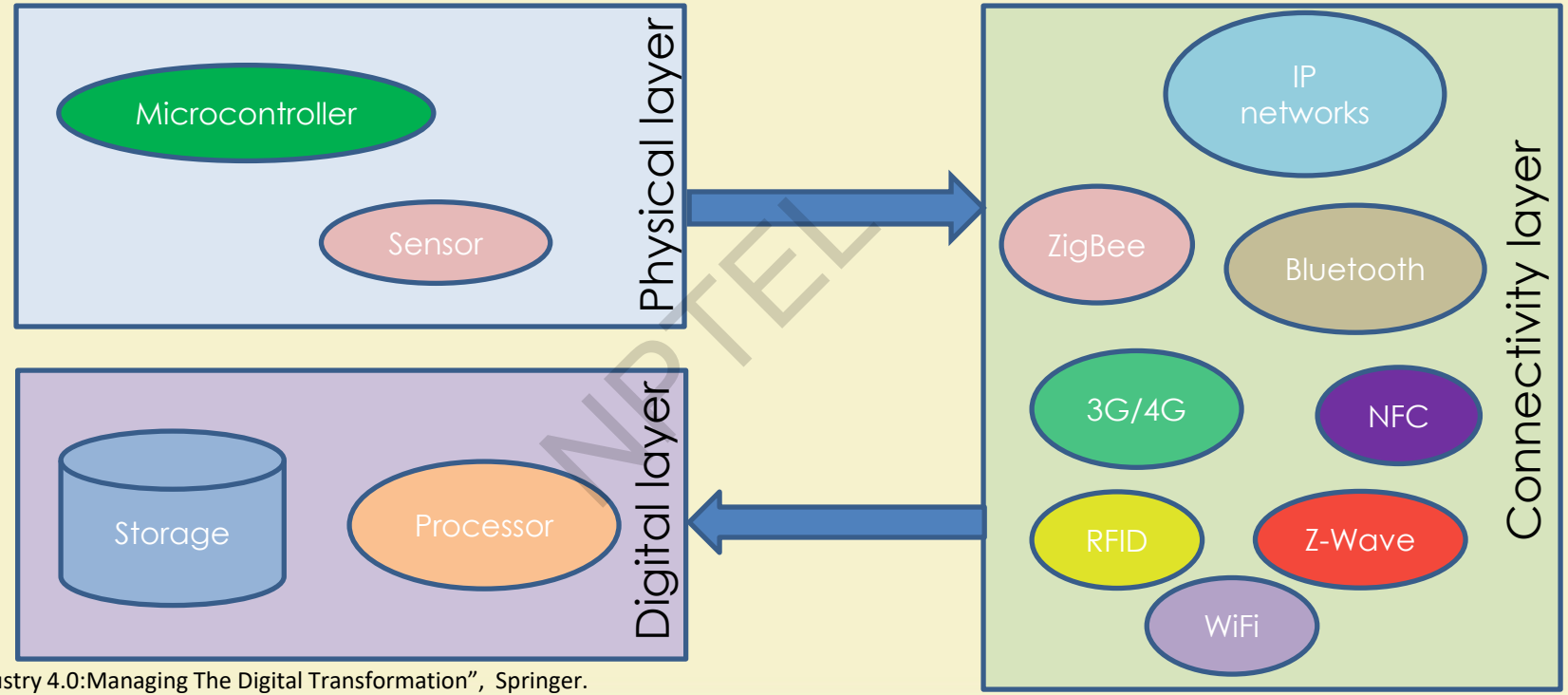
Complementary business model

- Product and services.
- On-line and off-line assets.
- Technologies.
- Activities.

Layers and technologies for creating values

- Physical layer.
- Connectivity layer.
- Digital layer.

Architecture



Source: "Industry 4.0:Managing The Digital Transformation", Springer.

Physical layer

- Responsible for collecting and acquiring data from object or environment.

- Equipped with micro-controllers and sensors.

Connectivity layer

- Connects smart devices, servers.
- Equipped with different communication technology including IP networks, ZigBee, NFC, Bluetooth etc.

Digital layer

- Stores the data.
- Analyzes the data.
- Processes the data

Examples of smart and connected business model

Product	Value proposition	Revenue streams	Physical layer	Connectivity layer	Digital layer
Amazon's dash button	Lock-in	Low cost	WiFi enabled embedded device	WiFi	Connected through mobile application
Semios	Efficiency	Yearly subscription, 24/7 monitoring and assistance	Sensor for soil moisture, insect, disease, climate monitoring	Cellular connectivity	Mobile application.

Source: "Industry 4.0:Managing The Digital Transformation", Springer.

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Thank You!!

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Industry 4.0: Smart Factories

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What is smart factory?

- According to Deloitte University Press –

"The smart factory is a flexible system that can self-optimize performance across a broader network, self-adapt to and learn from new conditions in real or near-real time, and autonomously run entire production processes. "

Source : "The smart factory", Deloitte

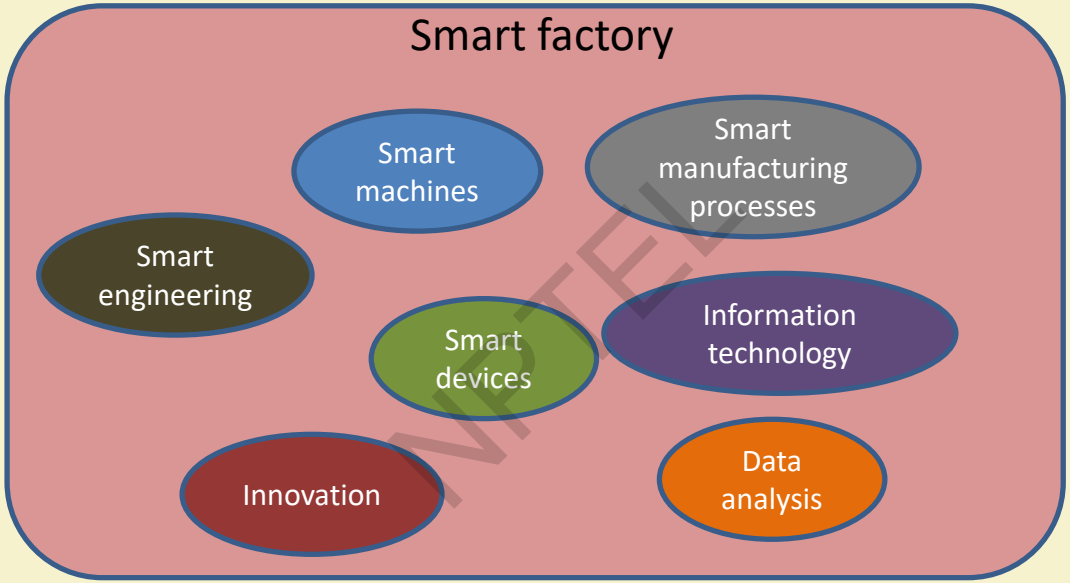
Why do we need smart factories?

- Evolution of technologies.
- High competitive market.
- High amount of production within minimum timeline.
- Reduce risk of failure.

Advantages of running smart factories

- Reducing cost.
- Increasing efficiency.
- Improving quality.
- Improving predictability.
- Improving safety.

Components of smart factory



Source: "Smart factories in Industry 4.0: A review of the concept and of energy management approached in production based on the Internet of Things paradigm. **",** IEEE ICIEEM.

Smart machines

- Communicate with other machines.
- Communicate with other smart devices.
- Communicate with humans.

Smart devices

- Connected with smart devices including
  - Field devices.
  - Mobile devices.
  - Operating devices.

Smart manufacturing process

- Dynamic.
- Automation.
- Real-time.
- Efficient.

Smart engineering

- Smart design of product.
- Smart development of product.
- Smart planning.

Information technology

- Smart software application.
- Monitoring.
- Control.
- Smart management process.

Characteristics of smart factories

- Connection.
- Optimization.
- Transparent.
- Proactivity.
- Agility.

Connection

- Connected smart devices.
- Connected smart machines.
- Connected with data.
- Connected processes.

Optimization

- Optimizing the task scheduling.
- Optimizing the use of energy.
- Optimizing the cost of production.
- Optimizing the tracking.
- Optimizing the throughput.
- Optimizing the reliability.

Transparent

- Real-time monitoring.
- Taking required action on time.
- Generating alert messages.
- Real-time tracking.

Proactivity

- Predicting the quality issues.
- Improving safety.
- Forecasting the future outcomes.
- Predicting the future challenges.

Agility

- Flexibility.
- Adaptation.
- Self-configuration.

Supporting technologies for smart factories

- Big Data.
- Cloud computing.
- Smart grid.

Use of Cloud computing in smart factories

- Provides the capability of high-performance computing.
- Easy access for product designing software and tools.
- Easy access for present and past data for analyzing.
- Scalability provides freedom in terms of computing and data storage.

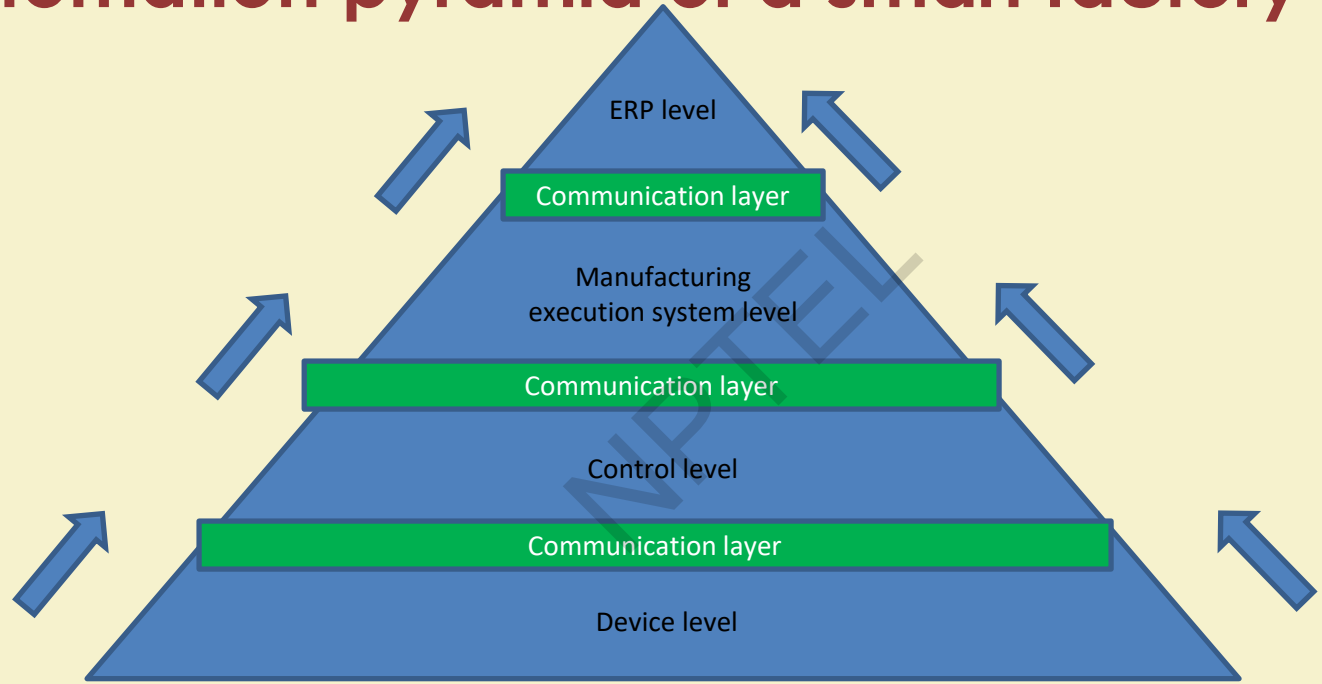
Use of Big Data analytics in smart factories

- Generating knowledge.
- Improving value streams.
- Future prediction.
- Key Performance Indicator (KPI).

Use of smart grid in smart factories

- Persistence in energy consumption.
- Load balancing.
- Reduction of energy consumption cost.
- Increase the life cycle of electronic equipment.

Automation pyramid of a smart factory



Source: "Towards a factory-of-things**",** ESLEVIER

Use of augmented reality in smart factories

- Operate instruments from remote.
- Providing precision.
- Providing safety especially for radio active zones.

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Thank You!!