The world according to Industry 4.0

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Three Chains of Activities

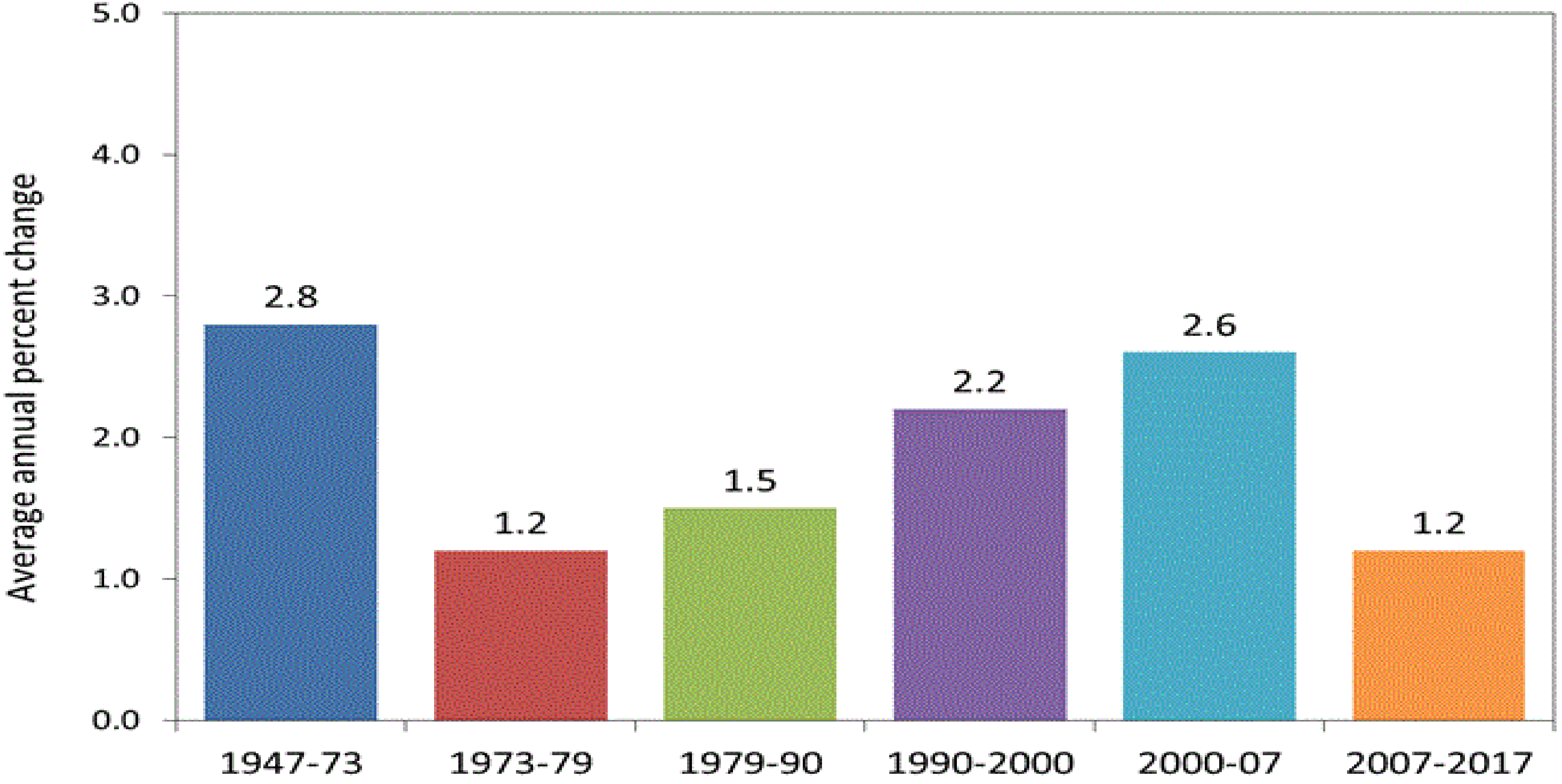
Pre - input	Input		In Process			Output	
Suppliers	Loading	Logistics	Quality control	Inspection	Process control	FG stores	Distributors
Vendors	In transit	Unloading	Business Excellence	Engineering	Project Management	Outbound Logistics	Retailers
Inventories	Warehousing	Inspection	PPC	Manufacturing	Maintenance	Warehousing	Last mile
Inspection	Loading	Returns	R&D	Technology	MIS/IT	In transit	
Insurance	Supplier Management	Storage/ RM stores	Procurement	CCHP	Customer returns		
		Strategic Sourcing	COO's Office/ OS	Systems certification	Packaging		
			Horizontal integration	New Products Development	Resources conservation and sustainability		

Customers

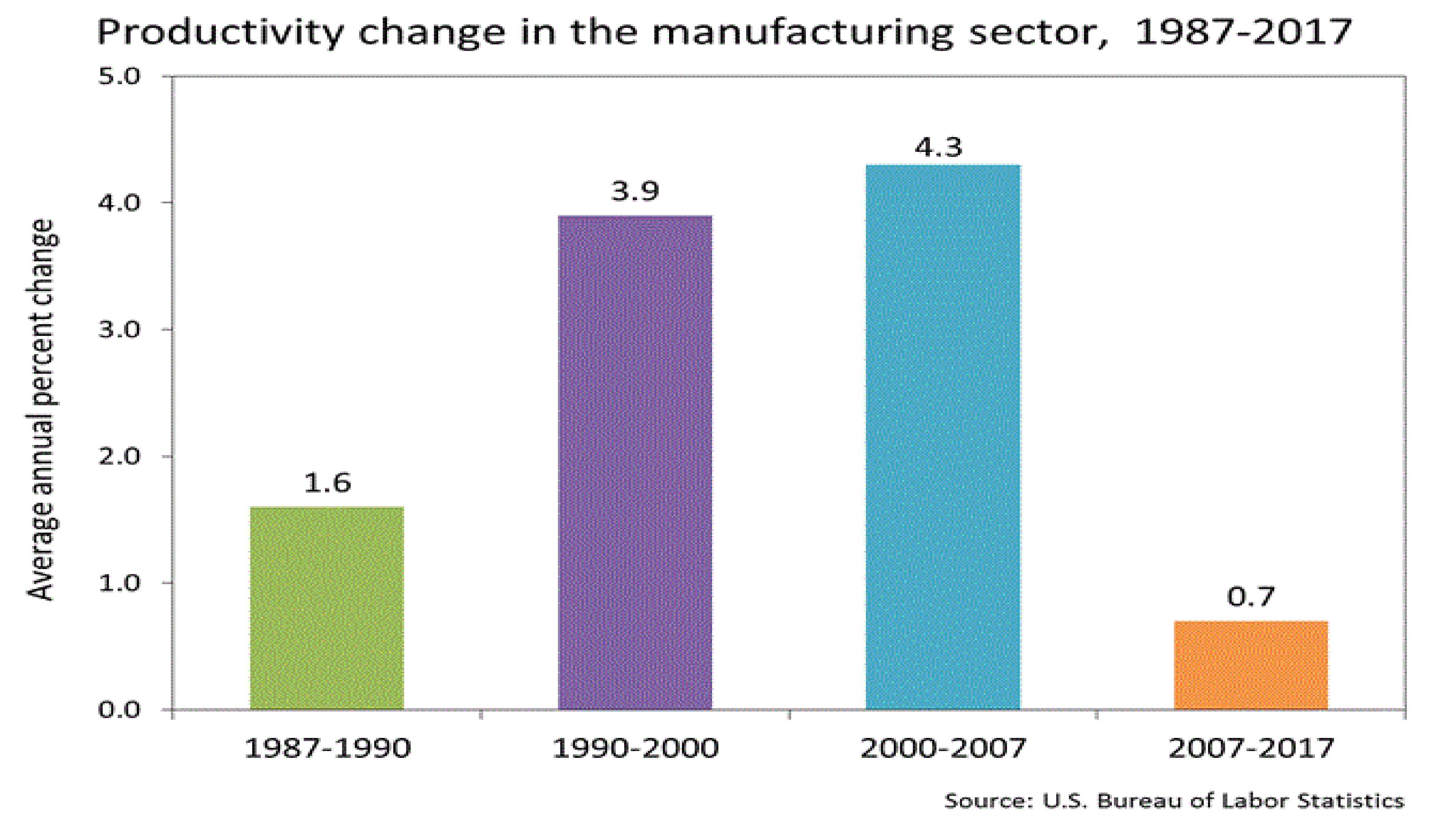
Why Industry 4.0

- Many reasons
- The productivity view
- The technology view – IOT (Connectivity), AI, Big Data, Algorithms, Analytics and robotics, RFID, super computing, cloud, digitisation
- The market view – social media, e Commerce
- The management view – Performance 4.0
- The quality view – Quality 4.0

Productivity change in the nonfarm business sector, 1947-2017



Source: U.S. Bureau of Labor Statistics



Productivity change in the manufacturing sector, 1987-2017
Average annual percent change
5.0
4.0
3.0
2.0
1.0
0.0
1.6
3.9
4.3
0.7
1987-1990
1990-2000
2000-2007
2007-2017
Source: U.S. Bureau of Labor Statistics

Country	Indicator Why Industry 4.0	1979-2012	2007-2012	2010-2011	2011-2012
United States	Output per hour	**4.0**	**2.7**	**0.4**	**3.8**
	output	2.6	-0.1	2.5	6.2
	hours	-1.3	-2.7	2.1	2.3
France	Output per hour	**3.1**	**0.8**	**2.5**	**-1.1**
	output	0.9	-1.6	2.1	-1.9
	hours	-2.1	-2.4	-0.4	-0.9
Germany	Output per hour	**2.8**	**0.5**	**5.6**	**-0.5**
	output	1.3	0.1	9.1	-0.7
	hours	-1.4	-0.4	3.3	-0.2
Japan	Output per hour	**3.3**	**1.2**	**-1.7**	**-4.7**
	output	2.3	-0.8	-2.7	-0.2
	hours	-1.0	-2.0	-1.1	4.6
Korea, Rep. of	Output per hour	**NA**	**5.1**	**3.7**	**2.4**
	output	8.3	5.0	7.3	2.2
	hours	NA	-0.1	3.4	-0.1
Singapore	Output per hour	**4.8**	**5.9**	**8.1**	**-1.4**
	output	6.6	5.1	7.8	0.1
	hours	1.7	-0.7	-0.3	1.5
Taiwan	Output per hour	**6.0**	**4.9**	**4.3**	**0.4**
	output	6.4	5.4	6.4	1.0
			0.5	2.0	0.6

Productivity (output per hour), output, and hours worked

Average Annual compound rates of change

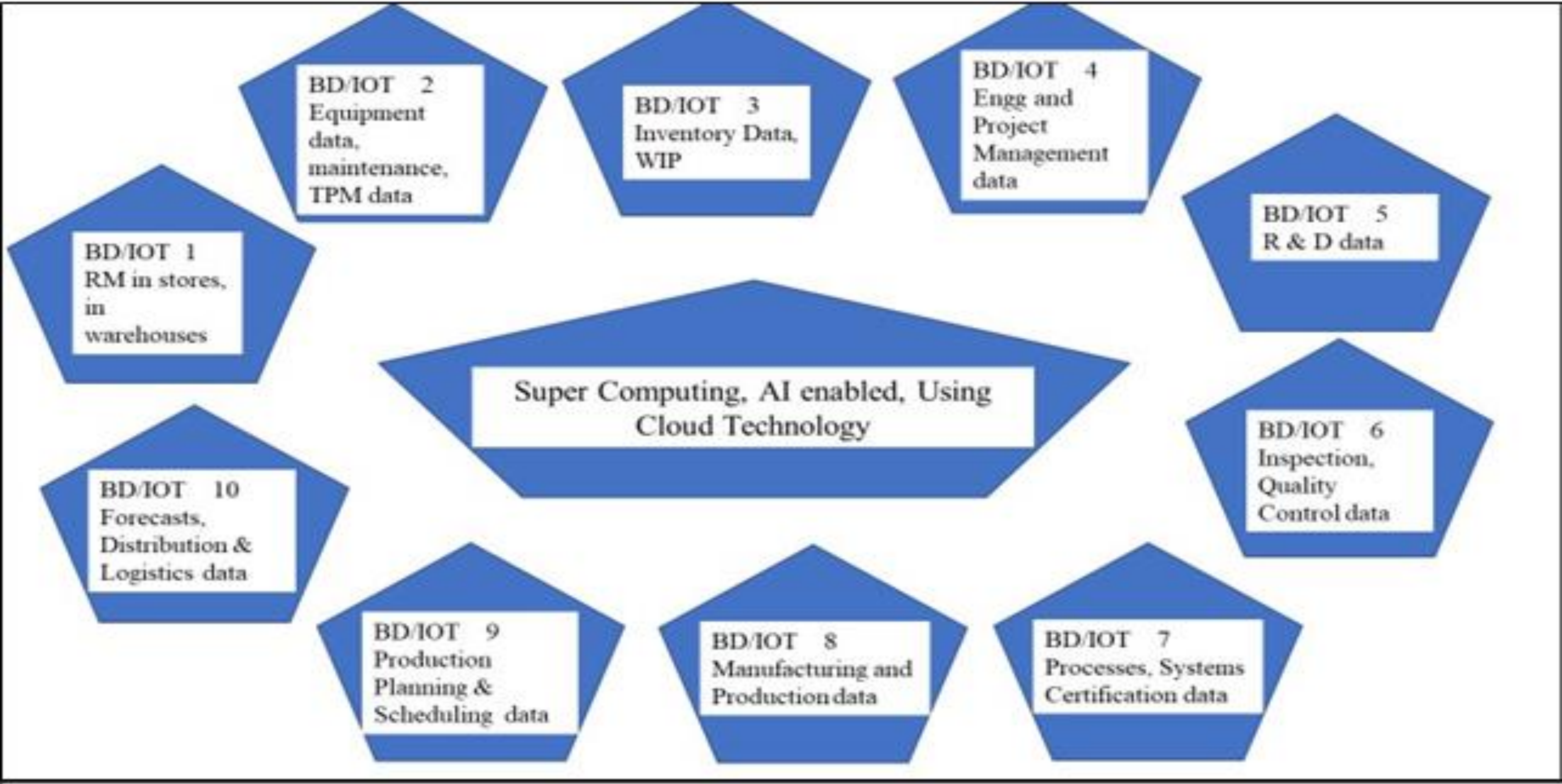


Fig. 1. Showing the Big Data Blocks (BD/IOT) Connected by IOT in the Operations Value Chain diagram I – 4.0 OVC

The Benefits of Industry 4.0 are Real

A recent survey by The Business Development Bank of Canada (BDC) revealed that only 39% of Canadian manufacturers have begun adopting Industry 4.0 solutions such as the Industrial Internet. However, the same survey found that companies who have adopted Industry 4.0 are experiencing very real operational benefits. Isn't it time you joined them?

Improve OEE

60% of adopters said digital technology helped boost productivity

- Predict and prevent unplanned downtime
- Optimize equipment effectiveness and maintenance

Reduce Costs

Almost **50%** reduced operating costs

- Real-time production monitoring and control
- Predictive maintenance
- Automation and 3D printing

Quality Control

42% improved overall product quality

- Reduce (or eliminate) customer returns with real-time quality control

Innovate Faster

13% experienced greater capacity to innovate

- 3D printing
- Remote expert and collaboration technologies

Discover your Industry 4.0 path now.

All data courtesy *Business Development Bank of Canada, Industry 4.0: The New Industrial Revolution (2017)*

- **The Big Data revolution is breathing new life into lean principles and Six Sigma standards.**
- **In effect, it provides back-door entry into a data-rich realm of reasoning that can unlock infinite efficiencies and savings when approached in the right way.**
- **Big Data offers the opportunity for professionals to solve problems previously thought to be unsolvable.**
- **While much progress has been made in medical research and internet marketing, one area overlooked to date is the use of Big Data in the design and improvement of products, services and process quality.**

- **Customer surveys can help us better understand customer needs and experiences.**

- **The collection of manufacturing data and integrating it with customer data can help improve products and processes.**

- **The bad news is that most data used in data mining and Big Data studies are what are called "observational data," in that they are passively collected, rather than produced by carefully designed and randomized experiments.**

- **Such data require a close assessment of the data pedigree as typically no study design is used to assure that good data and the right data needed to solve the problem are collected**

These data often have many limitations which need to be taken into account.

On the other hand, many have adopted a philosophy of “Big Data + Fancy Algorithms = Great Results.” If things were only so easy! This view ignores what has been learned over the years regarding fundamentals of data analysis:

- Problem context: a proper understanding of the problem context enhances the probability that the improvement project will be successful.

- Sequential nature of problem solving: studies are rarely completed with a single data set, but typically require the sequential analysis of several data sets over time

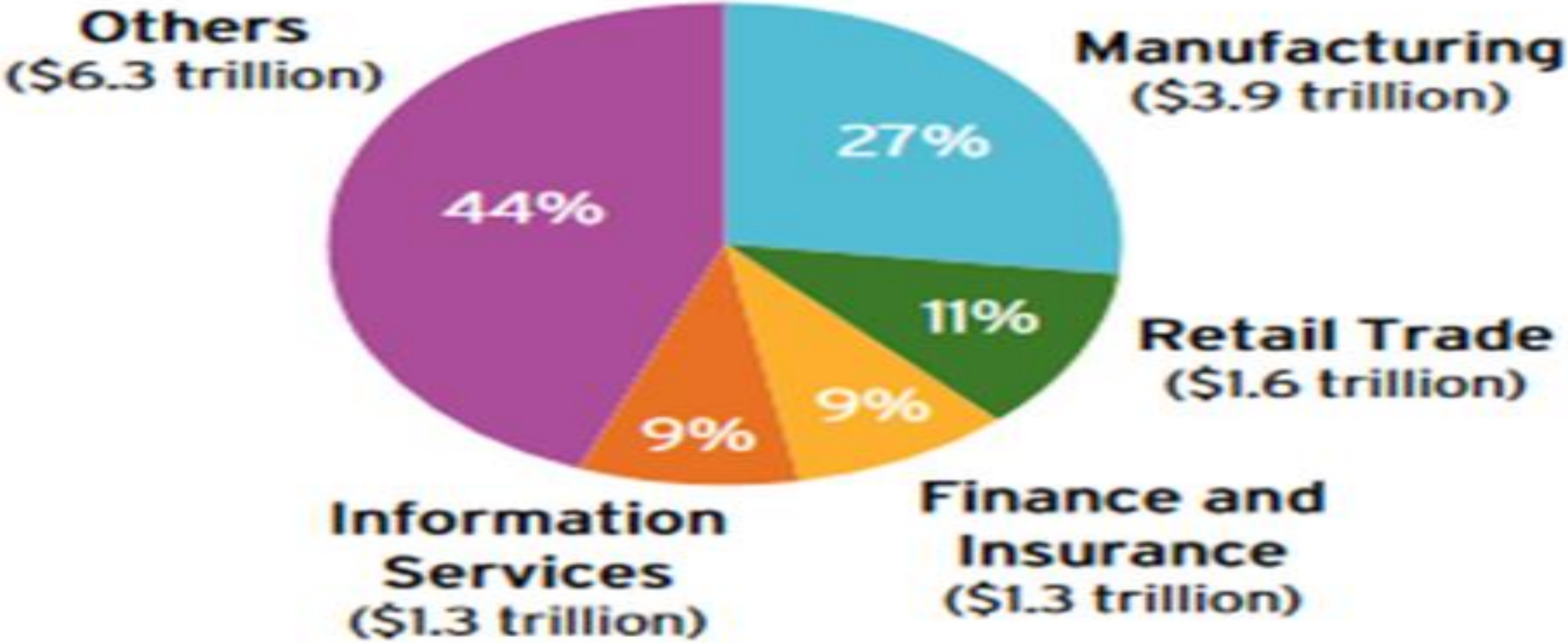
• Strategic thinking: is needed to identify a strategy for how the project will be executed and how the data analysis will proceed.

[Why Industry 4.0]

• Data pedigree: must be assessed to determine the value of the data for solving the problem, quality of the data and how the data should be analyzed.

• Subject matter knowledge: should be used to help define the problem, assess the data pedigree, guide analysis and interpret the results.

Four Industries with Most to Gain from IoT



(Total value: $14.4 trillion)

Source: Cisco

Cost of IoT adoption

- Cost of sensors
- Cost of RFIDs
- Cost of infrastructure and peripheral devices
- Cost of software development
- Cost of data storage capacity development
- Cost of integration with analytics applications
- Cost of software installation and implementation
- Opportunity cost of integration with legacy systems
    - *Loss of working hours during migration*
    - *Loss of sales during migration*
    - *Loss of quality/performance drop during migration*
- Cost of training personnel
- Cost of low productivity in operationalization period

Benefits out of IoT

- Increase in sales – increase in fill rate, customer satisfaction, service level
- Cost savings due to reduced miles in logistics
- Cost savings due to predictive maintenance – increased utilization of machines – greater productivity
- Cost savings from increased process efficiencies – reduced operating cost
- Cost savings due to reduced understocking of RM – smart procurement

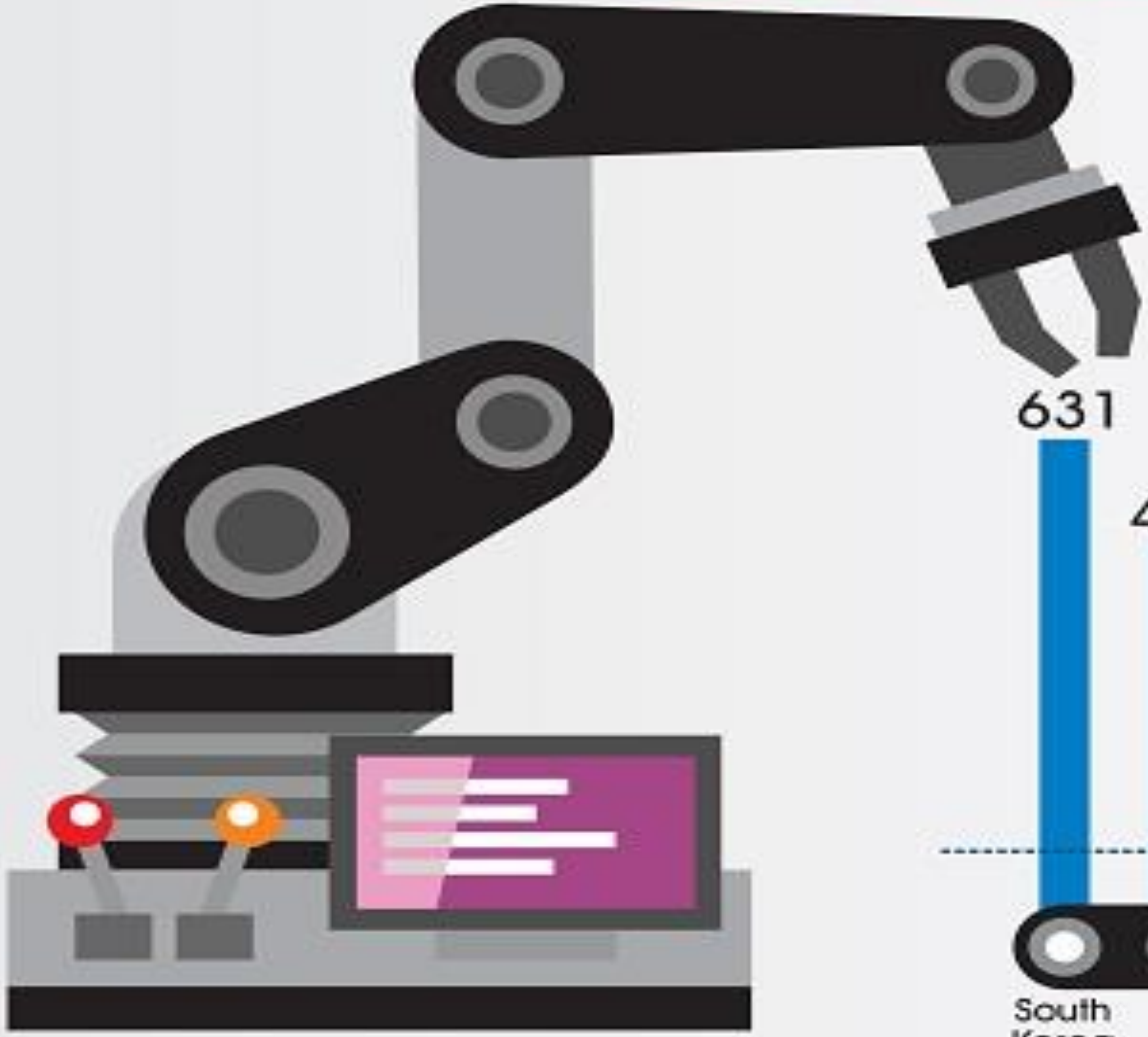
Total cost = Cost of IoT Architecture + Cost of Development & Integration + Cost of IoT deployment + Cost of Training = 33*N + 33000*P + 1600*M + A*(X+Y) + C+ D*T+B*Z

Total benefit = Savings from reducing unplanned downtime + Savings from reducing unnecessary maintenance + Benefits from increased MTBF and reduced MTTR

$= Q*R + K*L + Y*H1*N + MHR*T_f$

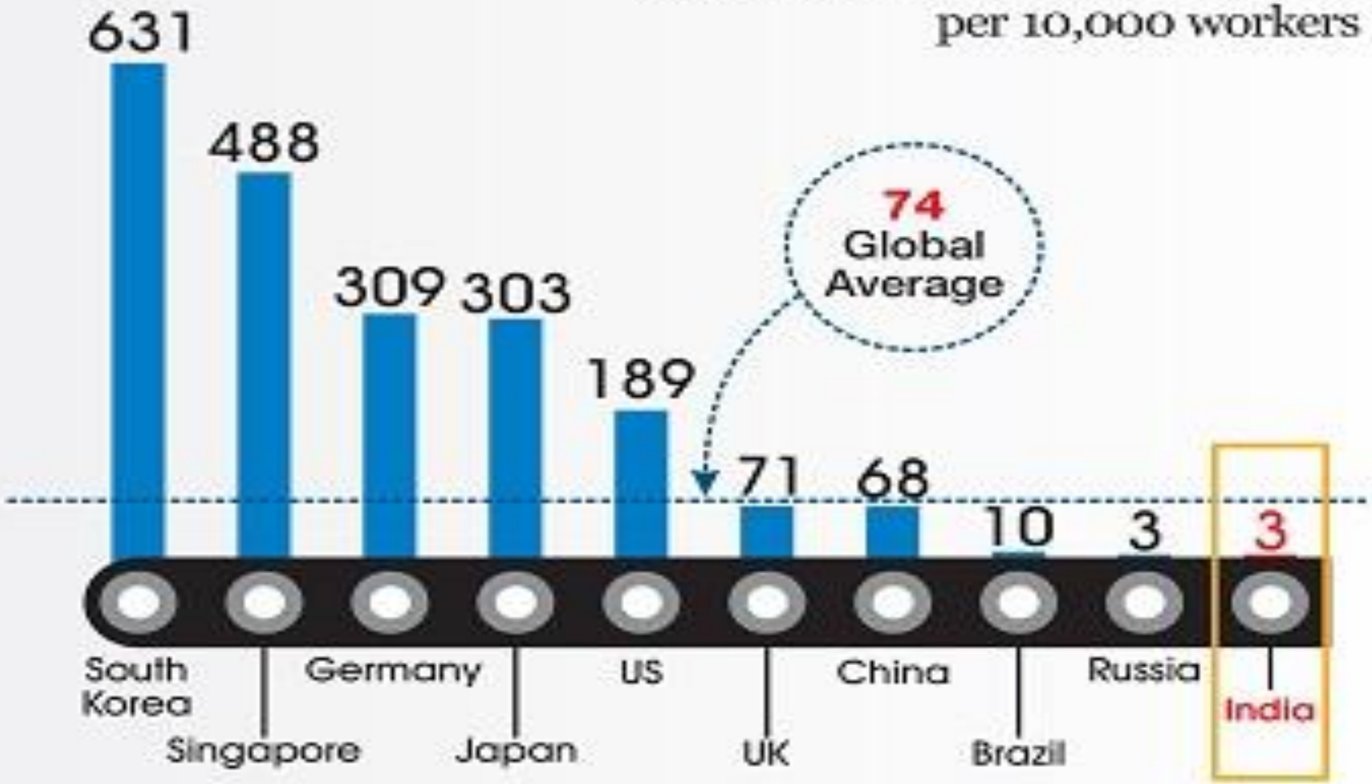
$33*N + 33000*P + 1600*M + A*(X+Y) + C+D*T+B*Z < Q*R + K*L+ Y*H1*N + MHR*T_f$

HOW READY IS INDIA FOR INDUSTRY 4.0?



ROBOTS STILL A RARITY

Despite being the sixth-largest manufacturing country, India's robot density is one of the lowest, with 3 robots per 10,000 workers



Themes and issues with Industry 4.0

- The smart factory – efficient, speedy, programmable, neat and clean, less wasteful, less employment opportunities, robots driven, humans go behind machines, will they result in robotized customers?
- Smart products – always on, monitorable, controllable, programmable, obedient, privacy, nuisance, demanding time and attention
- Cloud computing – voluminous, remote control, outsourcing, core competency, speedy adaptability (cloud owners can offer algorithms for optimization), cyber security, hacking, data manipulation and real time data damage, loss of competitiveness

Themes and issues with Industry 4.0

- IIOT – connectivity, reach, monitoring in real time, CAPA using AI, machine learning opportunities (replacing human continuous improvement interventions- what will happen to quality circles, small group activities, team work), preventive and real time maintenance, interruptions could be costly and need to be managed remotely (what will happen to gemba?)
- AI – more intelligent than the human, best practices, programmable, learnability, neural algorithms (self managing), the tyranny of the few, invisible controls, corruptibility of instructions leading to high damage (not if andon is installed), rigidity

Themes and issues with Industry 4.0

- Data analytics – fact and data based management (a Baldrige core value), discover interrelationships between various parts of the process, link with social media, optimization, better decision making, data overload, data confusion, data cross-wiring, extensive data gathering (how will costs be affected?), army of sensors
- Robotics – precision, programmable, repeatability, predictability, measurability, data gathering, reliable, durable, wont talk back, no shop floor excitement, shop floor too quiet, rigidity, maintenance intensive, costly?
- 3 D Printing – flexibility, distributed manufacturing, retail production, single piece flow, ideal for rural populations, transport needs could go down, cost could go up

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