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Industry 4.0 critics and comparative review – case study

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Keywords: Industry 4.0, Internet of Things, data analytics, automation systems, new age technologies.
Abstract: Advancements in analytics and IoT have enabled businesses to see more clearly throughout their supply chains. With this increased connectedness, supply chain management, wait times can be reduced, and logistics may be enhanced. Industry 4.0 has two effects on workers who are human. over the one hand, this enhances output and efficiency as machines take over tasks that humans can no longer accomplish. New skills and knowledge are nevertheless required as human tasks change. Regarding the need for new skills and knowledge, industry 4.0 is also having an impact on human labour. As a result of Industry 4.0, workplaces and the skills required for success are evolving. The main consequence is the need for new knowledge and abilities.

1 Introduction

The recognition of an innovation is contingent upon its potential for individual and social applications, which are multiplied and diverse due to their significance. It is also feasible to claim that true innovation consists of reshaping humanity's actual requirements by allowing the entirely unanticipated to become possible. These phrases clearly place the idea of Industry 4.0 in the innovative fields that are thought of as a theory ahead of actual practice, which is likely to create the connections between people and their societies with the future.

A sudden, drastic shift is indicated by the word "revolution." Throughout history, revolutionary shifts in social structures and economic systems have been brought about by new technology and fresh perspectives on the world.

However, the fourth industrial revolution is not limited to intelligent and networked systems and devices. Its reach is significantly wider. Concurrently, there are waves of new scientific breakthroughs in areas such as quantum computing, genome sequencing, nanotechnology, and renewable resources. Because of the confluence of these technologies and their interactions with the digital, biological, and physical worlds, the fourth industrial revolution is fundamentally different from previous revolutions.

Emerging technologies and broad-based innovation are spreading far more quickly and broadly in this revolution than in the others that are still happening in some regions of the world.

1.1 Characteristics of Industry 4.0

Characteristics of Industry 4.0:

- switch to robotronics from manual labor, ensuring that all production operations are automated.
- widespread deployment of unmanned vehicles has led to the modernization of transportation and logistical systems.
- The growth of physical system self-management and inter-machine connectivity is facilitated by the use of the Internet of Things.
- Implementation of self-learning initiatives to ensure ongoing production system development.

1.2 General views on Industry 4.0

A multifaceted concept, Industry 4.0 encompasses several aspects for diverse stakeholders. From our perspective, Industry 4.0 refers to a comprehensive set of cutting-edge technologies that assist industrial processes in becoming more dependable, efficient, productive, and customer-focused.

The change of manufacturing and other industries, driven by information, is known as Industry 4.0, among many other names. Connecting people, data, systems, services, and IoT-enabled industrial assets digitally between the physical and cyber realms is the aim of the Industry 4.0 environment. Acquiring, applying, and optimizing actionable information is the aim. Industry 4.0, according to some commentators, refers to a complete digitalization of the industrial process and a future stage of industry. Some perceive Industry 4.0 as an established concept that embodies enhanced production management and organization over complete value chains and product life cycles.

1.3 Foundational elements of the Industry 4.0 structure

Industry 4.0 frameworks are widely available. Every nation that is actively upgrading its manufacturing base has unique. Industry 4.0 is dependent on multiple cutting-edge technologies. While some are well-known, others have only recently been offered for sale.

The lists of technology used by various analysts vary slightly. (The Boston Consulting Group conducted a research in 2017 that inspired ours.) Nonetheless, Industry 4.0 frameworks typically highlight the following technologies:

Big data and advanced analytics: There are vast amounts of unanalyzed product and process data in the industrial environment. Its analysis and subsequent transformation into useful information can enhance services, optimize production quality, and facilitate quicker and more accurate decision-making.

Advanced robotics: Robots will interact with humans, collaborate with them safely, and eventually pick up knowledge from them as they develop in flexibility, cooperation, and autonomy. Industry 4.0 offers these opportunities within a production framework.

Advanced simulations: Pre-production testing and process optimization for products will be possible for operators in Industry 4.0 environments thanks to 3D simulation of product creation, material development, and manufacturing processes.

Artificial intelligence (AI) and cognitive computing: Cognitive manufacturing leverages the Internet of Things (IoT), sophisticated data analytics, and cognitive technologies like AI and machine learning. The quality, effectiveness, and dependability of industrial operations will all improve when these technologies are combined.

Industrial Internet of Things (IIoT): A growing number of products will include internet-connected components that communicate with one another via common protocols. With this manufacturing strategy, analytics and decision-making will be decentralized, allowing for real-time responses.

Additive manufacturing: In Industry 4.0 manufacturing settings, these technologies are the most effective option for creating high-performance, customized, small-batch goods.

Cloud-based service-enabling technologies: Compared to previous processes, Industry 4.0 manufacturing operations need a greater amount of data sharing between sites and businesses.

The creation of more industrial execution systems (MESs) that employ cloud-based machine data will be fueled by the move to cloud-based data management and storage.

Augmented reality (AR): AR allows real-world production views to be overlaid with virtual information to effectively portray manufacturing processes. The most likely use of AR in ASEAN nations is to teach technicians and future employees how production systems operate in real time.

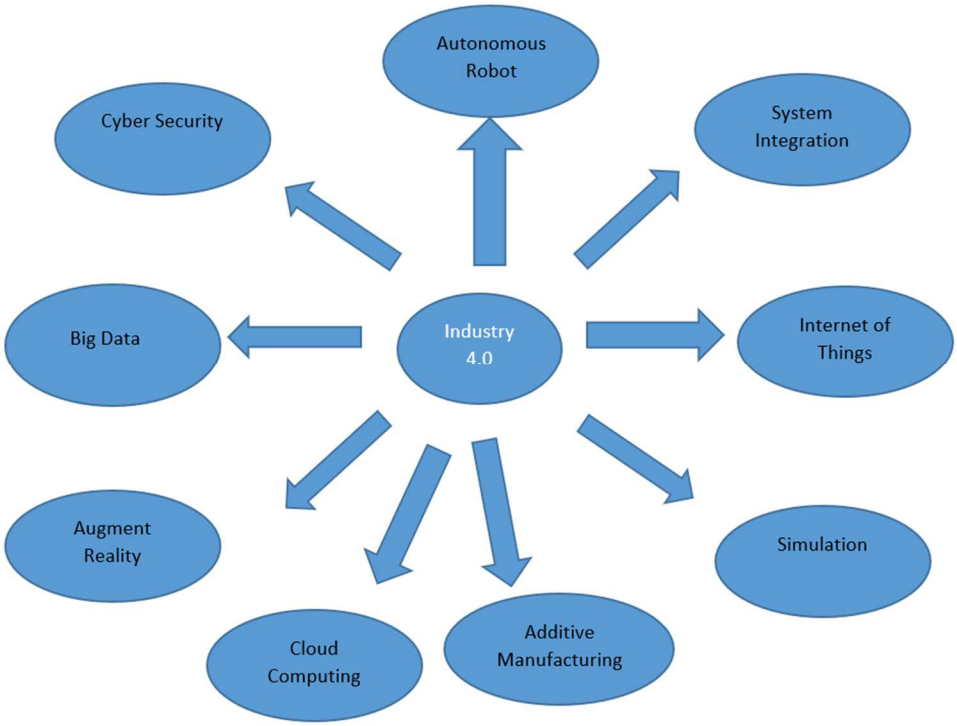

Figure 1 Industry 4.0 architecture

Figure 1 describes about the wide range of applications comprised Industry 4.0 are exemplified by Emerging Technologies. The technological world of Industry 4.0 is not one of solitary assembly lines or factories. Technologies interact with one another, with production hierarchies, with value chains, and with product life cycles in fully realized Industry 4.0 environments.

1.4 Network connectivity in Industry 4.0

Globally interconnected machinery, industrial products, internet-connected gadgets, virtual

representations of these things, and people are all connected by data transmitted over digital networks. An important aspect of Industry 4.0 systems is how various degrees of human participation interact with networked machines. This ubiquitous connectivity has consequences for design and operations for Industry 4.0 manufacturing and systems engineers. Interoperability and connectivity are linked; shared communication protocols are not only becoming the standard. They are increasingly being included in the design of the production process. Cyber-physical systems the technologies that allow for the operation of smart factories are made possible by connectivity. Intelligent production objects are linked to embedded physical devices that have the ability to store and process data through cyber-physical systems.

1.5 Data integration in Industry 4.0 – overview

Throughout the product life cycle and at various levels of the production hierarchy, integration deals with the data flow between linked equipment and devices.

The term "horizontal integration" describes the linkage and data transfer between IT systems for all production and business planning procedures linked to manufacturing. Thus, digitizing supply chains and value chains as a whole is the goal of horizontal integration. End-to-end horizontal integration connects IT systems, information flows, big data, analytics, and IoT devices from supplier to customer. In conventional manufacturing thought, the steps that take place after components enter the factory floor and before they exit as a finished product were all considered to be part of the production process.

A broader viewpoint is necessary for Industry 4.0 concepts. Currently, the life cycle of a product starts with the first concepts for its development and goes horizontally through the stages of research, development, and manufacturing, ending with sales and potential recycling or disposal. The term "vertical integration" describes the connection of IT systems to equipment and machinery operating at various stages of the production hierarchy. These hierarchical tiers, to use conventional language, consist of:

- Field level: sensors translate ambient data into signals for analysis, and actuators translate signals into actions.
- At the control level, actuators are driven by controllers that collect process data from sensors.
- Production process level: wherein automated systems keep an eye on, manage, and modify particular operations inside production processes.
- The operations level is where things like quality control and production scheduling are done.
- Production planning and market analysis are made possible by the enterprise planning level, which oversees the entire production system.
- The connected global level is where production facilities are no longer isolated, expanding the traditional hierarchy. Data flow between production systems is supported and connected by network assets and procedures at this level. Industrial communications networks transfer data from one level of the hierarchy to the next, connecting all vertically integrated levels.
- We are conversant with topics like the product life cycle, manufacturing procedures, and production hierarchy. Early on in the development of Industry 4.0, the challenge was figuring out how to combine these ideas in a way that was simple to use and comprehend.

2 Literature review

Literature information focused on various review and critics on Industry 4.0 challenges and Impact in present and future.

V. Alcácer et al [1], the digital age is ushered in by Industry 4.0. Business models, surroundings, manufacturing systems, equipment, operators, goods, and services are all digital. Everything is linked together within the virtual scene and its matching virtual representation. Continuous mapping of the physical fluxes will take place on digital platforms. At an advanced stage of automation, numerous systems and software are facilitating factory communications with the newest developments in information and communication technologies, creating a state-of-the-art factory both inside and outside the plant, and completing every link in the value chain in real-time. All things are intelligent. The paradigm shift towards smart manufacturing will be made possible by this disruptive effect on manufacturing enterprises. The demise of traditional centralized applications is coming with Industry 4.0.

Jesús Hamilton Ortiz et al. [2], the concept of Industries 4.0, one of the major shifts that will define our way of life, is the main topic of this article. We want to talk about the fundamentals, process automation and enhancements, how to turn SMEs into Industry 4.0 companies, some financial and educational considerations, investment payback, and so on. Although there is much to say about this subject, our goal is to present both the industry's current state of affairs and its anticipated future developments for Industry 4.0. This chapter also outlines the transition from Industry 4.0 to Society 5.0, which in turn contains an upcoming version of Industry 5.0 that is anticipated to launch in 2020.

Yongxin Liao et al. [3], the fourth industrial revolution has garnered increasing global interest over the past few years. The state of the art for this next industrial revolution wave is still not thoroughly reviewed in the literature as it is now. By examining the scholarly advancements in Industry 4.0, this study seeks to close this gap. To analyze the scholarly articles on Industry 4.0 that were published online through the end of June 2016, a thorough assessment of the literature was conducted.

Shashank Kumar et al. [4], this paper's goal is to examine the body of material already written about

Industry 4.0 and look for new developments in this field. "- Using the inclusion and exclusion approach, research papers are chosen for the literature review. In addition, the literature is separated into three sections according to the study field and framework. The report focuses on a rapidly expanding topic of study. In addition, the several Industry 4.0 frameworks from the manufacturing, ergonomics, production, and environment domains are recognized to organize the upcoming studies.

Dan Li et al. [5], as the industrial sector grows more complicated in the context of Industry 4.0, mostly as a result of shifting consumer demands, humans become increasingly important. SMEs can gain a competitive edge by effectively handling the difficulties posed by growing complexity.

Enabling technologies that facilitate the burgeoning phenomena of Industry 4.0 may streamline knowledge and information exchange among employees, particularly for Operator 4.0. Few SMEs, nevertheless, have really used these technologies for this reason. Thus, by outlining the stages of Industry 4.0 development of SMEs in terms of their capabilities, this study seeks to increase understanding of the existing status and obstacles that need to be overcome as well as to offer some views on future prospects. This qualitative research of interviews focuses on the ways that office and assembly work are today supported by human-centered manufacturing processes. In the course of studying two Swedish SMEs, in-person interviews with nearly every member of the management team and operators were conducted to get their opinions on the companies' present capacities.

Moustafa Elnad et al. [6], one of the most discussed and popular subjects in the last few years is the idea of Industry 4.0. Over time, it has drawn interest from academics, professionals, and decision-makers all around the world. To accurately reflect the current status of this new paradigm, a more thorough evaluation of the studies in the literature is nonetheless required. In order to close this gap, a thorough analysis of prior research on Industry 4.0 will be conducted in order to determine its managerial, organizational, and technology enablers as well as its implementation benefits and obstacles. The study indicated that industry 4.0 is still an immature topic and applying this new paradigm is not a matter of technology alone. Organizational and managerial aspects should be taken into consideration. A systematic literature review was conducted, in which 244 peer-reviewed journal papers were analyzed in the Scopus database until the end of May 2022. Conference papers, book chapters, and journal papers not written in English were excluded from this study.

Dimitris Mourtzis et al. [7], by boosting operational efficiency and creating and implementing new services, products, and business models, Industry 4.0 changed manufacturing and production systems. Improving the sustainability and effectiveness of manufacturing systems was the specific benchmark for Industry 4.0. Consequently, the focus was on the digitization as well as the digitization of systems, leaving opportunity for additional development. But rather than being focused toward humans, the contemporary technological growth is primarily oriented toward systems and machines. Consequently, a number of nations have started coordinating efforts aimed at designing and developing the human-centered component of systems, services, and technologies—a concept known as Industry 5.0. Impacts from Industry 5.0 will also be felt throughout society, which will ultimately result in the creation of Society 5.0, a new society. The advances will center on the tools and technologies presented within the Industry 4.0 framework, with a particular emphasis on their social and human-centric aspects.

Wichmann et al [8], given the 21st century's digital firms' explosive growth, industrial manufacturing is predicted to be nearing the advent of Industry 4.0, the term for the fourth industrial revolution. Combining the digital and physical factories into one is the key technology that will propel this development. Experts in the field and business agree that there will be a fundamental paradigm change in the way products are created and produced. There is no consensus on how specific organizations may make use of these developments, despite widespread conviction that the future factory will have unparalleled ability to meet complicated client demands.

Marina Crnjac Zizic et al. [9], economic development is significantly influenced by the industry. But the advent of new technology and the growing intricacy of goods and manufacturing processes have a direct impact on workers and industrial businesses. The technocratic orientation of the Industry 4.0 paradigm and its emphasis on digitization were highlighted by its detractors. Consequently, the emergence of the new industrial paradigm, known as Industry 5.0, quickly set off a discussion on the purpose and justification for implementing the new paradigm. The focus on the worker, who plays a crucial part in the production process and whose function was highlighted during the COVID-19 outbreak, is what Industry 5.0 brings to the table to complement the current Industry 4.0 paradigm.

Yang lu [10], Industry 4.0, often known as the fourth industrial revolution, was first introduced in Germany and has garnered a lot of interest in recent literature. It has close ties to information and communications technology (ICT), enterprise architecture (EA), enterprise integration (EI), cyber physical systems (CPS), and the Internet of Things (IoT). Nevertheless, despite the dynamic nature of Industry 4.0 research, there hasn't been a comprehensive and methodical overview of recent studies on the topic. As a result, by looking through the body of literature in every Web of Science database, this paper undertakes a thorough analysis of Industry 4.0 and provides an overview of its findings, content, and scope. A total of 88 Industry 4.0-related articles are reviewed and categorized into five study areas.

Hamed Nayernia et al. [11], Industry 4.0 (I4.0) is a rapidly developing topic of study that combines expertise from several academic disciplines to produce innovative manufacturing solutions. The organizational aspect of implementing I4.0 has received relatively little study attention, despite the rising body of published work spanning a wide range of I4.0 subjects. This systematic review study employed quantitative analysis using text-mining 97 publications from 2015 to 2021 in order to close this gap. Eleven research streams were found by the investigation and categorized into five levels: supply chain, data, smart factories, industry and company, and human resources.

Amr Adel [12], the industry has been using industry 4.0 for the past ten years to address its inadequacies; now, industry 5.0 is finally ready. Industry 4.0 has restrictions because smart factories are raising corporate productivity. The industry 5.0 opportunities, constraints, and prospects for future research are all covered in this report. With its reduced focus on technology and assumption that human-machine cooperation is the foundation for success, Industry 5.0 is bringing about a paradigm shift and resolution. Personalized products are helping the industrial revolution increase customer happiness.

Fengwei Yang et al. [13], the ideas of Industry 4.0 were first introduced in 2011, and since then, the revolution has developed and moved beyond abstract ideas to practical implementations. Its application is widespread and has a wide range of effects on almost everyone. On a national and worldwide level, modifications are beginning to show while we adjust to new developments. It's becoming obvious that more than simply fresh ideas are at work; markets, governmental regulations, and technological developments are all interwoven like never before. Here, we provide a general explanation of Industry 4.0 concepts along with an explanation of some new terminology and problems related to completeness and clarity.

Michael Sony [14], academicians and practitioners worldwide are currently discussing Industry 4.0. Because they will enable organizations to make informed decisions about the implementation of Industry 4.0, the benefits and drawbacks of this technology are enormous. The academic literature that compiles and evaluates Industry 4.0's benefits and drawbacks is scarce, despite the fact that there are several research on the topic. This paper's goal is to examine, from an academic standpoint, the benefits and drawbacks of implementing Industry 4.0 in organizations. The early research on Industry 4.0 are the subject of a thorough and systematic review of the literature. On the remaining sixty-four articles in the sample, descriptive, category, keyword, and thematic analyses are performed. This report explains the future research areas and finds nine benefits and seven drawbacks of applying Industry 4.0 in enterprises.

Ercan Oztemel et al. [15], economic and societal advancement are significantly impacted by the manufacturing sector. Since "industry 4.0" is now a widely recognized name for research institutes and universities, the business and research communities have taken a keen interest in the project. While the concept is not new and has been discussed in academic research for many years with varying perspectives, the name "Industry 4.0" has recently been introduced and is somewhat accepted in both academic circles and the industrial society. In order to raise awareness of the greatest experiences, this report provides a review that highlights the progress. Its purpose is to offer a clear concept to anyone who want to create a roadmap for digitizing the corresponding production suits. The purpose of offering this evaluation is to give academics and industry practitioners access to a practical resource on Industry 4.0. To make sure that the evaluation procedure was reliable, the top 100 headings, abstracts, and key phrases (that is, 619 publications overall, regardless of type) for each search keyword were examined separately.

The literature review revealed that while industry 4.0 principles have the potential to progress manufacturing, they also appear to be a barrier for shop floor personnel. Information from literature addresses the historical, contemporary, and prospective conditions of industrial businesses.

3 Case study of Industry 4.0 implementation and its challenges – overview

In this section brief case study is carried out to analyze the significant importance of Industry 4.0 challenges in workplace. The analysis is carried out by survey technique through google forms. While constructing the survey the following questionnaire were listed here below:

Q1. Do you agree that the concept Industry 4.0 has more awareness towards staffs and expert members in organization?

Q2. How far Educational Institutions in India pay willingness in realizing Industry 4.0 concept in Core curriculum?

Q3. How do you rate and access the Internet speed for Industry 4.0 in Indian Educational Institutes?

Q4. Whether funded projects related to Industry 4.0 is Important?

Q5. Do you think multidisciplinary team is Important?

Q6. Do you agree the scope for increase in market growth if Industry 4.0 implemented in Indian organization?

Totally 16 responses collected from various members in different organizations like Industries, Educational Institutes etc.

The sample survey form is illustrated in table 1, as listed below.

Table 1 Sample survey form

	B	C	D	E	F	G	H	I	J
1	Name of the Employee	Name of the Organization	email ID of employee	Designatio	Departme	Q1. Do yo	Q2. How f	Q3. How c	Q4. Whetl
2	Kishore Goud B	CTS	KishoreGoud.B@cognizant.com	Manager	Insurance	Yes I some	Yes I some	Better	strongly a
3	Bharathan	Dhaanish Ahmed college of Engineering	baskarbharath10@gmail.com	Assistant	Mechanic	Not agree	Neutral	poor	strongly a
4	Dr.C.Subramanian	Christ College of Engineering and Technology	csmanianmec@gmail.com	Professor	Mechanic	Yes I some	Neutral	Neutral	strongly a
5	Thamizhmaran.k	Christ college of engineering and technology	CCT 274	Senior ass	Mechanic	Yes I some	Yes I some	poor	agree
6	MD BAHAUDDIN	ISL ENGINEERING COLLEGE HYDERABAD	132	Assistant	MECHANI	strongly a	strongly a	strong	strongly a
7	Kannan GK	Chennai Institute of Technology	kannangk@citchennai.net	Assistant	Mechanic	strongly a	Yes I some	Better	strongly a
8	Rosi H	Manakula Vinayagar Institute of Technology	rosi.mphil@gmail.com	Assistant	Chemistry	strongly a	strongly a	strong	strongly a
9	Senthilmurugan	Yamaha	Senthilmurugan2001@yahoo.co.in	Incharge v	Vehicle as	Neutral	Neutral	Neutral	Neutral
10	P T RAJEENA MOL	Nehru College of Engineering and Research Centre	e 3499	Assistant	EEE	Not agree	Neutral	Better	agree
11	C V gowri Sankar	NIQR	cvgsankar@gmail.com	ECM	EC	strongly a	Neutral	Neutral	strongly a
12	Karthigayan K	Safe Infratech	879	Manager	Maintenai	Neutral	Yes I some	Neutral	agree
13	Guru Prasath	Ccet	velayuthamb65@gmail.com	B.tech	Mechanic	Neutral	Neutral	Neutral	Neutral
14	Naresh	Tech Mahindra		Senior As	Technical	Neutral	Yes I some	Neutral	strongly a
15	Capt. I.V.S. Rama Krishna	AMET City College	captainindraganti@gmail.com	Principal	Nautical	Neutral	Not agree	poor	Neutral
16	K. Palani	Ashok Leyland	kpalani76india@gmail.com	Senior Ma	Safety	strongly a	strongly a	Better	agree
17	Padmanabhan Panchu K	Anna University	66809	Associate	Industrial	Yes I some	strongly a	Better	strongly a
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									

Table 1 indicates the basic information about the respondents and sharing of opinion given by the respondents are clearly indicated in the form as shown in table 1.

3.1 Observations from respondents

In the survey analysis there are totally 6 questions constructed. All questions are analyzed based on the inferences from various respondents.

Q1. It is observed that 31.3% of the employees given their opinion regarding the awareness of Industry 4.0 in workplace. Today Majority of the Organizations recognize the need of Industry 4.0.

Q2. Only 31.3% of the respondents have positively replied on Industry 4.0 concepts in the introduction of education Curriculum.

Q3. Just 12.5% of the employees given their positive opinion on network speed and access to Industry 4.0.

Q4. 56.3% of the respondents given the reply towards the financial support for carrying out projects on Industry 4.0 related work.

Q5. 56.3% of the employees accepted that cross functional team is necessary to work in Industry 4.0.

Q6. Only 50% of the employees shared their positive feelings towards market growth potential of Industry 4.0 In Indian Organization.

4 Conclusion and future scope

In this research work attempt has been made to preform detailed review and sensitivity study on Industry 4.0 with respect to Indian working climate. Case study was illustrated to analyze the potential challenges of Industry 4.0 in workplace organization through survey method. Nearly 16 responses recorded in the survey form. Based on the survey form data it is reported that most of the critical parameters like internet speed, self-readiness, Multidisciplinary approach, Market growth are some of the critical factors influences the success of Industry 4.0. Hence it is recommended to improve the infrastructure and other facilities like training, team projects etc. Management must take enough care to adopt the employees to accept the change by improving the method of work, culture etc.

4.1 Future scope

Industry 4.0 enhances the method of work apart from conventional work. It increases the productivity through smart automation method. At the outset the modern technology helps to keep the human stay strong and updated with all knowledge in recent trends of engineering and technology.

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