Asia-Pacific Economic Cooperation

TECHNOLOGICAL TOOLKIT

Industry 4.0: Enabling Technologies and Inclusive Digitization for Post-COVID-19 Economic Recovery in APEC Value Chains

APEC Policy Partnership on Science, Technology and Innovation
September 2022

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The present technological toolkit contains Industry 4.0 solutions for increasing technical and commercial capabilities in APEC economies.

The main objective is to present solutions based on the real case study found to support developing economies affected by COVID-19 in the current stage of recovering response to the pandemic. These solutions and best practices presented in this document can help developing economies from the APEC region to understand and learn about Industry 4.0 technologies.

Industry 4.0 is a new era that has created a digitized world where manufacturers must actively work to learn, adapt, and evolve. The cumulative effect of technological advances, adaptations, and optimizations has combined to shape the technological landscape. Nowadays, this concept matured enough to promise a prosperous future for value chains inclining to make the incremental and operational changes necessary to prosper.

It is time to embrace the fourth digital revolution for better, wiser, faster, and inclusive digitation for post-covid 19 economic recoveries in APEC value chains.

Developing the value chains of the different sectors provides a transversal and systemic vision of the characteristics, advantages, and barriers that can arise in a production cycle and in the economic development of the industries, new actors, and generation of business models that increase the efficiency of the flows between suppliers and consumers.

Industry 4.0 is a fusion of the new production methods that allow manufacturers to achieve their targets more speedily.

In this project, the key technologies studied were Artificial Intelligence, the Internet of Things, Blockchain, Cloud Computing, and Robotics.

The new business of tomorrow will rely on modern computer models, such as mobile and interactive systems interconnected. New technologies such as Artificial intelligence, Cloud Computing, Robotics, the Internet of Things, Blockchain, and data processing can help to achieve the establishment of societal foundations where any individual can develop value, at any place or time, in a safe environment and according to natural environments, without limitations such as those that currently exist.

For many value chains, the typical approach is to use specific features within their existing platforms to start the process of digitization.

In this toolkit are presented the best practices to follow when implementing artificial intelligence, Internet of Things, Blockchain, Cloud Computing and Robotic technology in the affected value chains identified in the preliminary diagnosis.

The three-value chain identified were Tourism, Commerce, and Hospitality (Restaurant) which

In the case of the *tourism value chain,* Covid-19 has led to the fact that the primary content of the specialized tourist offers can no longer assure tourist demand. It is expected that post-Covid, the

fundamental dilemmas of tourism supply development will focus on the importance of designing new strategies to specialize the content offered.

The conduct of travelers and the public, in general, is changing very fast. Travelers around the world are increasingly inclined to actively participate in the processes that affect them. In this era, it is also key to use social media tools to confirm their reputation as an identity.

The new technologies can enhance the travel experience throughout the cycle (virtual visits to natural and cultural sites, planning, booking, experience, and information exchange) and open new avenues for more responsible and sustainable consumer behavior. The new digital ecosystem for tourism has also changed as companies and destinations embrace innovation in marketing and communication processes, use a new digital language, adapt digital marketing strategies, and incorporate sustainable principles into their business.

- From the first case study is learned that blockchain has the potential to monitor social and environmental responsibility, improve provenance information, facilitate mobile payments, credits, and financing, decrease transaction fees, and facilitate real-time management of supply chain transactions in a secure and trustworthy way.
- From the second case study, it is learned that different technological solutions can facilitate a touch-free and highly automated shopping experience supported by four basic competitive strategies: branded performance superiority, enhanced customer experience, frictionless shopping experience, and operational excellence-cost efficiencies.

In the case of the *commerce value chain*, it is recommended the integration of online-offline channels for retailer success in the present environment due to changing consumption patterns.

In the case of the commerce value chain, the COVID-19 pandemic has transformed the retail sector and consumer spending habits.

Before the COVID-19 pandemic, many retailers concentrated on investing in e-commerce as a strategy to raise their profitability and last competitive. It turned out to be an opportune decision, as it kept a line of revenue open during confinement restrictions.

- From the first case study is learned that Afterpay is simple technology with a huge meaning for its users. This new way of payment allows consumers to shop now and pay later, always interest-free. With Afterpay, any purchase will be split into four payments, payable every two weeks. Also, it is recommended
- to encourage regulatory and financial systems by the side of the government of each economy, as was the case of Australia, and allow them to become leaders in adopting new payment technology.
- From the second case study, it is learned that different technological solutions that facilitate a touch-free and highly automated shopping experience support four basic competitive strategies: branded performance superiority, enhanced customer experience, frictionless shopping experience, and operational excellence-cost efficiencies.

In the case of the Hospitality (restaurants) value chain has been extremely hard hit by the current Covid-19 pandemic.

Restaurants in many economies were forced to close or operate at reduced serving capacity due to government pandemic containment measures. Even as government-imposed standards were slowly loosened up, the industry continued to suffer from consumers' perceived risks, lack of confidence, and pervasive loss of safety induced by the pandemic.

- From the first case study, it is learned that robotics, in collaboration with the AI sector has developed technology that reduces human contact and has seen implementation worldwide; robots are an example of how they can improve safety and customer service in restaurants. Also new Business Intelligence tools allow restaurants to have information such as visitor prediction AI or traffic volume survey through data analyses.
- From the second case study, is learned that an appropriate combination of strategies from five themes (pandemic prevention and control, customer service innovation, cooperation with third parties, product innovation, and innovative marketing strategy) can lead restaurant enterprises to make the right decisions. It is recommended that the restaurant value chain should assess its technological needs and adopt the relevant technologies to accelerate innovation's pace and scope.

Also, a synthesis of the best practices of the participating economies from the Virtual Symposium is presented.

- Artificial Intelligence (AI) basically is the ability of a machine controlled by a computer to do tasks that are usually accomplished by humans because they require human intelligence and discernment, therefore. The best practices founded in Artificial Intelligence were: (1) data is key for the implementation, (2) design a strong use case that delivers impactive benefits, and (3) consider customer satisfaction as key.
- In the case of the Internet of Things (IoT), industries are always searching for different ways to improve device security. As many threats arise nowadays, each new IoT endpoint introduced into a network brings a potential entry point for cybercriminals that must be addressed. The best practices found for the implementation of the Internet of Things were: (1) updated Systems, (2) have correct device management, and (3) security and regular audit actions on the network.
- Blockchain is a system of recording data that is difficult to change or hack. This technology provides a record of almost real-time replicated between a network of business partners and is unchanging. The best practices found in Blockchain were: (1) smart contracts security, (2) blockchain security, and (3) interoperability.
- Cloud Computing is a concept that offers computing as a service, making it possible for shared resources to become available to devices on demand. It is a technique that enables ubiquitous access to computing and network resources and is a system of recording data that makes it difficult to change or hack the data. The best practices found in Blockchain were: (1) conceive an

adoption strategy, (2) educate and train Resources, (3) choose the right model, and (4) automation.

- The case of Robotics generates an undeniable upward change in the activity of a company when applied correctly. It positively affects routine operations, streamlines the overall assembly workflow, and even works to manufacture food. The best practices found in Robotics Technology were: (1) select the processes to be automated, (2) consider the correct human resources, and (3) train and educate the resources.

In future works, it is proposed to start projects implementation of Industry 4.0 technologies in developing economies to generate a more competitive advantage for their more affected value chains.

I. INTRODUCTION

This technological toolkit reports on the project "Industry 4.0: Enabling Technologies and Inclusive Digitization for Post-COVID-19 Economic Recovery in APEC Value Chains" last deliver and comprises:

1. A synthesis of the best practices of the participating economies (from Virtual Symposium); validating the diagnosis of the value chains most impacted by Covid-19 in the APEC region.
2. Business models and the adoption of 4.0 technologies in main production chains to ensure growth or take-off as intervention strategies to reactivate APEC economies through ICTs (2 case studies were selected by APEC for each value chain identified in the preliminary document).
3. Recommendations to increase awareness of the existing challenges in the application of technology to promote the upgrade of value chains, supporting the digitization of its processes to derivatives for innovation, ensuring connectivity, and, above all, resilience.
4. The main activities and topics covered in the Virtual Symposium analyses the speakers' presentations, the panelists' discussions, and the reactions of the public to draw conclusions about the enabling technologies and inclusive digitization for post-covid-19 economic recovery in APEC value chains
5. An annex is containing the "Diagnosis of the Value Chains Most Impacted by Covid-19 in the APEC Region".

II. INDUSTRY 4.0

In 2013, Germany proposed ten primary projects as pillars of Germany's High-Tech Strategy 2020 Action Plan. Moreover, that Industry 4.0 plan was identified as the most promising endeavor for Germany to establish itself as a leader of the digital integrated industrial supply chain[1]. Soon after the announcement of the industry 4.0 plan, the concept of digitization of manufacturing was widely discussed, and many researchers made proposals regarding new technologies that will allow the achievement of Industry 4.0.

The network of advanced technologies such as services, automation, robotics, artificial intelligence, the Internet of Things (IoT), and additive manufacturing are the elements that will reshape businesses in different industries. The new wave of transformations in production systems will blur the boundaries between the real world and virtual reality, causing the phenomenon of Cyber-Physical Production Systems (CPPS)[2]. These new technologies have opened the vision of how Industry 4.0 will shape the future of different value chains.

2.1. New Technologies

Industry 4.0 is a fusion of the new production methods that allow manufacturers to achieve their target more speedily. Many researchers have been conducted on various Industry 4.0 technologies like Artificial Intelligence (AI), Big data, Blockchain, and Internet of Things (IoT), and how they could create significant interruptions in recent years[3].

2.1.1. Artificial Intelligence

The term "artificial intelligence" was formally proposed at a conference at Dartmouth University, in 1956, that was the first step in a new topic of studying how machines simulate human intelligent activities.

In 2016, AlphaGo defeated the world chess champion. This event immediately aroused global interest in artificial intelligence[4]. The development of artificial intelligence has brought interesting economic benefits to mankind and has benefited all aspects of life, even as it has greatly promoted social development and brought social development into a new era [5].

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[1] Xu, Li & Xu, Eric & Li, Ling. (2018). Industry 4.0: State of the art and future trends. International Journal of Production Research. 56. 1-22. DOI:10.1080/00207543.2018.1444806.

[2] Schumacher, A.; Erol, S.; Sihn, W. A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises. Procedia CIRP 2016, 52, 161–166.

[3] Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shahbaz Khan, Rajiv Suman(2021). Blockchain technology applications for Industry 4.0: A literature-based review. Blockchain: Research and Applications. Volume 2, Issue 4. ISSN 2096-7209, https://doi.org/10.1016/j.bcra.2021.100027.

[4] Xu, L.D. (2013), Introduction: Systems Science in Industrial Sectors. Syst. Res., 30: 211-213. https://doi.org/10.1002/sres.2186

[5] Y. Lu, L.D. Xu, Internet of Things (IoT) cybersecurity research: a review of current research topics, IEEE Internet Things J. 6 (2) (2018) 2103–2115.

The Artificial Intelligence (AI) uses computers to simulate human intelligent behaviors and it trains computers to learn human behaviors such as learning, judgment, and decision-making[6]. AI is a knowledge project that takes knowledge as the object, obtains knowledge, analyzes, and studies the expression methods of knowledge, and employs these approaches to achieve the effect of simulating human intellectual activities[7].

AI is a compilation of logic, computer science, psychology, biology, and many other disciplines, and it has achieved remarkable results in applications such as speech recognition, image processing, natural language processing, the proving of automatic theorems, and intelligent robots[8]. AI plays an indispensable role in social development, and it has brought revolutionary results in improving labor efficiency, reducing labor costs, optimizing the structure of human resources, and creating new job demands[9].

2.1.2. Internet of Things

The Internet of things is converting any system to be intelligent. Recent operating systems are used to meet the requirements of modern systems. There are many platforms for the Internet of things that have been developed. However, most of them are made for certain implementations and do not manage the current limitations of the current systems[10].

The IoT concept was created by a member of the Radio Frequency Identification (RFID) development community in 1999. It has recently become more appropriate to the practical world primarily because of the growth of mobile devices, embedded and ubiquitous communication, cloud computing, and data analytics[11,12].

The Internet of things is a network of physical objects. The Internet is not only a network of computers, but it has expanded into a network of devices of all sizes and types, smartphones, home appliances, medical instruments, and industrial systems, animals, people, buildings, all connected, all communicating & sharing information based on specific protocols in order to achieve intelligent reorganizations, positioning, tracing,

[6] L.D. Xu, Y. Lu, L. Li, Embedding Blockchain Technology into IoT for Security: a Survey, IEEE Internet Things J Early Access (2021), https://doi.org/10.1109/ JIOT.2021.3060508.

[7] L. Duan, L. Xu, Business Intelligence for Enterprise Systems: a Survey, IEEE Trans. Ind. Inf. 8 (3) (2012) 679–687.

[8] L. Duan, L. Xu, Y. Liu, J. Lee, Cluster-based Outlier Detection, Ann. Oper. Res. 168 (1) (2009) 151–168.

[9] N. Duan, L.Z. Liu, X.J. Yu, Q. Li, S.C. Yeh, Classification of multichannel surface electromyography signals based on convolutional neural networks, J. Industr. Integr. Manag. 15 (2019) 201–206.

[10] Majd S. Ahmed, Designing of internet of things for real time system,Materials Today: Proceedings,2021, ISSN 2214-7853, https://www.sciencedirect.com/science/article/pii/S2214785321026122

[11] Patel, Keyur & Patel, Sunil & Scholar, P & Salazar, Carlos. (2016). Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges.

[12] Infocomm Media Development Authority, https://www.imda.gov.sg/ (Accessed on: December 2021)

safe & control & even personal real-time online monitoring, online upgrade, process control & administration[12, 13,14].

The IOT can be divided into three categories: (1). People to people, (2) People to machine /things, (3) Things /machine to things /machine, interacting through internet[12].

Internet of Things is a new revolution of the Internet. Objects make themselves recognizable and they obtain intelligence by making or enabling context related decisions thanks to the fact that they can communicate information about themselves. They can access information that has been aggregated by other things, or they can be components of complex services. This transformation is concomitant with the emergence of cloud computing capabilities and the transition of the Internet towards IPv6 with an almost unlimited addressing capacity[12,13]. The goal of the Internet of Things is to enable things to be connected anytime, anyplace, with anything and anyone ideally using any path/network and any service[12].

2.1.3. Block Chain

Industry 4.0 involves innovations with upcoming digital technologies, and blockchain is one of them. Blockchain can be incorporated to improve security, privacy, and data transparency both for small and large enterprises[15].

Blockchain, is a group of blocks, as shown in Fig. 1 and can be defined as a decentralized, distributed directory driving smart contracts and providing the opportunity to traceability aid, record management, automation for the supply chain, payment applications and other business transactions.

This technology provides a record of almost real-time replicated between a network of business partners and is unchanging. The process takes information that would have previously been stored in the Enterprise Resource Planning (ERP) of the company. It now makes it available in a distributed network of records across disparate companies. Several benefits of blockchain enable organizations to better understand their customers, particularly on the demand side. Data analytics and artificial intelligence have well-understood cases of application. It can also reach a glass ceiling when it comes to technological viability, but several businesses strive for convenience [15].

[13] Dr. Ovidiu Vermesan SINTEF, Norway, Dr. Peter FriessEU, Belgium, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", river publishers' series in communications, 2013.

[14] Dr. Ovidiu Vermesan SINTEF, Norway, Dr. Peter FriessEU, Belgium, "Internet of Things–From Research and Innovation to Market Deployment", river publishers' series in communications, 2014.

[15] Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shahbaz Khan, Rajiv Suman, Blockchain technology applications for Industry 4.0: A literature-based review, Blockchain: Research and Applications,2021,https://www.sciencedirect.com/science/article/pii/S2096720921000221

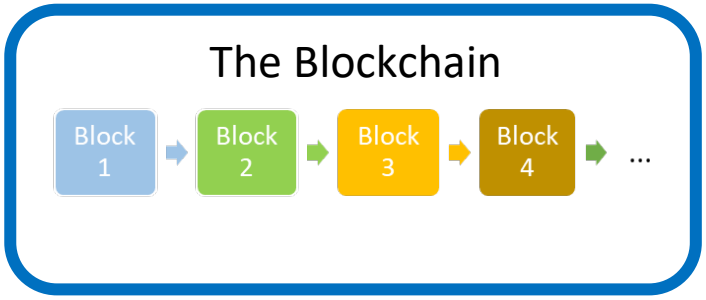


Figure 1. Blockchain graphic representation

2.1.4. Cloud Computing

Cloud computing is a concept that offers computing as a service; making possible that shared resources become available to devices on demand. It is a technique that enables ubiquitous access to computing and network resources[16].

The United States Institute of Standards and Technology, in 2011, defined cloud computing as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., servers, networks, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [17]. The fig. 2 show the relation between Cloud Computing and Internet.

The cloud computing movement is motivated by the idea that data processing and storage can be done more efficiently on large farms of computing and storage systems accessible via the Internet. Computer clouds support a paradigm shift from local to network-centric computing and network centric content where distant data centers provide the computing and storage resources. In this new paradigm users relinquish control of their data and code to Cloud Service Providers[17].

[16] A. Fernandez, E. Insfran, S. Abrahão. Usability evaluation methods for the web: A systematic mapping study. Inf. Softw. Technol. 2011. 53. 789–817. ISSN 0950-5849

[17] Dan C. Marinescu,Chapter 1 - Introduction, Editor(s): Dan C. Marinescu, Cloud Computing(Second Edition) ,Morgan Kaufmann, 2018, Pages 1-12, ISBN 9780128128107, https://doi.org/10.1016/B978-0-12-812810-7.00001-7.

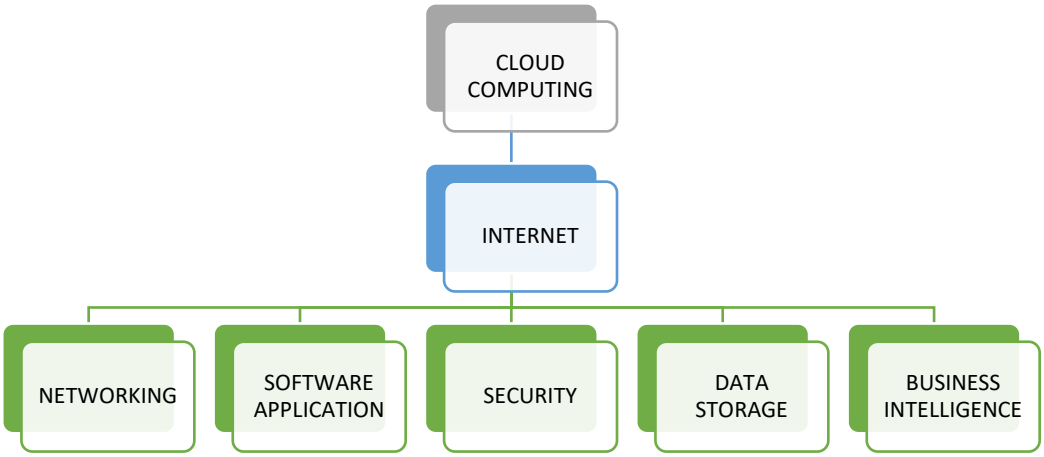


Figure 2.Cloud Computing and the internet relation[18]

Cloud computing uses Internet technologies to offer elastic services. The term "elastic computing" refers to the ability of dynamically acquiring computing resources and supporting a variable workload. A cloud service provider maintains a massive infrastructure to support elastic services [17].

The fig. 3 shows the Cloud Computing features such as resources, attributes, infrastructure, delivery models and deployment models.

[18] Awaneesh Gupta, Bireshwar Dass Mazumdar, Manmohan Mishra, Priyanka P. Shinde, Surabhi Srivastava, A. Deepak, Role of cloud computing in management and education, Materials Today: Proceedings, 2021, https://www.sciencedirect.com/science/article/pii/S2214785321052299

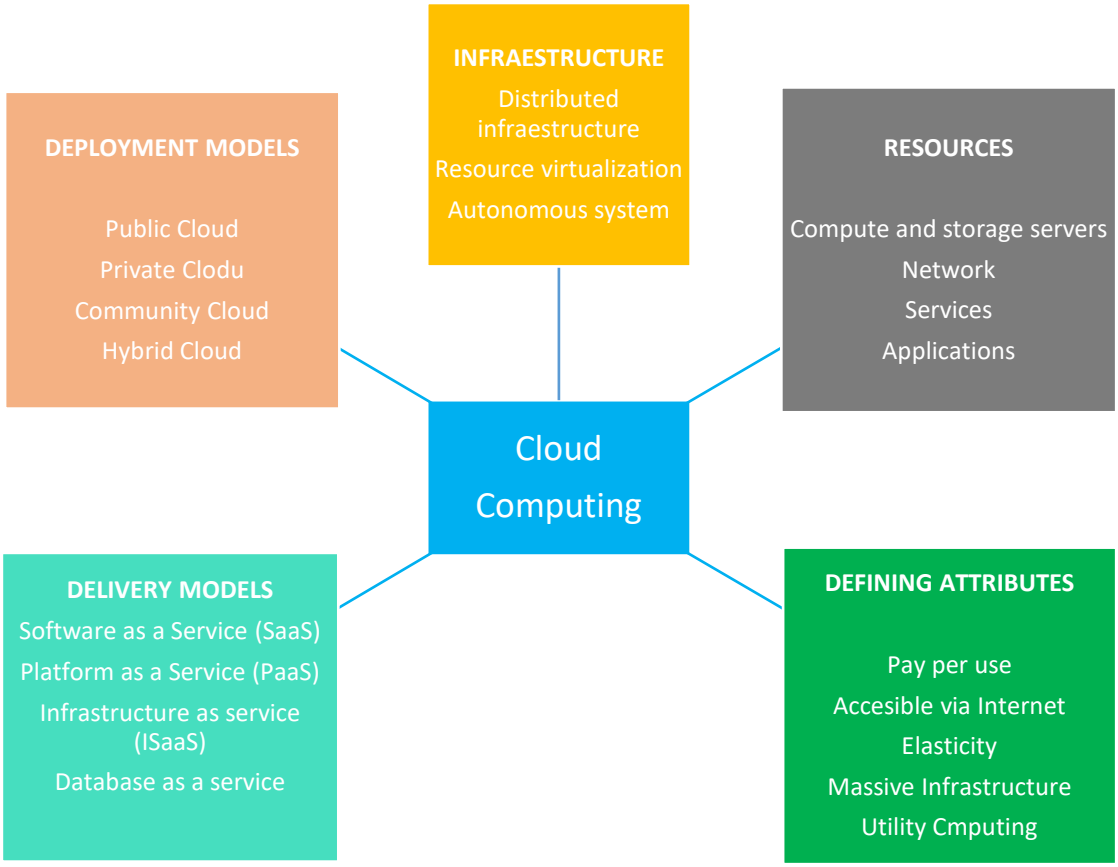


Figure 3. Cloud Computing and its different attributes [17].

2.1.5. Robotics

Robotics generate an undisputable upward change in the activity of a company when applied correctly. It positively affects daily operations, streamlines the assembly workflow, and even works to manufacture food. Many job tasks are unsafe or contain high quantities of content that can injure people. The repetition of their jobs can cause workers frustration, mistakes, or distractions in the short term. However, robots should avoid making those errors due to their high machine learning levels[19,20].

The industry 4.0-enabled robots focus on achieving ideal performance and zero downtimes. When robots use more sensors, they become even less endangered to interference and are digitally linked. Unprogrammed plant downtime is one of the most common sources of today's production inefficiency.

[19] B.A. Kadir, O. Broberg, Human-centered design of work systems in the transition to industry 4.0., Appl. Ergon. 92 (2021) 103334.

[20] G. Rathee, M. Balasaraswathi, K.P. Chandran, S.D. Gupta, C.S. Boopathi, A secure IoT sensors communication in industry 4.0 using blockchain technology, J.

The automation of previously manual activities with an in-place set of real-time AI and computer networking is being increased by Industry 4.0[21,22,23].

[21] F. Yang, S. Gu, Industry 4.0, a revolution that requires technology and strategies, Complex Intell. Syst. (2021) 1–15.

[22] J. Cárcel-Carrasco, C. Gómez-Gómez, Qualitative analysis of the perception of company managers in knowledge management in the maintenance activity in the era of industry 4.0, Processes 9 (1) (2021) 121.

[23] E. Oztemel, S. Gursev, Literature review of Industry 4.0 and related technologies, J. Intell. Manuf. 31 (1) (2020) 127–182.

III. ADOPTION OF INDUSTRY 4.0 TECHNOLOGIES IN MAIN PRODUCTION CHAINS

In this chapter is presented the adopted Industry 4.0 technologies in main production chains to ensure growth as intervention strategies to reactivate APEC economies through Information and communications technology, solutions of 2 selected case studies of APEC for each value chains identified in the preliminary diagnosis are displayed in the following lines.

In the Preliminary Diagnosis (see ANNEX 1), the Analytical Hierarchy Process was carried on, three value chains were selected, and they were: Tourism, Commerce and Hospitality (Restaurants).

3.1. Tourism Post Covid-19

The conduct of travelers and the public, in general, is changing very fast. Travelers are increasingly inclined to actively participate in the processes that affect them and are more and more interested in using social media tools to confirm their reputation as an identity[24].

The new technologies can enhance the travel experience throughout the cycle (virtual visits to natural and cultural sites, planning, booking, experience, and information exchange) and open new avenues for more responsible and sustainable consumer behavior. The new digital ecosystem for tourism has also changed as companies and destinations embrace innovation in marketing and communication processes, use a new digital language, adapt digital marketing strategies, and incorporate sustainable principles into their business[25].

In the ANNEX 1, it is presented more information related to the Tourism Value Chain.

3.1.1. Industry 4.0 technologies applied to the Tourism Value Chain

In case of the Tourism Value Chain, two technologies were identified, which are helping to ensure the growth of the Value Chain, as shown in the image below.

24 T. Pencarelli: "The digital revolution in the travel and tourism industry", Information Technology & Tourism, 22(3), pp. 455- 476, 2020.

25 Petrović Nenad, Roblek, V., & nino papachashvili. (2021). Smart technologies for the post-covid-19 tourism industry. 15th International Online Conference on Applied Electromagnetics - ПЕС 2021.

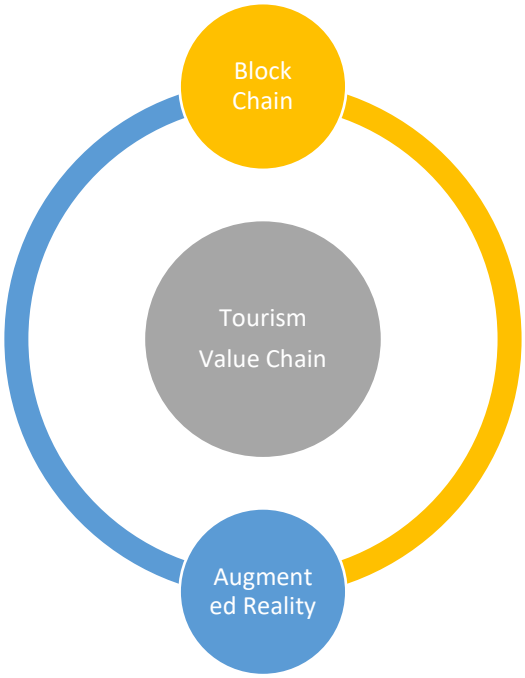


Figure 4. Solutions for the Tourism Value Chain

3.1.2. Case of Study 1: A blockchain application to a Smart Tourism Region

Blockchain is a new emerging digital technology allowing omnipresence financial transactions among distributed untrusted parties [26]. In this study, a blockchain-based system to manage an agri-food supply chain for tracking food items was designed by using smart contracts; the platform guarantees efficiency, transparency, and trustworthiness [27].

In the ANNEX 1, it is presented more information related this case of study.

3.1.2.1. How can Block Chain and Internet of Things help the growth of Tourism Value Chain?

Until years ago, only experts traveled to discover local food, dying to meet new territory and searching for new tastes or authentic flavors. Nowadays, gastronomic tourism is a fast-growing industry; many areas are popular for food, thus becoming a holiday destination.

Touristic destinations must, therefore, be equipped with cutting-edge tools that, in the context of Smart Tourism, guarantee the originality of local products. Indeed, this kind of tourism can attract potential visitors, offering huge potential growth for local areas and cities. A good visitors experience can ensure loyalty from visitors; in addition, the same visitors can become promoters of the area for future tourists.

[26] Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The Rise of Blockchain Technology in Agriculture and Food Supply Chains. Trends in Food Science & Technology. doi:10.1016/j.tifs.2019.07.034

[27] Baralla, G, Pinna, A, Tonelli, R, Marchesi, M, Ibba, S. Ensuring transparency and traceability of food local products: A blockchain application to a Smart Tourism Region. *Concurrency Computat Pract Exper*. 2021; 33:e5857. https://doi.org/10.1002/cpe.5857

To exploit this potential, on the one hand, destinations must adapt marketing strategies, and on the other hand, authorities must protect and promote cultural heritage. For these reasons, the guarantee of product quality, authenticity, and provenance is a key aspect to consider in supply chain management [27].

The digitization of the food supply chain, supported by blockchain technology, is shown in fig. 5. Under the physical flow (top layer), there is the digital flow layer (middle layer), consisting of various digital technologies (i.e., QR codes, RFID, NFC, online certification and digital signatures, sensors and actuators, mobile phones, etc.). The Internet serves as the connecting infrastructure. Every action conducted along the food chain, empowered using digital technologies, is documented to the blockchain, which serves as the fixed means to store information that is accepted by all participating parties.

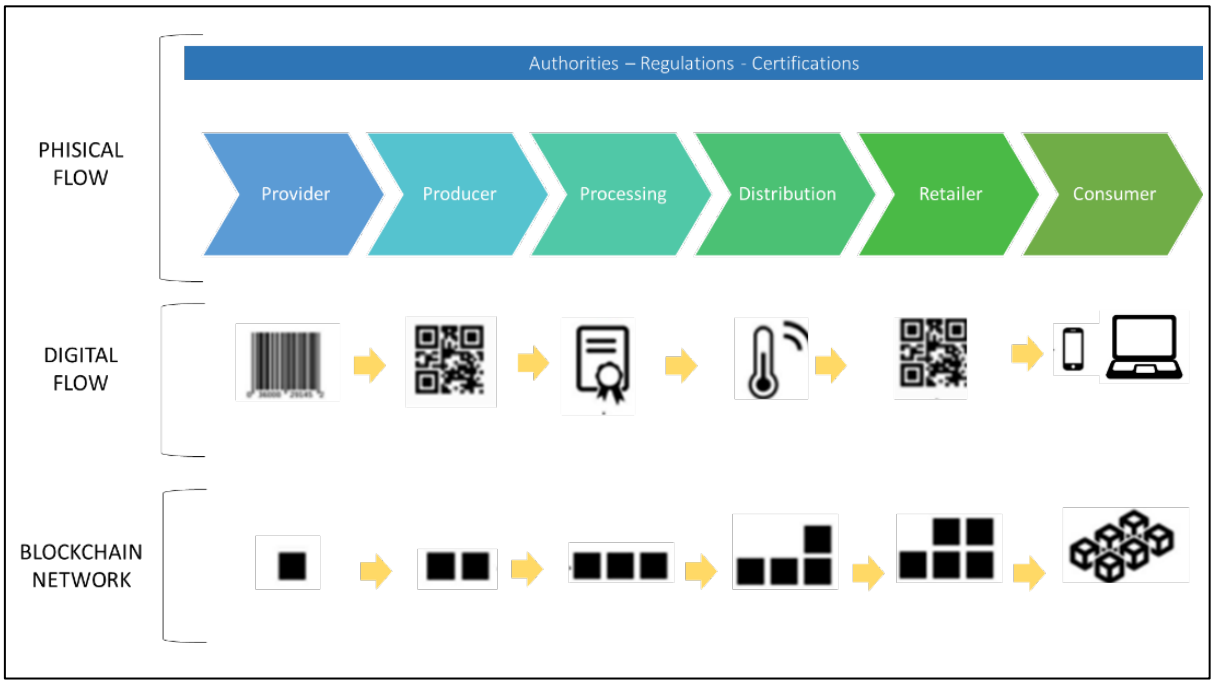


Figure 5. Food supply chain Blockchain System [27]

The information caught during each transaction is validated by the business partners of the food supply network, creating an agreement between all participants. After each block becomes validated, it is joined to the chain of transactions, becoming a perpetual record of the whole process. At each stage of the trajectory of food, different technologies are required, and different information is written to the blockchain, as described beneath for each of these stages[26].

- ✓ Provider: Information about the crops, pesticide, and fertilizers used, the machinery involved. The transactions with the producer/farmer are documented.
- ✓ Producer: Information about the farm and the farming practices employed. Also, information about the crop cultivation process, weather conditions, or animals and their welfare are also possible to be added.

- ✓ Processing: Information regarding the equipment and the factory, the processing methods used. The financial transactions that take part with the procedures and with the distributors are recorded too.
- ✓ Distribution: This stage is about trajectories followed, storage conditions (e.g., temperature, humidity), time in transit at every transport method, shipping details, etc. All transactions between the distributors and final recipients are written on the blockchain.
- ✓ Retailer: Information about each food item, very detailed, its current, expiration dates, quantity, storage conditions, quality, and time spent on the shelf are listed on the chain.
- ✓ Consumer: The final stage, where the consumer can use a mobile phone connected to the Internet to scan a QR code associated with some food item and see in detail all information regarding the product, from the provider and producer until the retail store.

In this case of the study presented, the author proposed a particular system to manage a low temperature-controlled supply chain since the system interfaces with IoT network devices providing precise information about data monitoring food such as environment humidity, storage temperature, and GPS data. The involved actors can share data and information in a more efficient and transparent proof way than traditional systems. The final consumer can access with transparency all the agri-food chain of the purchased product and verify origin by recovering all detailed information registered in the blockchain public ledger[26].

Within this context, Baralla et al. propose a blockchain-oriented platform to secure storage origin and provenance for food data. By exploiting the blockchain's distributed and immutable nature, the proposed system ensures supply chain transparency with a view to encouraging local regions by promoting smart food tourism and by increasing the local economy[27].

A consumer can buy a product through specialized e-commerce and can obtain information about the production chain and the supply chain to check the authenticity, goodness, and provenance of the product. In the figure 6, is present a simplified diagram.

The system is designed to certify the local agri-food product to prevent fraud and to promote the economy in the geographical area. All the information about a product is stored in the blockchain. For every product, the system recovers the information and shows it to the consumer, who can check the information by using a simple QR-code reader, or a specialized mobile app linked to the system[27].

The smartphone application retrieves information about a product. The client can also manually verify the product information integrity by comparing the hash code stored with the hash code of the information shown on the web[27].

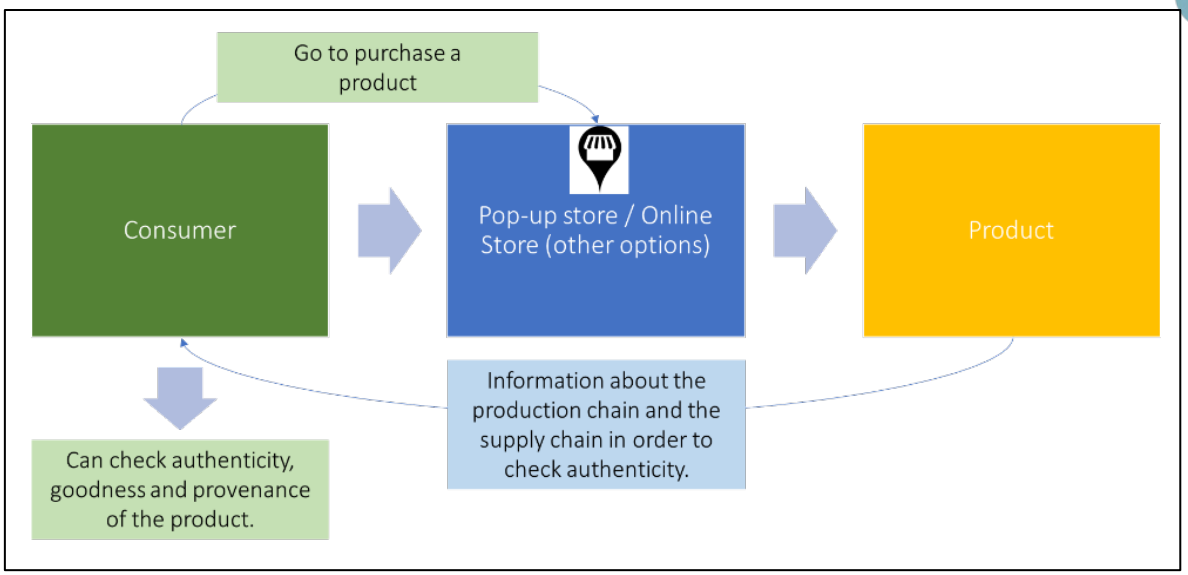


Figure 6. Product Traceability simplified diagram.

This solution appears better than traditional solutions because all the infrastructure is already there and is the blockchain itself. There is no necessary pay for cloud solutions or for service providers. Furthermore, maintenance is avoided, and customers' trust is maximized because all the infrastructure has no ownership. There are no actors able to manipulate data as it could be for owned or rented infrastructures. In the specific case of the Sardinia Region, but this is true in general, our solution minimizes the role of the central authority, increasing customers' trust[27].

The authority is responsible only for actors and products accreditation by using already existing infrastructures. After that, no intermediary is involved in the supply chain, which is completely controlled through smart contracts in a completely transparent and freely accessible, and immutable way. Moreover, in comparison with other public blockchain solutions, only hashed information is recorded into the system, reducing Gas costs and payload[27].

All involved actors can share information (data) in a faster, cheaper, and more efficient way with respect to traditional systems. In fact, everyone in the supply chain can track the ownership of the product and the location all the time. Our system is also particularly suitable for cold chain management thanks to the use of IoT devices, such as humidity and temperature sensors to monitor the food preservation environment and GPS to check goods delivery. The presence of certifiers allows evaluating the provenance and the food integrity during the entire distribution chain. In case of batch anomaly, it will be possible to trace all batch ancestors or their successors[27].

3.1.3. Conclusions of Case of Study 1

- ✓ The proposed system of this case of study aims to increase the tourism potential of a region through the enhancement of local products, able to tell, even with their taste, the uniqueness of the tradition and culture.
- ✓ The system this case of study presents is based on blockchain technology and uses the Ethereum platform to implement an agri-food distribution chain by means of smart contracts. To aim the end consumer, each product deals with a production and distribution network, and in the most recent period, the need for transparency for end-users is increasing even more rapidly. Sometimes information about origin exists, but trustworthiness is often hard to verify[27].
- ✓ Currently, there is a strong need to rely on someone who can guarantee the integrity and provenance of goods and products. Furthermore, given the complexity of the supply chain, it would be desirable to have specialized entities for each different process in the supply chain, causing the increase of product price. In a way to solve the traceability problem, it is proposed a decentralized and reliable blockchain technology to create their digital identity card. By using smart contracts, the platform guarantees provenance, trustworthiness, integrity, and transparency.
- ✓ The final client/consumer can verify the product provenance by checking the product history from the introduction in the distribution chain to the end retailer. For example, will be easy to verify the producer from the information recorded in the Ethereum blockchain[27].
- ✓ The integrity of data can be proved by comparing the hash code stored in the public ledger with the hash code of the resource stored in the external database. Transparency is ensured using a permissionless blockchain where all transactions are public, and anyone can verify them. Eventually, trustworthiness is guaranteed using a blockchain system where data are unchangeable once they are written within the system. Moreover, each stakeholder must be authorized to write data related to the agri-food chain avoiding fraudulent access[27].
- ✓ Finally, this case of study presents one new smart solution the Blockchain can also be utilized as a credit evaluation system to strengthen the effectiveness of supervision and management in the food supply chain. It can also be used to improve the tracking ofworldwide agreements relevant to agriculture, such as World Trade Organization agreements and the Paris Agreement on Climate Change [26,101].

3.1.4. Case of Study 2: A new perspective of tourism, TaipeiPass

In a post-pandemic era, Chinese Taipei is transitioning from the current situation to the new normal, making all the industries review their status. Because every corporation has the potential to become a technological company and join the digital industry, the government must collaborate with non-government sectors to anticipate the lifestyle and industry conditions in the post-pandemic era and propose transformation strategies [28].

In the ANNEX 1, it is presented more information related this case of study.

3.1.4.1. How Augmented Reality can ensure the growth of Tourism Value Chain?

- AR Museum Guide

With the development of the 5G era entering the business model transformation phase, digital technology applications have been introduced to provide consumers with new experiences of conventional physical entertainment through online channels. In the wroldwide sports industry, combining competitive sports with technological innovations, such as multiple synchronized perspectives, interactive time slice displays, 360° real-time VR streaming, and VR panoramic pictures, has become a key development trend to provide audiences with new viewing experiences [28].

Taipei City promotes the digital transformation of the arts and culture industry, sports broadcasting industry, and large-scale tourism activities and attractions to provide consumers with online experiences. The government supports these industries in adopting an innovative entertainment production and creation approach and guides them in employing cross-disciplinary integrated technologies to create transformation opportunities, further driving the creation of a new 5G economy for the film and television entertainment industry[28].

[28] Tapei City (2021). Taipei City's Post Pandemic Industrial Digital Transformation Policy White Paper – Embracing the New Normal, https://www.metropolis.org/sites/default/files/resources/New-Normal-New-Tapiei.pdf

Figure 7. Advertisement of the app[29]

By planning digital arts and culture performances at large exhibition events, Taipei City Government increases the visibility and relevance of innovative programs. The city government has applied public resource platforms to attract private resource investments in the digital production field[28].

Chinese Taipei's Ministry of Economic Affairs joined forces with the companies' private companies to launch a guided tour system using augmented reality (AR) in on of Chinese Taipei Museum's [29].

This is the first time AR technology has been utilized in a tour to bring dinosaurs back to life in realistic 3D. The curator of the museum explained that the exhibitions would be easier to understand and more catching with the new technology[30].

Figure 8. Augment Reality application[28]

[29] Ministry of Culture,(2020, August 03). The Chinese Taipei Museum brings dinosaurs to life via AR app, tour. https://www.moc.gov.tw/en/information_196_116355.html

[30] Yang S.,(2021, September 04). Taipei City aces COVID-19 response with smart technology. Chinese Taipei News. https://www.taiwannews.com.tw/en/news/4260707

With the applications of AR technology that show reality and an altered version side by side, the program transports visitors to the Mesozoic Era. The museum also offers 40 tours using indoor positioning technology to allow independent navigation [29].

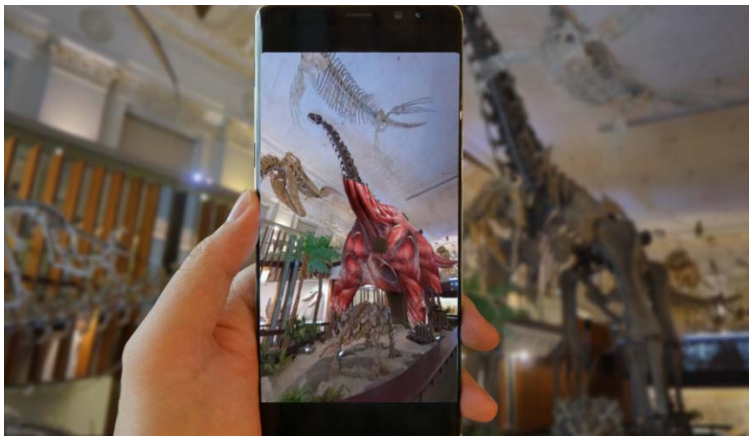


Figure 9. User showing the AR app [29]

- Tainan MR360

The National Museum of Prehistory (NMP), Tainan branch, during the COVID-19 pandemic was temporary closure and, in a way, to provide more ways for people to view exhibitions, the Museum of Archaeology collaborated with the Cultural Heritage Research and Innovation Center of the Tainan University of the Arts to launch a Multi-Route Audio-Visual Guidance system (MR360) for people who were confined to their homes[31].

MR360 is a display interface that equips with the technique of a 360-degree immersive view of the exhibition hall, which provides a virtual tour of the Museum of Archaeology. In addition, viewers can enjoy customized tours by making use of the audio touring system; they can click on the exhibits to select what they want to listen to during their visit to the virtual galleries, leading visitors to understand Chinese Taipei's prehistory through archaeological findings [31].

Mr. Huang Yi-ping, the MR360's principal investigator and professor at Tainan University of the Arts, pointed out that the museum services are improved and optimized using digital technology to achieve the goal of being a cultural hub. The museum expectation is that the value-added service of the digital innovation will keep up to bring more development possibilities for the museum in the post-epidemic era [31].

[31] Ministry of Culture,(2021, June 25). NMP launches VR tour for visitors to view exhibitions at home. https://www.moc.gov.tw/en/information_196_130443.html

3.1.5. Conclusions of Case of Study 2

- ✓ In the case of tourism, because of the travel restrictions in response to the pandemic, most citizens have turned to domestic traveling. However, Taipei City tourism relies on foreigners' tourists; consequently, the tourism and accommodation industries in Taipei have been the most impacted by the Covid-19 pandemic.
- ✓ Taipei pass application developed by the Taipei City Government in 2014, serves as a digital ID for Taipei citizens as well to deliver city government services; it was designed as a one-stop solution for municipal services, from paying taxes and parking tickets to utility bill payments and access to the library resources. But, since the origin of the pandemic in 2020, the service was adapted for COVID check-ins that enable contact tracing. In addition, it will have to incorporate digital proof of vaccination.
- ✓ This new adaptation of Taipei Pass helped to create a safe environment and promote domestic traveling, making the domestic tourist feel safe during their visiting city around the economy.
- ✓ Unfortunately, case City tourism has not enjoyed the benefits of this rising trend because this city mainly remains foreign tourists. To overcome this situation, Taipei City Government has held professional seminars for hotel operators to assist them in improving their hotel environment and service quality as well as in strengthening their marketing position.
- ✓ In addition to hosting tourism events to connect potential tourism attractions and unique local shops in Taipei City and neighboring counties, Taipei City Government has combined these events with tourism festivals and experience activities to provide tourists who visited Taipei City with a new traveling experience. Taipei City Government implemented a trial program to provide reward mechanisms for tour agencies that bring tourists to Taipei City. The program encouraged tour operators to plan tours with a focus on Taipei City's features and ultimately increasing tourist numbers.
- ✓ Taipei City promotes the digital transformation of the arts and culture industry, sports broadcasting industry, and large-scale tourism activities and attractions to provide consumers with online experiences. The government supports these industries in adopting an innovative entertainment production and creation approach and guides them in employing cross-disciplinary integrated technologies to create transformation opportunities.
- ✓ Chinese Taipei's Ministry of Economic Affairs joined forces with the external companies to launch a guided tour system using augmented reality (AR). With the applications of AR technology that show reality and state an altered version side by side, the program transports visitors to the Mesozoic Era. The Museum also offers 40 tours using indoor positioning technology to allow independent navigation.
- ✓ The National Museum of Prehistory (NMP), Tainan branch, during the COVID-19 pandemic was temporary closed and, in a way, to provide more ways for people to view exhibitions, the Museum of Archaeology collaborated with the Cultural Heritage Research and Innovation Center of the

Tainan University of the Arts to launch a Multi-Route Audio-Visual Guidance system (MR360) for people who were confined to their homes.

- ✓ MR360 is a display interface that equips with the technique of a 360-degree immersive view of the exhibition hall, which provides a virtual tour of the Museum and allows viewers to enjoy customized tours by making use of the audio touring system.
- ✓ This case of study presents 3 new smart solutions and are presented in fig. 10, which are some of the responses the Chinese Taipei Government had in a way to recover the tourism value chain from COVID-19.

Figure 10. Chinese Taipei Tourism response

3.2. Commerce Value Chain

The COVID-19 pandemic has transformed the retail sector and consumer spending habits. Integrating online-offline channels is crucial for retailer success in the current environment due to changing consumption patterns.

E-commerce is nothing new, but it was not until the mid-2000s that the Internet became an essential part of people's daily lives as well as of their consumption, first in North America and Europe but quickly also in most other developed economies. As technological progress facilitated access to services regardless of location and time of day, online shopping became increasingly common, turning into a social phenomenon[32]. In the ANNEX 1, it is presented more information related to the Commerce Value Chain.

3.2.1. Industry 4.0 technologies applied to the Commerce Value Chain

In case of the Commerce Value Chain, two technologies were identified, which are helping to ensure the growth of the Value Chain, as shown in the image below.

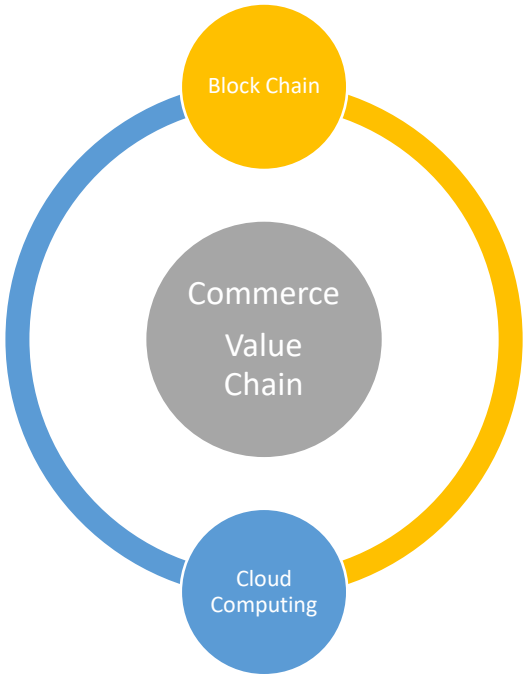


Figure 11. Solutions for the Commerce Value Chain

3.2.2. Case of Study 1: Australia a top market for e-commerce and online platforms

[32] Rastas, A. 2014. Exploring the value creation of online microenterprises, Master's dissertation, Aalto University.

E-commerce has become the favorite option for many purchases, such as food delivery in Australia. According to a software company, Cheetah Digital, over 61% of Australian consumers say that e-commerce is the preferred method for buying everything they want to buy [33].

Australians are already comfortable with digital payments and online purchasing. The recent launch of 5G broadband networks provides further opportunities to introduce artificial intelligence and augmented reality platforms that revolutionize consumer experiences[33].

An encouraging regulatory and financial system has helped Australians become leaders adopting new payments technology. Contactless such as 'tap and go' payments were introduced in 2006.According to the Reserve Bank of Australia, the COVID-19 pandemic has further accelerated the move to cashless payments. Commonwealth Bank of Australia (CBA) indicates that 8.3 million Australians made digital-enabled payments in 2020. CBA also reported that monthly digital wallet transactions doubled from March 2020 to March 2021[33].

In the ANNEX 1, it is presented more information related this case of study.

3.2.2.1. How can Cloud computing support the growth of Commerce Value Chain?

Leading Australian 'buy-now-pay-later digital payment platforms such as Afterpay have fundamentally changed the whole retail experience. Now, they are disrupting the payments space traditionally held for decades by credit cards [34].

33 Brosnan A, Enthusiastic consumer engagement makes Australia a top market for e-commerce and online platforms. Available online: https://www.austrade.gov.au/news/economic-analysis/enthusiastic-consumer-engagement-makes-australia-a-top-market-for-e-commerce-and-online-platforms (accessed on 06 November 2021).

34 Laudon, K.; Traver, C. 2011. E-commerce: Business, technology, society, 7th edition (Harlow, Pearson Education).

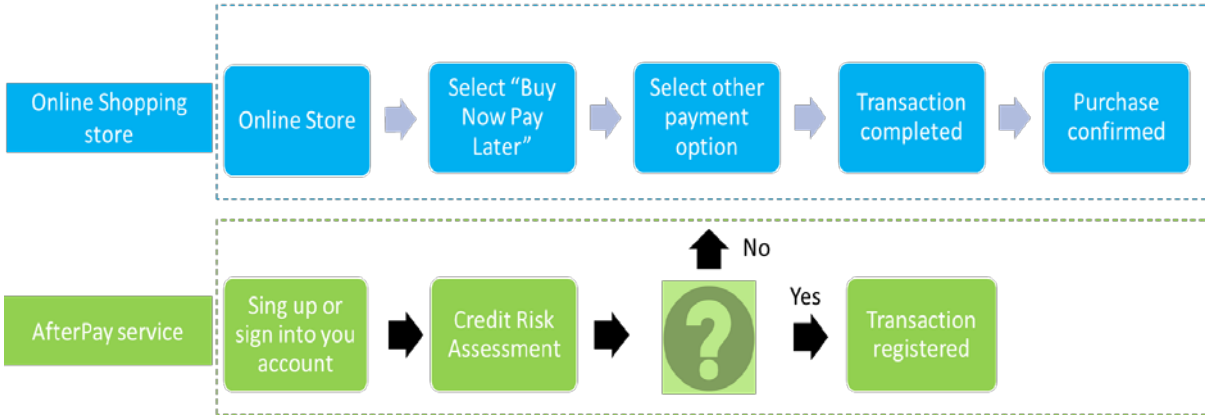


Figure 12. AfterPay Service flow summarize[35]

Afterpay is a pay-by-installment service that enables customers to buy products on a modified, 'buy now, receive now, and pay later. The company rolled out in 2015 and has already notched up its ten-millionth customer. Furthermore, the success of this billion-dollar Australian start-up showcases the creativity and global ambitions of Australian fintech[36].

[35] Debt Rescue. The 'Buy Now, Pay Later' Online Trend. Available Online: https://solutions.debtrescue.com.au/articles/the-buy-now-pay-later-online-trend (accessed on 07 November 2021).

[36] Díaz-Martín, Ana & Quinones, Myriam & Roche, Ignacio. (2021). The Post-COVID-19 Shopping Experience: Thoughts on the Role of Emerging Retail Technologies. 10.1007/978-981-33-4183-8_6.

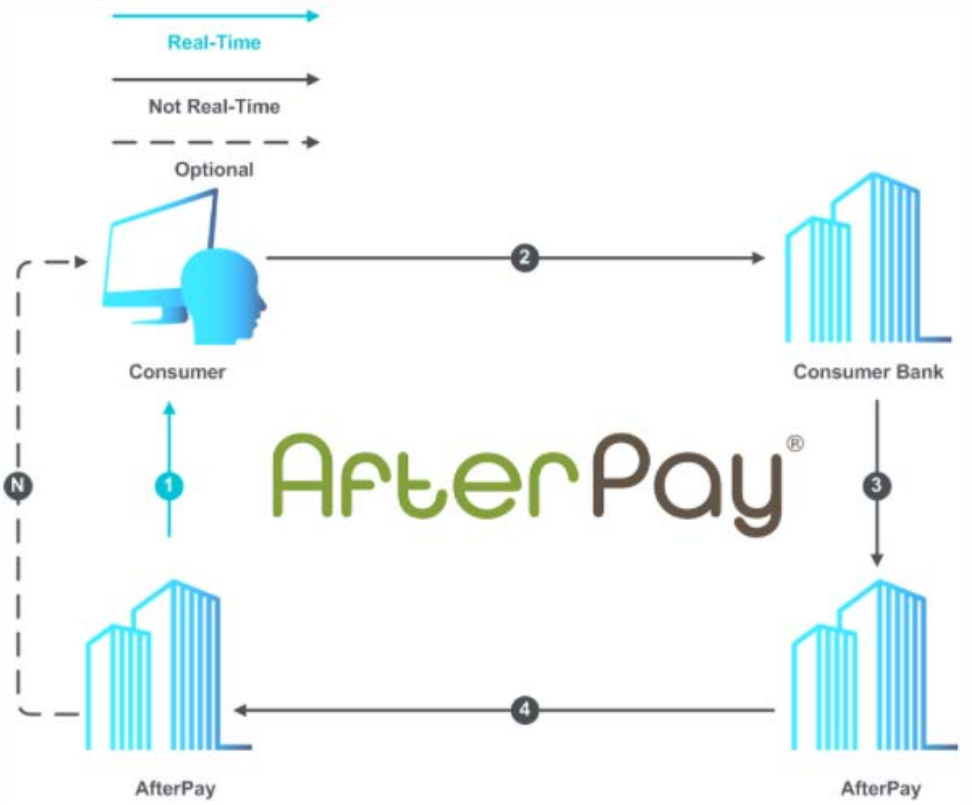


Figure 13. Key Actors in the AfterPay application[37]

Afterpay's product is simple. If a person has $200 in the cart and chooses to pay with Afterpay, it will charge to the bank card (typically a debit card) $50 every two weeks. No interest, no revolving debt, and no fees with on-time payments. For the consumer, this meant they could get the primary benefit of a credit card (the ability to pay later) with their debit card, without the need to worry before about all the fees that come with credit cards — high-interest rates and revolving debt [38]. As it is shown in the Fig. 13, only 4 actors are part of the payment process, and they are: Consumer, Consumer Bank and Afterpay. The retailer is the platform owner that will allow the interaction in the system and at the end will receive the payment through Afterpay.

[37] World Line. Adterpay Installments. https://epayments.developer-ingenico.com/payment-product/afterpay-installments/process-flows(accessed on 11 November 2021).

[38] Tech Crunch. The next generation of global payments: Afterpay + Square. Available Online: https://techcrunch.com/2021/08/02/the-next-generation-of-global-payments-afterpay-square/ (accessed on 07 November 2021).

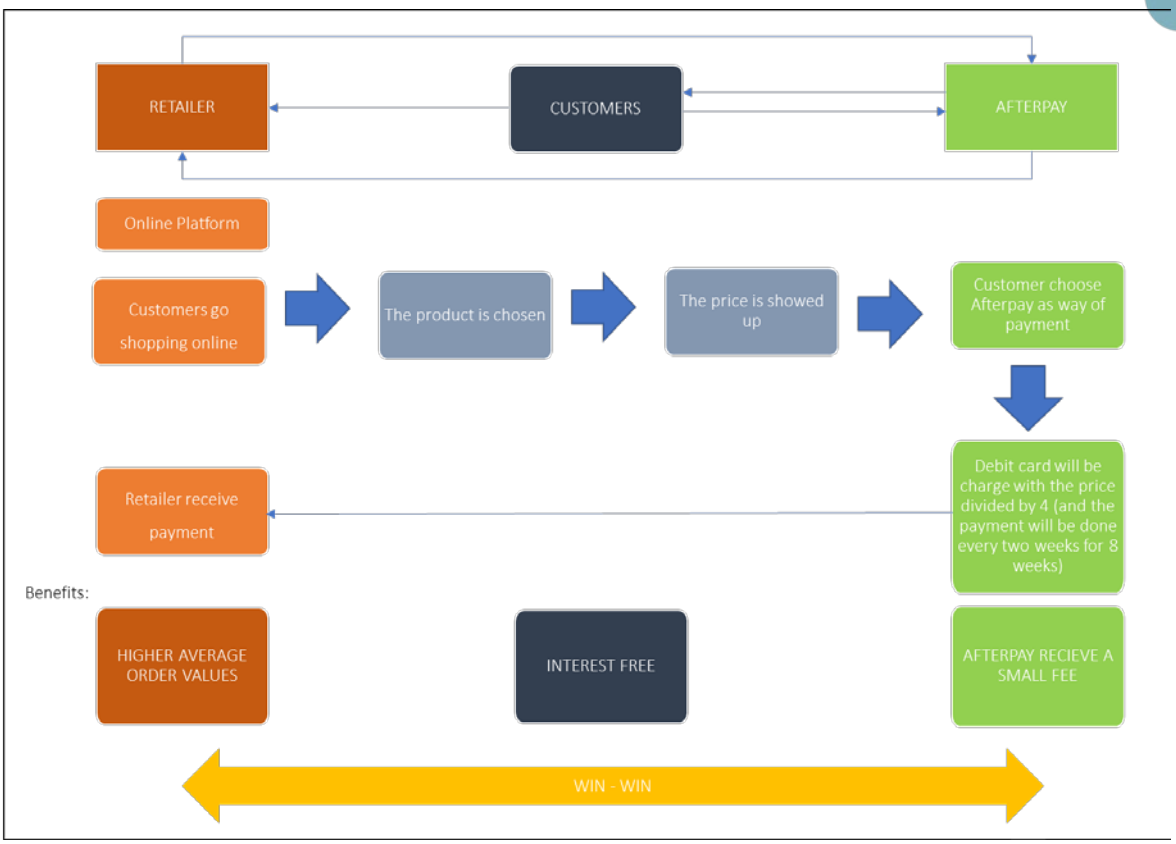


Figure 14. Afterpay actors' interaction

For the early retailers, virtually all of whom relied on millennials as their crucial growth segment, they got a fair deal: Paying a small fee above payment processing to Afterpay, get significantly higher average order values. The goal was a win-win proposition, and, with lots of execution, a new payment network was born [38].

Afterpay's collected data has shown a significant shift to debit over the COVID-19 period, with almost 90 percent of customers now electing to use their debit cards to pay overtime [39].

Also, retailers have responded by giving millennials and Gen Z buyers the option to spend in the different ways they prefer, such as social shopping, mobile shopping, and letting them choose their own money and pay overtime.

For these reasons, buy-now-pay-later (BNPL) solutions are being so rapidly adopted around the world. According to Worldpay's FIS 2020 Global Payments Report, BNPL solutions are poised to grow by 28 percent in important markets around the world.

[39] FST Media. Afterpay unveils 'Money' app, spruiked as bank for Gen Z & Millennials. Available Online: https://fst.net.au/financial-services-news/afterpay-launches-money-app-as-next-gen-bank-for-gen-z-millennials/(accessed on 07 November 2021).

It is encouraging to see that, amid this terrible pandemic, consumers are choosing their own money safely and responsibly. Financial wellness and budgeting will continue to be the future of payments[40].

- The Afterpay Process

In the figure 15, it is presented a diagram indicating the process flow of the APP AfterPay.

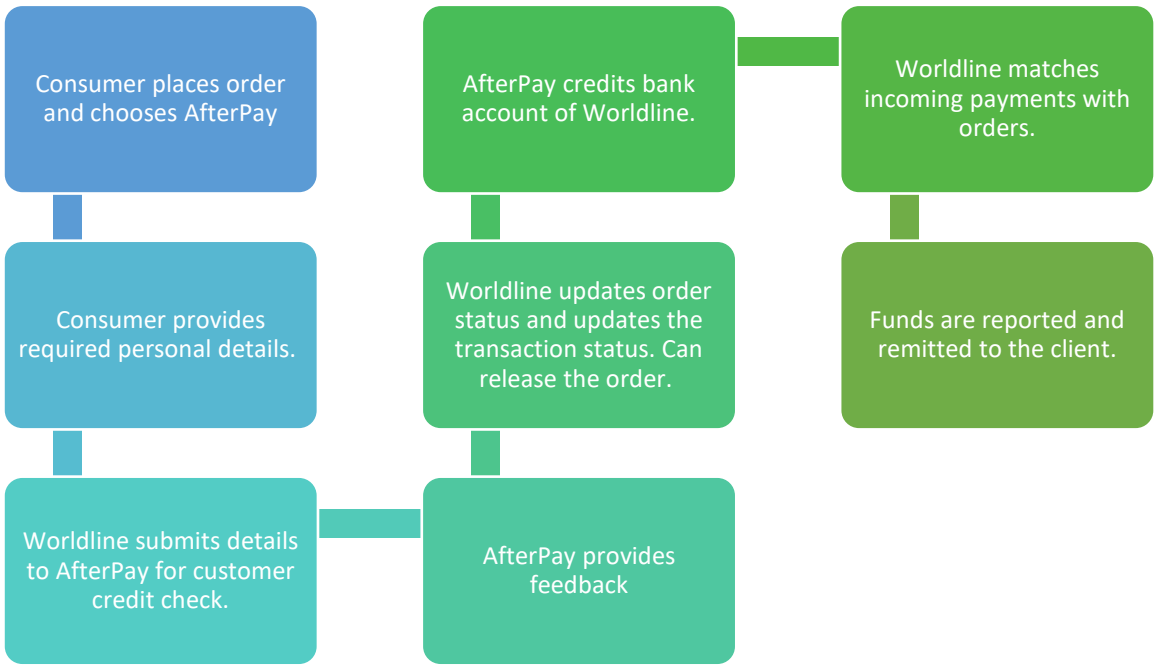


Figure 15. Afterpay process[37]

As soon as Step 6 of the previous flow is completed, Afterpay sends an invoice to the consumer by email.

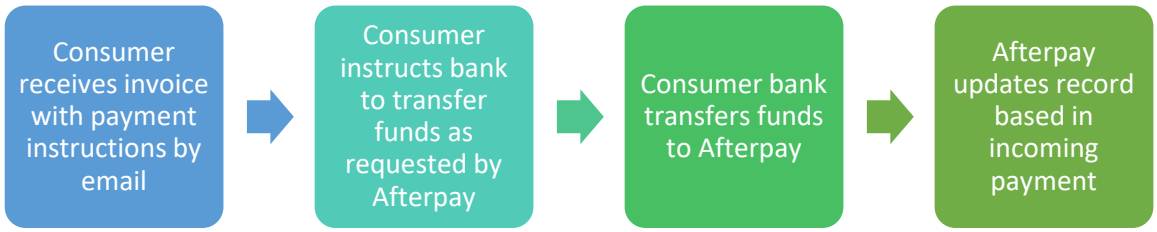


Figure 16. Steps after the consumer receives the transaction email [37]

Additional steps:

40 PYMNTS. Afterpay: How COVID Is Reshaping Payments. Available Online: https://www.pymnts.com/news/payments-innovation/2020/afterpay-how-covid-is-reshaping-payments/ (accessed on 07 November 2021).

- ✓ For each installment the consumer will receive the instructions and step 2 and 3 will be repeated until the agreed number of installments have been paid.
- ✓ If consumer doesn't pay: Dunning process starts. Please be advised that this does not affect the status of the transaction.

Afterpay can be a handy app to have in urgent or unforeseen expenses. But also, it is important to know that it can also lead to problems if used recklessly. It's up to consumer to assess the circumstances and decide if Afterpay is an appropriate platform for people to use.

3.2.3. Conclusions of Case of Commerce Study 1

- ✓ Afterpay's product is simple, allow consumers to shop now and pay later, always interest-free. With Afterpay, any purchase will be split into 4 payments, payable every 2 weeks.
- ✓ Only 4 actors are part of the payment process, and they are: Retailer, Consumer, Consumer Bank and Afterpay.
  - The retailer is the platform owner that will allow the interaction in the system between the consumer and Afterpay.
  - The consumer is the person who will allow the interaction between the bank and Afterpay
  - Afterpay is the app that will allow split the consumer payment without interest (in case the payment schedule is accomplish on time) and allow the retailer to receive the payment and increase the number of sale.
  - Consumer Bank is the entity that after the approval of the consumer will provide the money transaction to Afterpay base on the split payments agreed by the consumer

- ✓ According to Forbes, this way of payment, considered BNPL (buy now pay later) have the following advantages and disadvantages [41]:

  Advantages
  - Can split up the payments. This might make an expensive item more achievable since the customer does not have to pay the total value at once.
  - There is no hard credit pull evaluation. Unlike applying for a new credit card, Buy-Now-Pay Later systems are easier to apply and be accepted. This means that someone who does not have a strong credit profile or is new to credit could find it more appealing to purchase this way.

[41] Frankel R. FORBES. Buy Now, Pay Later: Here's What You Should Know About Offers From Affirm, Klarna, AfterPay And Other Installment Purchases. Available Online: https://www.forbes.com/advisor/credit-cards/buy-now-pay-later/(accessed on 07 November 2021).

- Very simple to do. Online shoppers may find the instant satisfaction of buying what they want in easy-to-understand terms a preferable way to shop.
- Improve cash flow management. Buy-Now-Pay Later systems can help someone buy what they need at a payment plan that fits their budget.

Disadvantages

There are some potential weaknesses to be aware of with this type of payment.

- Terms may change: Before committing to a BNPL loan, it is essential to know the terms of the deal. The 0% interest may not last the loan length, leaving the client with expensive finance charges, and there could be very high penalties if a payment is missing.
- The fixed fees. Some Buy-Now-PayLater systems add a fixed fee to the monthly payments, which can cost extra over the life of the loan versus just buying the item outright.
- Do not help to build credit. In case the payment is made on time, it will not help the score credit. On the other side, late payments may be reported and have a negative impact.
- Can stimulate overspending. Over time, paying off an item can make a purchase seem more manageable and accessible.

✓ This case of study presents 1 new technology/ smart solutions and consist in a new payment method, Buy Now Pay Later explained lines above

3.2.4. Case of Study 2: Thoughts on the Role of Emerging Retail Technologies Post-COVID-19

Prior the coronavirus outbreak, a called shopping revolution[42] was already well underway. Building on prior academic studies. It is noting several forces that are converging to change the retail industry since the beginning of the twenty-first century[43,44,45,46].

Díaz-Martín et al, reflects in this study the technological advancements that retail companies could adopt to deliver superior value to customers, while supporting their long-term economic goals as the economic and health implications of the coronavirus crisis unfold [47].

In the ANNEX 1, it is presented more information related this case of study.

3.2.4.1. How Internet of Things and Cloud Computing Technology to ensure the growth of Commerce Value Chain?

- Cash- Free Stores

During the pandemic, as cash-free stores became the new normal, consumers grew more comfortable with contactless and mobile payment methods [48].

[42] Kahn, B.: The shopping revolution: how successful retailers win customers in an era of endless disruption. Wharton Digital Press, Philadelphia (2018) 3.

[43] Grewal, D., Roggeveen, A., Nordfält, J.: The future of Retailing. J. Retail. 93(1), 1–6 (2017) 4.

[44] Grewal, D., Motyka, S., Levy, M.: The evolution and future of retailing and retailing education. J. Market. Educ. 40(1), 85–93 (2018) 5.

[45] Kahn, B., Inma, J.J., Verhoef, P.C.: Introduction to special issue: consumer response to the evolving retailing landscape. J. Assoc. Consumer Res. 3(3) (2018) 6.

[46] Berman, B.: Flatlined: combatting the death of retail stores. Bus. Horiz. 62(1), 75–82 (2019)

[47] Díaz-Martín, Ana & Quinones, Myriam & Roche, Ignacio. (2021). The Post-COVID-19 Shopping Experience: Thoughts on the Role of Emerging Retail Technologies. 10.1007/978-981-33-4183-8_6.

Figure 17. AiFi, a cashierless checkout startup [48]

- Solution A: Technology-driven solutions that reduce in-store physical contact also include AiFi technology, which enables payments to be automatically charged when the product is scanned with a smartphone, becoming completely checkout-free. In the short term, these in-store solutions will be a key to meeting emerging social-distancing norms. In the future, biometric technology could enable more sophisticated touch-free payment and checkout methods[48].

- Solution B: As retailers invest in low-touch solutions, they should consider expanding the use of smart tags powered with QR codes as a solution to offer shoppers product information without encountering anything in the store [48].

Figure 18. QR codes in retail stores[49].

[48] THE SPOON. AiFi to Launch 330 Autonomous Stores by the End of 2021. Available Online :. https://thespoon.tech/aifi-to-launch-330-autonomous-stores-by-the-end-of-2021/ (Accessed on 11 November 2021)

[49] UQR.ME. 6 things must know about QR codes in retail stores. Available Online : https://uqr.me/dynamic-qr-codes-retail-stores/(Accessed on 11 November 2021)

- Solution C: Retailers could also consider radio-frequency identification (RFID) tags to manage their inventory and optimize the store layout. RFID technology connected to smart mirrors and associates' tablets can be used to keep track of products that shoppers bring into the fitting rooms. On the mirror, the shopper can request a different size or color of the product without needing to talk to an associate. The mirror will ping an associate's tablet, allowing associates to checkout shoppers from anywhere in the store without the inconvenience of having to wait in line. Sales associates should feel safer if they work in an autonomous contactless store [48].

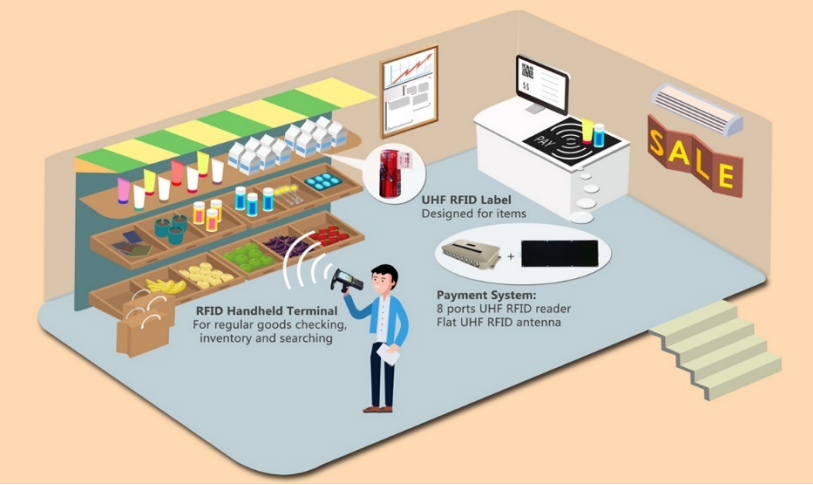


Figure 19.RFID application in a minimarket [50].

- Solution D: Bluetooth or Wi-Fi-based beacon technologies, which support identifying a person's location and navigation via smartphone [51], could help limit the number of people entering a shopping location or be used to give assistance to speed up the purchase process. Spatial sensors can be redeployed to promote social distancing. Retailers can monitor in-store traffic and identify when locations are busy using video feeds and computer vision modeling to evaluate the amount of human activity in a particular place over time. Physical distance measurement was not a real need before COVID-19, but now parking areas, individual aisles, and departments need to be monitored for traffic and densities. It also provides valuable data and advanced analytics such as real-time and historical foot traffic counts, cumulative impressions, dwell times, recurrent visits, and peak hours.

[50] Hope Land. Gestion de Ventas (2016). Available Online : https://es.hopelandrfid.com/retail-management_n10 (Accessed on 11 November 2021)

[51] Reinartz, W., Wiegand, N., Imschloss, M.: The impact of digital transformation on the retailing value chain. Int. J. Res. Mark. 36(3), 350–366 (2018)

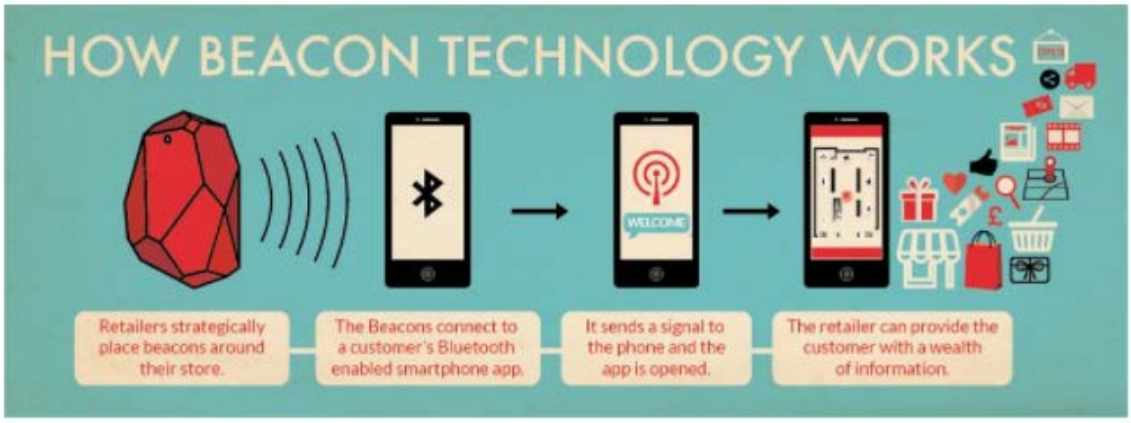


Figure 20. Wi-Fi-based beacon technologies [52]

3.2.4.2. Conclusions of Commerce Case of Study 2

- ✓ Before the Covid-19 pandemic, a growing number of industry events focused on the role of technologies in retail, showing that this was an exciting topic for practitioners. Despite these initiatives, extant literature suggests the topic is still under-researched. As a first contribution to the literature, this study shows how the retail landscape has changed and will continue changing based.
- ✓ The COVID-19 has accelerated the adoption of e-commerce and forced companies to sell online even though they were not planning to. As a result, competition increased, and companies needed to focus on consumer experience as a differentiating factor[53].
- ✓ By combining Industry 4.0 and e-commerce the results obtained are just positive for the value chain. Industry 4.0 can analyze data, and e-commerce needs that analysis to manage and improve current practices [54]. By using data, enterprises can know their customer's preferences, what they prefer or want, and how to improve their services to keep old and attract new customers. At the same time, enterprises can use that data to add new characteristics to products, making them more attractive to the customer[55].

[52] Shopify Retail Blog. Proximity Marketing: How to Attract More Shoppers With Beacon Technology (2017). Available Online: https://www.shopify.com/retail/the-ultimate-guide-to-using-beacon-technology-for-retail-stores (Accessed on 11 November 2021)

[53] G2. 2021 Trends in E-Commerce and Industry 4.0 (2020). Available online: https://www.g2.com/articles/e-commerce-and-industry-4-0-trends-2021 (Accessed on 11 November 2021)

[54] Linzbach, P., Inman, J.J., Nikolova, H.: E-Commerce in a physical store: which retailing technologies add real value? NIM Market. Intell. Rev. 11(1), 42–47 (2019)

[55] Restart 4.0. Industry 4.0 and its effect on e-commerce. Available online: https://restart-project.eu/industry-4-0-effect-e-commerce/(Accessed on 11 November 2021)

- ✓ The Kahn Retailing Success Matrix [43] was the framework to identify which technological solutions might help retailers create a competitive advantage in the post-COVID-19 retail marketplace. Also, identify technologies developed according to the retailing success strategy they allow [56].
- ✓ While technology can enhance customer experience, drive efficiencies, and deliver reduced costs, it is essential to mention that trained employees will continue to have a crucial role in managing customer services and interactions. Thus, the ability to adapt to an ever more digital future depends, in part, on closing. the gap between talent supply and demand [57].
- ✓ The Covid-19 crisis has been a stimulant for the retail sector, and it may also accelerate consumer adoption of delivery curbside pickup. In the longer term, replenishment robots, which Tesco and Amazon, among others, are already testing, and humanoid robots like Pepper from SoftBank Robotics could be part of the list of technology-driven solutions that reduce in-store physical contact.
- ✓ Technology has been disrupting the retail sector for many years now, but the outbreak of COVID is set to both accelerate and change this in ways would not have previously imagined. Customers are getting used to the comfort of shopping from home, further reducing footfall in traditional retail outlets. Touchless technologies for safe in-store experiences are being rapidly developed, and artificial intelligence and machine learning offer the potential for automated and highly personalized online shopping experiences. Competitive benefits will flow to those companies most able to swiftly adapt to this fast-evolving new retail environment.
- ✓ In a post-pandemic era, automated activities, and processes, which operate without active human input or control can offer self-serve, contactless options for shoppers and store operators [55].
- ✓ This case of the study shows different technological solutions that facilitate a touch-free and highly automated shopping experience support four basic competitive strategies: branded performance superiority, enhanced customer experience, frictionless shopping experience, and operational excellence-cost efficiencies.
- ✓ Most existing studies analyze individual technologies, while the work integrates different technologies into a common framework based on the Kahn Retailing Success Matrix. It is essential to acknowledge that the four dimensions of Kahn's matrix are interrelated. This means that one technological solution could serve several retailing strategies. For example, voice assistants can add an experiential component to the shopping experience and increase convenience at the same time. Similarly, blockchain technology can help generate trust and increase operational efficiency.
- ✓ This case of study presents four new smart solutions, and they are:

56 Díaz-Martín, A.M., Cruz, I., Gómez Suárez, M., Quiñones, M., Schmitz, A.: Transformación digital en distribución: Soluciones tecnológicas y estrategias competitivas de las empresas minoristas españolas. Revista Ibérica De Sistemas e Tecnologias De Informação. E(24),151– 167

57 Frankiewicz, B., Chamorro-Premuzic, T.: Digital transformation is about talent, not technology. Harvard Business Review. Retrieved from (2020). https://hbr.org/2020/05/digital-transform ation-is-about-talent-not-technology

Solution A: Technology-driven solutions that reduce in-store physical contact also include AiFi technology, which enables payments to be automatically charged when the product is scanned with a smartphone, becoming completely checkout-free [48].

Solution B: As retailers invest in low-touch solutions, they should consider expanding the use of smart tags powered with QR codes as a solution to offer shoppers product information without encountering anything in the store [48].

Solution C: Retailers could also consider radio-frequency identification (RFID) tags to manage their inventory and optimize the store layout[48].

Solution D: Bluetooth or Wi-Fi-based beacon technologies, which support identifying a person's location and navigation via smartphone to resolve the limitation number of people entering a shopping location or be used to give assistance to speed up the purchase process[46].

3.3. Hospitality (Restaurant) Value Chain

The COVID-19 pandemic is one of the worst global health emergencies not seen in modern history. Like many other industries, the restaurant industry has been extremely hard hit by the current pandemic. Restaurants in many economies have been forced to close or operate at reduced serving capacity due to government pandemic containment measures. Even as governmental imposed standards were slowly loosened up, the industry continued to suffer from consumers' perceived risks, lack of confidence, and pervasive loss of safety induced by the pandemic [58].

In the Annex 1, it is presented more information related to the Hospitality (Restaurant) Value Chain.

3.3.1. Industry 4.0 technologies applied to the Hospitality (Restaurant) Value Chain

In case of the Hospitality (Restaurant) Value Chain, two technologies were identified, which are helping to ensure the growth of the Value Chain, as shown in the image below.

[58] Bin Li, YunYing Zhong, Tingting Zhang, Nan Hua. Transcending the COVID-19 crisis: Business resilience and innovation of the restaurant industry in China. Journal of Hospitality and Tourism Management, Volume 49, 2021, Pages 44-53, https://doi.org/10.1016/j.jhtm.2021.08.024.

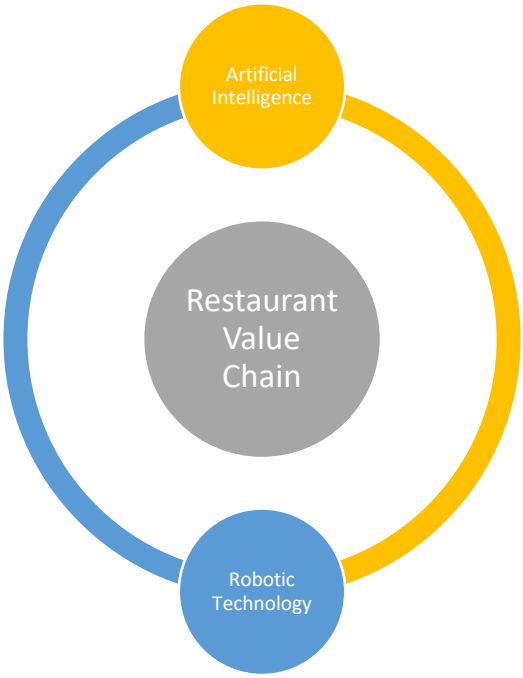


Figure 21. Solutions for the Hospitality(Restaurants) Value Chain

3.3.2. Case of Study 1: AI in the Japanese Restaurants, Servi and Touch Point BI

Japan's Artificial Intelligence sector has been at the vanguard of hardware development, including the production of robots and automobiles. Although, companies from Europe and the United States continue to lead when it comes to software development [59].

The pandemic changed people's interests and priorities relating to AI. For instance, AI that supplements human labor was previously limited to specific outlets because people tended to prefer face-to-face interaction in business. Nevertheless, nowadays, technological solutions that offer reduced physical interaction are preferred [60].

In the ANNEX 1, it is presented more information related this case of study.

3.3.2.1. How to use Artificial Intelligence can ensure the growth of Hospitality (Restaurant) Value Chain?

- TouchPoint BI: The Japanese analysis tool

"TOUCH POINT BI" is a tool that provides an in-store analysis service[60]. It is a POS data analysis tool necessary for management, visitor prediction AI, and traffic volume survey.

[59] The AI Market in Japan: Spearheading Industry Innovation. Available online: https://tokyoesque.com/ai-market-in-japan/ (accessed on 05 November 2021).
[60] EBILAB. Available online: https://ebilab-jp.translate.goog/?_x_tr_sl=ja&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=nui,sc (accessed on 05 November 2021).

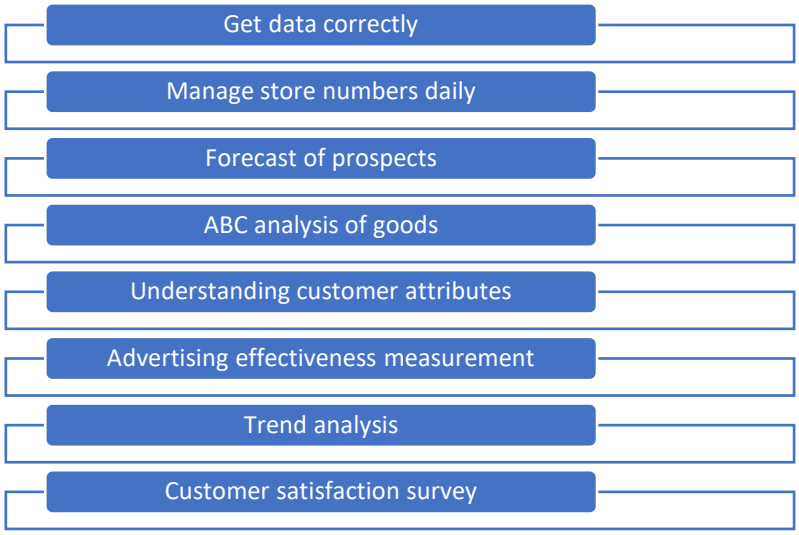


Figure 22. Advantages of centralized management through TOUCH Point BI

Benefits of TOUCH Point BI

- ✓ Labor shortage, sluggish sales, work style reform,
- ✓ Where to start improving
- ✓ Ideal for sites that are worried if they do not know if it is good.
- ✓ Various data related to store management
- ✓ By integrating and visualizing currently grasping and making correct management decisions, Make it possible.

Figure 23.Touch BI interaction through iPad [61]

[61] EBILAB. Available online: https://ebilab-jp.translate.goog/service/analysis/?_x_tr_sl=ja&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=nui,sc (accessed on 05 November 2021).

3.3.2.2. How robots can help the development of Hospitality (Restaurant) Value Chain?

- Servi: The Robot for Japanese Restaurants

Due to Covid-19, the AI technology market in Japan has provided several technological solutions for remote access, automation, and social distancing. To contribute to social distancing requirements, artificial intelligence has been incorporated in e-payment and video analytics services. In addition, remote working has given rise to the need for digitization solutions, including e-document management and IoT systems where connected sensors can automatically gather and analyze business data [60].

The robotics in Japan's AI sector have developed technology that reduce human contact and have seen implementation worldwide. Some examples are the robots produced by Softbank Robotics. For example, Servi is enjoying increasing popularity in the restaurant sector, as it provides waiting services devoid of physical human contact[60].

The serving and transporting robot "Servi" was introduced to the restaurant in March of this year, and since then shortened the travel distance of staff, allowed them to devote their time to customer service, and created new value for customers, such as creating memories for their families. The results generated by the robot had been considered with multiple effects. The main challenge this restaurant faced and was the main reason to consider Servi was the walking distance of the staff during busy hours. The distance that one staff member walks is about 10,000 steps in 5 hours during the lunch zone. The owner considers that walking time makes the waitress get tired and less efficient. If the travel and time distance was reduced, would be possible to devote that amount of time to customer service to provide a better experience to the customers. With the introduction of Servi, the staff is spending more time on customer service, which humans can only do, creating a sense of excitement for customers. In addition, various possibilities have been realized, such as Servi playing a role as a communication tool.

Figure 24. Waitress manipulating SERVI [62]

One of the restaurant owner's initial concerns was that the customers could not accept restaurants with robots, especially because restaurants are part of one page of the family's memories. Nevertheless, on the other side, it was considered that Servi could improve the work efficiency of the restaurant.

- Customers reaction to the robot working in the restaurant

In the case of this restaurant, not only the customers become happy, but the staff themselves. The restaurant received good responses from customers of all ages. Adults seemed to overlap Servi with the future robots they saw when they were children, saying, "Robots are working." On the other hand, children were excited to touch and chase Servi because it may feel like a theme park attraction for them.

In the case of the operation process, the hurdles for the operation were lower than expected. The staff member enjoys using Servi as if they were using a smartphone. It seems that they are devising ways to use it, such as carrying food to tables close to each other and letting Servi carry it to tables that are far.

[62] 100 spoons Tachikawa store. Available online: https://www.softbankrobotics.com/jp/product/servi/cases/100spoons/ (accessed on 05 November 2021).

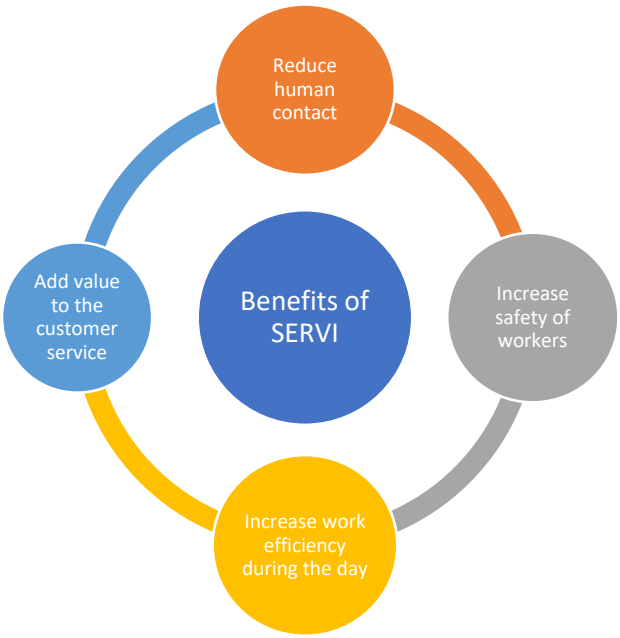


Figure 25.Benefits of the robot Servi

About the safety inside the restaurant also was improved. For example, Servi can be carried more safely by using an assist plate with a seismic isolation function. The advantage of Servi is that it can always serve customers with the same quality. Also, in the case of Servi, the staff only needs to arrange the dishes on the customer's table, so even heavy plates are safe. The seismic isolation function allows those tall glasses cannot fall.

Figure 26.Customer interacting with Servi [62]

3.3.3. Conclusions of Case of Study 1

- ✓ The robotics in Japan's AI sector have developed technology that reduce human contact and have seen implementation worldwide.
- ✓ In the case of the robot Servi, has been helping to reduce human contact and improve the customer service, allowing the restaurant to provide a more efficient customer service. This robot act as a waiter, with the ability to carry food and drinks from the kitchen to tables. It use 3D cameras and LIDAR technology to navigate around tables and customers, the same technology used by autonomous vehicles[63].
- ✓ TOUCH POINT BI is a customer prediction system with more than 95 percent accuracy. It uses a unique algorithm to predict the number of future customers based on store information such as past sales data and event information, and big data like the weather forecast. TOUCH POINT BI was developed unprecedentedly by a restaurant, not by an IT company. EBILAB developed this system carefully listening to the opinions of the people who work for the service industry.
- ✓ The new technologies this case of study share is: Servi and Touch Pint BI, both examples all just a few parts of all the several technologies and tools developed by Japan in order to improve services and to overcome the COVID-19 pandemic.

[63] Business Insider India. Softbank's new food service robot Servi could replace waitstaff and food runners at restaurants Available online: https://www.businessinsider.com/softbank-food-service-robot-servi-in-photos-2020-10(accessed on 06 November 2021).

3.3.4. Case of Study 2: Business resilience and innovation of the restaurant industry in China

Understanding effective ways for restaurants to survive, adapt, innovate, and recover from a health-related crisis like the current COVID-19 pandemic poses tremendous value for the industry's long-term viability [59].

The authors, Li B.et al, of this study consider two critical stages that necessitate studying the restaurant industry's business strategies in the emergency response and recovery[59]. The case of study also explores how the restaurant practices can potentially improve against the backdrop of the pandemic, given no study has explored the practices of restaurants from a holistic perspective. Further, there still appears to be a void in exploring the underlying themes instrumental in rebuilding and strengthening the restaurant industry. This study, therefore, explores the resilience and innovation mechanism in the industry. The resilience of the restaurant industry refers to the ability of a restaurant enterprise to withstand shocks and transform in the face of challenges [64].

In the ANNEX 1, it is presented more information related this case of study.

3.3.4.1. Can Cloud Computing to ensure the growth of Hospitality (Restaurant) Value Chain?

In the emergency response five dimensions of innovative strategies were defined: pandemic prevention and control, government and community, corporate social responsibility, marketing response, and management response.

a) Pandemic Prevention and Control
   - ✓ China adopted a prompt reaction to the outbreak of COVID-19 such as closing restaurants.
   - ✓ But the restaurant industry began facing operation difficulties.
   - ✓ Most of the restaurants took actions to handle the pandemic situation.

b) Government and Community Support
   - ✓ The restaurant industry in China faced 44.3% of its revenue loss.
   - ✓ The authorities reducing loan interest rates, exempting VAT, and issuing consumption coupons.
   - ✓ Property owners also provided a reduction in rent for restaurant enterprises.

c) Corporation Social Responsibility
   - ✓ Enterprises have come together by donating funds and daily necessities.
   - ✓ It improved the restaurant enterprise's customer loyalty

d) Marketing Response
   - ✓ Smart food cabinets were equipped with automatic disinfection.
   - ✓ Checking body temperature, mask-wearing, and other disinfection procedures.
   - ✓ Customers scanned QR code providing safety information to customers.

[64] Barasa, E., Mbau, R., & Gilson, L. (2018). What is resilience and how can it be nurtured? A systematic review of empirical literature on organizational resilience. International Journal of Health Policy and Management, 7(6), 491.

- ✓ Another solution as part of the emergency response was the driverless vehicles to deliver fruits and vegetables to residents in Beijing's. This food delivery vehicle previously released, could choose the best route based on analysis of map data and avoid any visible barriers in rather complicated geography settings [65]. The intelligent distribution system assigns orders to the autonomous vehicles which pick up items at outlets and then head out to delivery sites at their destinations. Residents collect their orders from delivery boxes, with no human contact during the whole process [66].

Figure 27. Smart Delivery Self Driving Vehicle from Meituan's [67]

e) Management Response

- ✓ Product line adjust strategy
- ✓ Selling raw material became an option to reduce the loss.
- ✓ Also many restaurants developed semi-finished products for customers to cook at home.
- ✓ Re-factoring the service process has helped restaurants to prevent the pandemic in the long run. Most restaurants give the correct importance to food safety. They started to re-factor their service processes from several perspectives, such as kitchen facilities, food delivery systems, and cooking raw material purchasing, utensils selection, personnel training, and menu design.
- ✓ Cost-saving is essential to support a restaurant to have enough backup to beat the cash flow crunch. A cost reduction initiative was implemented including temporary closings, pay cuts,

[65] Pandayli. Meituan Unveils Driverless Food Delivery Platform and Multiple Autonomous Vehicles (2018). Available Online: https://pandaily.com/meituan-leads-in-chinas-food-delivery-market-followed-by-ele-me-and-baidu/ (Accessed 11 November 2021)

[66] Yicai Global, China Inside. Meituan Dianping Starts Unmanned Grocery Deliveries on Beijing's Open Roads(2020). Available online: https://www.yicaiglobal.com/news/meituan-dianping-starts-unmanned-grocery-deliveries-on-beijing-open-roads(Accessed on 11 of November 2021)

reducing raw materials and other operating expenses. Among them, a very innovative labor sharing scheme was implemented to alleviate the pressure on labor costs.

3.3.4.2. Recovery Response

In the recovery response five dimensions of innovative strategies were defined: covid-19 prevention, product innovation, product innovation, innovative marketing strategy, cooperation with third parties.

a) Covid-19 Prevention
   - ✓ Visible sanitization procedures may make guests feel at relative safety when dining out.
   - ✓ Social distancing measures such as capacity controlling, curbside pickup, and mobile payments only.
   - ✓ Separate dining, along with using disposable chopsticks, is also mandatory when dining out.
   - ✓ Customer Service Innovation
   - ✓ To implement social distance and improve a customer's psychological sentiment about the safety.
   - ✓ Robot aids in restaurants, kiosks with mobile payment, and automated kitchens.

b) Product Innovation
   - ✓ New products have already been launched in the restaurant product portfolio
   - ✓ Smaller dishes campaign has successfully gained the support of local government and customers in a niche market.
   - ✓ Changing raw materials has also been considered for restaurants. More than 60% of restaurants tried to reshape their product portfolio from traditional food service to retail catering.
   - ✓ New types of food, such as semi-finished products, have become the prioritizing research project to meet the emerging consumption market.
   - ✓ Efforts of large-scale chain restaurants were focused on research and development. New types of food, such as semi-finished products, have become the prioritizing research project to meet the emerging consumption market.

c) Innovative Marketing Strategy
   - ✓ The online sales market increased consumer expectation
   - ✓ The intense competition environment is forcing the fast response of the industry
   - ✓ Several measurements were enacted to reduce the adversary impacts of the COVID-19 pandemic, including a stay-at-home order, a lock-down, and traffic restrictions. As a result, restaurants tried to gain cash flow from take-out or delivery services.
   - ✓ To promote restaurant business, contactless deliveries were innovated with the help of technology facilities to guarantee food safety. QR codes were provided with a food package so that customers can quickly scan the code and choose their meals, and by March 14, more than 110,000 restaurants had received the safe logo from the food ordering app
   - ✓ Smart food cabinets were equipped with automatic disinfection to ensure food safety.

- ✓ Several measures, such as checking a deliverer's body temperature, mask-wearing, and other disinfection procedures, were also strictly implemented. Furthermore, customers scanned a special QR code and watched live cooking videos or other disinfection store photos, providing thorough safety information to customers.

- ✓ Smart Food Cabinets

Figure 28. Meituan's smart food cabinets [67]

A company in China, was the first adopting the facilities for contactless delivery in Shanghai. A smart cabinet equipped with ultraviolet disinfection and heat preservation functions, the food cabinets can ensure proper hygiene standards while reducing the risk of cross-infection, as shown in fig. 28. With the consent of customers, the delivery person places the food in the cabinet. This company has installed the smart food cabinets in roughly 100 public places in Shanghai, some locations include hospitals, office buildings, and residential compounds, according to the company [68].

[67] People's Daily Online. Chinese food delivery giants install smart cabinets in Shanghai. Available Online : http://en.people.cn/n3/2020/0522/c98649-9693313.html (Accessed on 11 of November 2021)

Figure 29.Smart Food Cabin equipped with ultraviolet disinfection and heat preservation functions [68].

d) Cooperation with third parties

- ✓ An essential collaborative response of the restaurant is to group meal orders on Banking apps.

3.3.5. Conclusions of Case of Study 2

- ✓ The study presented by Li B. et al. provides practical guidelines to assist restaurant industry practitioners in adopting innovative activities to achieve crisis resilience. The study presents multiple solutions in two stages of the Covid-19 pandemic that led to external and internal performance to help the restaurant value chain to make better decisions in a fluid business environment.
- ✓ Prior studies have demonstrated several innovation strategies during COVID-19, new business models, and new equilibria are established. The restaurant value chain practitioners need to take a holistic approach to deal with the COVID-19 pandemic, and there is a necessity for the industry practitioners to co-operate with multiple stakeholders to effectively face the challenges of the pandemic. This study offers valuable directions for industry practitioners to revise their marketing strategies for the pandemic from a holistic perspective.
- ✓ This study proposes that an appropriate combination of strategies from five themes (pandemic prevention and control, customer service innovation, cooperation with third parties, product innovation, and innovative marketing strategy) can lead restaurant enterprises to make the right decisions.

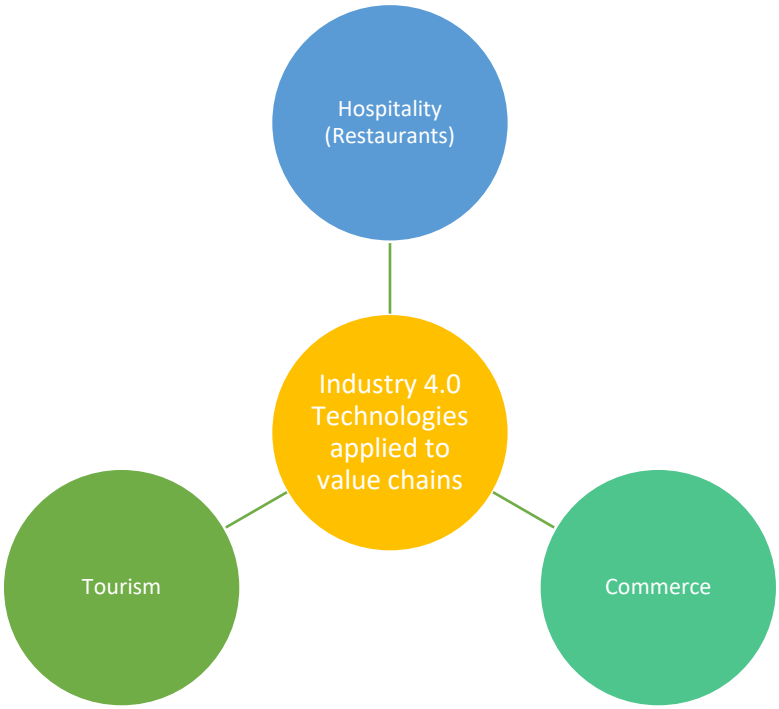
[68] Domeet Webmaster. Smart cabinets take meals from unmanned vehicles to deliver food, and how far can be delivered without contact delivery (2020). Available online: https://www.ww01.net/en/archives/59157 (Accessed on 11 of November 2021)

- ✓ These strategies should also be prioritized by industry practitioners based on their specific situations. Furthermore, this study identifies five critical, innovative activities.
- ✓ In the emergency response, five dimensions of innovative strategies were defined: pandemic prevention and control, government and community, corporate social responsibility, marketing, and management response. On the other hand, the recovery response the five dimensions of innovative strategies were: covid-19 prevention, product innovation, product innovation, innovative marketing strategy, cooperation with third parties.
- ✓ This study shows that technology has been applied in various business operation procedures of the restaurant industry, such as customer relationship management, restaurant robotization, digital sales-platform construction, and product innovation. Digital technologies, such as artificial intelligence (AI), big data, cloud computing, smart vehicle, and blockchain, have effectively assisted China in pandemic monitoring and resource allocation [69]. The restaurant value chain should assess its technological needs and adopt the relevant technologies to accelerate innovation's pace and scope.
- ✓ Cooperation appears to be the most vital and frequently performed activity for innovative crisis management practices. It is identified in the COVID-19 prevention process in the restaurant industry. Several measurements, such as continuing social distancing measures, environmental disinfection, and employee training, need multi-parties to understand the importance of pandemic prevention and have the same perceptions of each party's responsibility. Sincere communication and cooperation with employees and customers will maintain an honest and reliable business image. Next, production innovation practices, such as smaller dishes campaigns and changing raw materials, have challenged customers' traditional dining experience. The intention of innovation needs to be fully explained and gain external parties' support.
- ✓ In this pandemic, the accelerated landing of intelligent food cabinets and the delivery through vehicles and robots, just to cite a few examples, have demonstrated the application prospects of "contactless distribution" [69].
- ✓ The challenging circumstances make the industry practitioners spontaneously deepen the network of relationships, develop bonds with third parties, and exchange resources to gain mutual benefit and competitive advantage. And lastly, restaurant enterprises need to recognize the critical role technology plays in achieving and improving crisis resilience.
- ✓ The new technologies this case of study share is: Smart Food Cabinets and Driverless Vehicles to distribute the food.

[69] Qi, X. X. (2020). How next-generation information technologies tackled COVID-19 in China. Retrieved September 3, 2020, from https://www.weforum.org/agenda/2020/ 04/how-next-generation-information-technologies-tackled-covid-19-in-china/

IV. BEST PRACTICES OF NEW TECHNOLOGIES

In the following lines will be find a synthesis of the best practices of the participating economies (from Virtual Symposium), validating the diagnosis of the value chains most impacted by Covid-19 in the APEC region.



Tomorrow's new business will rely on modern computer models, such as mobile and interactive systems interconnected. New technologies such as Artificial intelligence, Cloud computing, Blockchain, the Internet of things, and data processing can help to achieve the establishment of societal foundations where anyone can develop value, at any time and place, in a safe environment and according to natural environments, without limitations such as those that currently exist.

For many value chains, the typical approach is to use specific features within their existing platforms to start the process of digitization.

In the following lines, best practices to follow when implementing artificial intelligence, Internet of Things, Block Chain, Cloud Computing, and Robotic technology in the affected value chains identified in the preliminary diagnosis are presented.

2.1. Best Practices in Artificial Intelligence

Artificial intelligence technology is playing an essential role in the future of retaining a competitive advantage. In a crowded and always-on marketplace, organizations need to progress.

This technology can unlock many opportunities while driving revenue. However, it is essential to understand how to do so, from creating teams to prepping the data to testing. The classical approach uses specific features within their existing platforms for many companies[70].

The following lines present the three best practices to follow when implementing artificial intelligence

2.1.1. Data is key for the implementation of Artificial Intelligence Systems

Few operations have developed data fabrics that contain all the relationships of an organization's data, no matter the data source or type, and just a few have data that has been thoroughly vetted and prepared to assure its accuracy.

- ✓ When there is not enough data, it may lead to misrepresented results conducing to the implementation failing.
- ✓ Collecting the raw data and amassing the business experts' assistance to access a comprehensive interpretation is necessary.
- ✓ Search through the data to ensure there are no missing components, typos, skewed labels, or other mistakes. Also, make sure the data samples contain every element needed to analyze.
- ✓ It is compulsory to understand the relationship between data and what it wants to predict and ensure the data is not biased or has limitations. These limitations can help set expectations for the scope of the predictions[71].

2.1.1.1. Lessoned learned: 16,000 COVID-19 cases had gone unreported in The United Kingdom.

The public health entity in United Kingdom, answerable for counting new COVID-19 cases, uncovered that borderline 16,000 Covid cases went not reported between the 25th of September and the 2nd of October 2020. The reason for this was that data limitations in excel were the key reason.

PHE utilized an automated process to move COVID-19 positive lab results as a CSV record into Excel formats by announcing dashboards and contact tracing. Unfortunately, Excel sheets have a limit of 1,048,576 lines

[70] Shacklett Mary E., Four Best Practices for Successful AI Projects, July 14, 2021. https://www.informationweek.com/it-strategy/four-best-practices-for-successful-ai-projects

and 16,384 columns for each worksheet. When the cases surpassed the 16,384-section limit, Excel pulled out the 15,841 records at the bottom, and as a result, the cases were not reported[71].

2.1.2. Design strong use cases that deliver impactive benefits

The based software solutions in AI have been applied to many real-world cases. Not all Artificial Intelligence and Machine Learning technology can bring immediate success. Nevertheless, the technology can resolve numerous problems in different value chains with innovation assets and data science engineers' expertise.

For example, a German automotive supplier, employed Artificial Intelligence to predict the optimal points for tire changes on commercial fleets. The AI technologies enable increasing uptime, optimizing tire stock, and reducing maintenance costs.

Another case is in the energy sector; AI can be beneficial for power consumption forecasting and optimization. Aiming to detect patterns and trends, machine learning models predict future energy consumption by processing and analyzing historical data. For example, the Swiss corporation ABB provided manufacturers with an AI-driven platform to prevent peak-time energy costs.

The last example of this best practice is General Motors which, in collaboration with Autodesk, applied AI to develop a new seat belt bracket. The unique bracket design created a 40% lighter and 20% stronger product than the original[72] .

These are just three examples where companies got positive results after implementing AI technologies. Success stories like these inspire management and boards and make them want to invest more[71].

2.1.3. Customer satisfaction it is key

Artificial Intelligence systems need to put more effort into better customer service. Many people can relate to the frustration and bad experience of getting caught in an automated telephone buckle answer. In some cases, it is pervasive that many as half a dozen layers of robotic questions before getting to a real human agent capable of dealing with a complex question. In other cases, the connection is lost when human contact is needed.

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71 Dialani P., Famous AI Gone Wrong Examples in The Real World We Need To Know Artificial Intelligence Latest News, (March 9, 2021), https://www.analyticsinsight.net/famous-ai-gone-wrong-examples-in-the-real-world-we-need-to-know/

72 El iazàt A. ,Five Successful AI and ML Use Cases In Manufacturing (10th of September, 2020), https://hackernoon.com/five-successful-ai-and-ml-use-cases-in-manufacturing-ac3a30ol

- ✓ Excellent AI system designers enlist genuinely skilled personnel in customer service. The customer service experts bring the optimal interface between man and machine. These skills are not typically found among data scientists or IT professionals[71].
- ✓ It is necessary to consider that customers are willing to pay more for the know-how and service than just the product or service.

2.2. Best Practices in Internet of Things

The Internet of things is converting any system to be intelligent. Recent operating systems are used to meet the requirements of modern systems. There are many platforms for the Internet of things that have been developed. However, most of them are made for certain implementations and do not manage the current limitations of the current systems[10].

In the following lines are presented the 5 best practices to follow when implementing Internet of Things:

2.2.1. Updated Systems

Industries are always searching for different ways to improve device security. As many threats arising nowadays, each new IoT endpoint introduced into a network brings a potential entry point for cybercriminals that must be addressed.

- ✓ Once a fix is identified, the code that is into their software is updated. Keeping the IoT up to date with the latest software updates is necessary.
- ✓ The upgrades during the lifetime of the device are inevitable. Building devices with secure paths for upgrades and cryptographic assurance of firmware versions will allow the device to be protected during and after upgrades.
- ✓ Ensure that device operating systems and all device drivers are upgraded to the latest versions [73].

2.2.2. Device Management

It is crucial to perform good management of all devices within an IoT system. The management includes:

- Diagnosis of the health of devices within an IoT system.
- Monitoring and tracking IoT devices and their states.
- Patch security holes.
- Configuration of IoT devices using remote access.
- Remote troubleshooting and error handling.
- Updating the firmware of parts of the devices (like a processor) and the installed applications and software.

[73] Sumasoft (March 28, 2022) (IoT) update management – Complete Guide. https://sumatosoft.com/blog/internet-of-things-iot-update-management-complete-guide

- Monitoring of usage and performance metrics.

Every new device in an IoT system entails a procedure for its registration and requires additional efforts to manage and troubleshoot it [74].

2.2.3. Security

Securing an Internet of Things infrastructure requires a meticulous security-in-depth strategy. This strategy requires connecting data in the cloud, protecting data integrity while in transit over the public internet, and securely providing devices. Each layer builds greater security assurance in the overall infrastructure [74].

Installing antivirus software and enabling automated threat detection relieves the needing to patrol the network manually. Cloud-based systems with machine learning capability are especially adept at understanding regular network performance and identifying anomalies. Regularly audit actions on the network

By taking an opportunity to look back on what is happening on the network, it can assess security performance. Keeping a log of activity and metrics can help monitor for strange behaviors and irregularities [75].

2.2.4. Regularly audit actions on the network

It is necessary to look back on what is happening on the network to assess security performance.
Keep a log of activity and metrics and help monitor strange behaviors and irregularities [75].

Auditing IoT infrastructure for security-related issues is crucial when responding to security incidents. Most operating systems provide built-in event logging that should be reviewed frequently to make sure no security breach has occurred. Audit information can be sent as a separate telemetry stream to the cloud service where it can be analyzed[75].

2.3. Best Practices in Block Chain

Blockchain is a system of recording information that makes it difficult to change or hack the data. This technology provides a record of almost real-time replicated between a network of business partners and is unchanging. The process takes information previously stored in the company's Enterprise Resource Planning (ERP). And then, makes it available in a distributed network of records across disparate companies. Several benefits of blockchain enable organizations to better understand their customers, particularly on

[74] Burkhalter M., (2021, November 16) Best practices for securing IoT devices. https://www.complianceweek.com/internet-of-things-role-in-internal-audit-and-compliance/10350.article

[75] Groopman J., (2022, January). 8 best practices for blockchain security. https://www.techtarget.com/searchsecurity/tip/8-best-practices-for-blockchain-security

the demand side. Data analytics and artificial intelligence have well-understood cases of application. It can also reach a glass ceiling regarding technological viability, but several businesses strive for convenience [15].

In the following lines are presented the three best practices to follow when implementing Blockchain Technologies:

2.3.1. Smart contracts security.

The chaincode (smart contracts), are sets of code within a blockchain, which trigger transactions based on programmed conditions.

These smarts contracts create another point of vulnerability because their integrity determines the reliability of the operation and trustworthiness of the results [76].

Smart contracts are developed using different programming languages, some of the best practices are [77]:

- Document the procedures of migration or upgrading before the deployment.
- *Function composition* – write small and meaningful functions, split the logic either through multiple contracts or grouping similar functions.
- Implement logging of all events and operations.
- Use well-tested libraries.
- Use the recommended version of the programming language compiler
- Regularly monitor the contracts after deployment.
- Implement security for the wallets of privileged users using cryptography.
- Craft an incident response plan. Smart contracts can be hacked.

2.3.2. Blockchain security.

Blockchain security is attained by implementing security testing methodologies, cybersecurity frameworks, and secure coding practices to protect a blockchain solution from online cyberattacks, frauds, and other breaches.

The multiparty essence of blockchain means network connections from various parties beyond a single corporate network must interact. Part of this essence includes information technology and networking infrastructure, databases, servers, and more, introducing the potential for security flaws or exploits [77].

Smart contracts are developed using different programming languages[78].

- Define and enforce endorsement agreements based on business contracts.
- Securely store identity keys.
- Use a data classification approach to safeguard data or user information.

[76] Tagade K. Tagade (2022, February). Smart Contract Security Audit: Intro & Top 5 Best Practices. https://www.getastra.com/blog/security-audit/smart-contract-security/

[77] Liao R. (2020, May). How interoperability establishes blockchain's utility and effectiveness for trade finance. https://www.weforum.org/agenda/2020/05/blockchain-interoperability-utility-effectiveness/

- Use privacy-preserving technologies for sensitive information.
- Implement multi-factor authentication.
- Keep strong cryptographic key management.
- Patch security loopholes to protect blockchain-based applications from vulnerabilities and data breaches.
- Get an industry-recognized security certification for a Blockchain solution.
- Enforce compliance and other security controls for the solution.

2.3.3. Interoperability.

It is essential to know how data, interactions, and identities occur over networks, smart contracts, and large-scale applications is another lens to evaluate in a distributed security landscape. Threats arise as systems complexity and interfaces expand; security weak points and errors at any end in the ecosystem can guide unauthorized transactions, not enough user authentication, misconfiguration, data manipulation, and other unpredictable results [77].

Interoperability between blockchains is most directly achieved by facilitating the transfer of data payloads. This is arranged through API (Application Programming Interfaces), explicitly designed to allow systems to communicate with one another. APIs are a well-established tool and generally do not require specialized blockchain programming skills to implement[78].

2.4. Best Practices in Cloud Computing

Cloud computing is a concept that offers computing as a service, making it possible for shared resources to become available to devices on demand. It is a technique that enables ubiquitous access to computing and network resources[16].

The pandemic has forced people, households, companies, and economies to digitize, accelerating digital transformation.

In this forced and accelerated transformation, cloud computing has made it possible not only to fight the pandemic but also to manage, organize and analyze large volumes of data quickly and without involving high costs. This has made it possible to withstand the volatility of the market and the scalability of services and has also allowed obtaining strategic information for both public policies in the case of governments and competitiveness strategies in the case of companies.

Cloud computing has become a model that allows companies, cities, regions, and economies to innovate technologically. In the following lines are presented the four best practices to follow when implementing Cloud Computing Technologies:

[78] Synoptek (2020, January) 10 Best Practices for Successful Cloud Implementation. https://synoptek.com/insights/it-blogs/10-best-practices-for-successful-cloud-implementation/

2.4.1. Conceive an All-Enclosing Adoption Strategy

Formulating a solid cloud adoption strategy can aid in a faster implementation with less risk. To build a comprehensive approach to cloud computing across the organization, consider the various aspects that the adoption will impact: namely the business, the people, the governance strategy, security, and platform considerations, as well as day-to-day operations [79].

2.4.2. Educate and Train Resources

The success or failure of the cloud implementation also depends on how well-educated users are. Since these users will be performing daily tasks using the cloud, it is essential to provide the users with in-depth training. This is to ensure the users understand the importance and benefits of cloud adoption and reduce potential cloud adoption barriers[80].

2.4.3. Choose the Right Model

Successful cloud implementation also requires choosing the correct cloud model for the business. With the various models available, it is critical to understand the need and approach and select one that best fits the value chain's needs[80].

Infrastructure as a Service (IaaS) comprises highly scalable, and automated compute resources. IaaS allows businesses to acquire resources on-demand and as-needed instead of buying hardware outright [80].

Platform as a Service or PaaS supplies cloud components to specific software while being used mainly for applications. PaaS brings a framework for developers to build upon and use to create personalized applications. All servers, networking, and storage can be managed by the enterprise or a third-party provider, while the developers can maintain management of the applications [81].

Software as a Service or SaaS represents the most utilized option for businesses in the cloud market. It utilizes the internet to supply applications, which a third-party vendor manages, to its users[81].

For example, with IaaS, businesses can access virtualized computing resources over the internet. With PaaS, can have a third-party provider deliver hardware and software tools for application development. And with SaaS, can access software online via a subscription rather than buy and install it on individual computers[80].

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[79] S.Watts, M. Raza. (2019, June). SaaS vs PaaS vs IaaS: What's The Difference & How To Choose. https://www.bmc.com/blogs/saas-vs-paas-vs-iaas-whats-the-difference-and-how-to-choose/

[80] Terrell Hanna K. (March, 2022) What is robotics? https://www.techtarget.com/whatis/definition/robotics#:~:text=Robotics%20is%20a%20branch%20of,on%20a%20number%20of%20forms.

2.4.4. Automation

Cloud implementation takes time; it is recommended to automate as many aspects as possible to reduce operating costs. Consider automating cloud-based infrastructure provisioning, configuration, and management and free up precious time and resources to minimize disruption and drive mission-critical innovation[80].

2.5. Best Practices in Robotics

Robotics generate an undeniable upward change in the activity of a company when applied correctly. It positively affects routine operations, streamlines the overall assembly workflow, and even works to manufacture food.

Robotics is part of the engineering that includes the conception, design, manufacture, and operation of robots. The robotics field aims to create intelligent machines that can assist humans in various ways. Robotics can take on several forms[81].

In the following lines are presented the three best practices to follow when implementing Robotics Technologies:

2.5.1. Select the processes to be automated

Automating the whole process at once is a straightforward recipe for failure. Instead, experiment with Robot Process Automation (RPA) by rolling it out in stages, starting with a department. Have a business plan that discusses the costs and timeline for the solution [82].

It is essential to start an RPA implementation with the processes that are best suited for automation. Some of the criteria to consider for the process selection are [83].

- Choose stable processes. It is better to start with predictable and well-documented processes, with operation costs that are consistent and well-defined.
- Consider processes with high volume and high frequency because they can often provide a faster return on investment.

2.5.2. Consider the correct human resources

It is necessary to persuade managers and executives about the benefits of enacting RPA. People are at the key point of any successful, sustainable robotic process automation program[84].

2.5.3. Train and educate

[81] Convedo (2022, March) 5 Best Practices for Robotic Process Automation

[82] CiGen (2020, September). Top 6 Robotic Process Automation Best Practices for Maximum Gain. https://www.cigen.com.au/top-6-robotic-process-automation-best-practices-maximum-gain/

[83] R. Murphy, V. Gandudi Texas A&M, J. Adams, Center for Robot-Assisted Search and Rescue (2020)

Robot Process Automation (RPA) agents are intended to work in close collaboration with humans. The primary purpose is not to replace people, balancing out each group's strengths and weaknesses. To encourage adoption, employees should understand the capabilities of RPA and how RPA agents can assist them in their daily activities[83].

It is essential to explain to the employees the purpose of the automation projects, identify where the automation will assist in the responsibilities and how this forges a pathway towards higher value, business-building projects that will tap into the proper skills and expertise of the workforce.

Also, it is mandatory to be very clear regarding what robotic process automation can do (and what it cannot) to maintain expectations at a realistic level[84].

V. TOPICS COVERED IN THE VIRTUAL SYMPOSIUM

The virtual symposium "**Industry 4.0: enabling technologies and inclusive digitization for post-covid-19 economic recovery in APEC value chains**" consisted of 6 sessions. In each session, a speaker made a 45–60-minutes presentation followed by a Q&A sub-session in which the public was able to raise questions to the speakers.

The analysis of the speakers' presentation, the panelists' discussions, and the reaction of the public in this report are analyzed and presented following lines.

Speaker(s)	Session and topic
Speaker (1): Msc. Elisa Talla	Session 1: Preliminary Diagnosis of the Affected Value Chains • This session aims to explain the 'Diagnosis to identify the Value Chains most Impacted by Covid-19 in the APEC Region'.
Speaker (1): Dr. Chen-Lung Wei	**Session 1:** Industry 4.0 • What is Industry 4.0? • The importance of Industry 4.0 • Applications of Industry 4.0 • How can Industry 4.0 help the most affected Value Chains by Covid-19?
Speakers (2): Dr. Jonathan Blanchard Dr. Gissella Bejarano	**Session 2:** Industry 4.0 & Artificial Intelligence • Definition and Introduction to AI • The importance of AI • How this technology can be used for APEC Economies affected by Covid-19? • Applications of this technology in Commerce, Tourism, Hospitality (Restaurants) Education and Healthcare • Recommendations to face challenge applying AI
Speaker(1) : Msc. Andres Arias	**Session 3:** Industry 4.0 & Internet of Things • The concept of Internet of Things • The advantages of Blockchain • The disadvantages of Blockchain • Uses Cases of Block Chain • How to start the implementation of Block Chain

Speaker: Msc. Willson Deng	**Session 4:** Industry 4.0 & Blockchain • The concept of Block Chain • The advantages of Blockchain • The disadvantages of Blockchain • Uses Cases of Block Chain • How to start the implementation of Block Chain
Speakers(2) : Dr. Norma León Ms. Lisa Morales-Hellebo	**Session 5:** Industry 4.0 & Cloud Computing • Definition and Introduction to Cloud Computing • The importance of Cloud Computing • How can this technology be used for APEC Economies affected by Covid-19? • Applications of this technology in Commerce, Tourism, Hospitality (Restaurants) Education and Healthcare • Successful cases of Cloud Computing
Speaker (1): Msc. Ganaventhan Thiagarajah	**Session 6:** Industry 4.0 & Robotics • Industry 4.0: Robotics Technology • Pandemic Recovery and Robotics • Applications of Robotics Technology

Table 1: Sessions & participants

A. Session 1: Industry 4.0

This session aimed to explain the importance of Industry 4.0 and main objectives of this new industrial revolution.

- What is Industry 4.0?
- The importance of Industry 4.0
- Applications of Industry 4.0
- How Industry 4.0 can help the most affected Value Chains by Covid-19

a.1. About the Speaker

Dr. Chen-Lung Wei is currently an Executive Assistant to GM in CIMFORCE in New Taipei city and received his Ph.D. degree in Industrial Engineering and Engineering Management from National Tsing Hua University (NTHU). He worked for Precision Machinery R&D Center (PMC) and Roundtop Machinery Industries Co Ltd

before he joined CIMFORCE. And has gained a lot of experience in design and manufacturing of machine tools over 20 years.

Dr. Wei was a team leader and co-founder of SKYMARS for IOT application of CNC in PMC. This team has received 2012 IENA Gold Medal Award in Nuremberg, Germany. And has built the first Industry 4.0 Implementation Center in Chinese Taipei with National Taiwan University of Science and Technology (NTUST), 2016.

a.2. What is Industry 4.0

Industry 4.0 is a fusion of the new production methods that allow manufacturers to achieve their target more speedily.

Industry 4.0 has as main goal to develop the solution based on Internet Technology: “Software + IOT + Domain knowhow”. The goal is to create highly flexible solution for products and services that is the result of the integration of physical world, information, and data"

To achieve Automation, it is necessary to cross through Standardization, Rationalization and Digitization, as shown in the Image 1. The standardization should be done before automation. It is necessary to review the Digital tools and software especially compatibility and Extensibility.

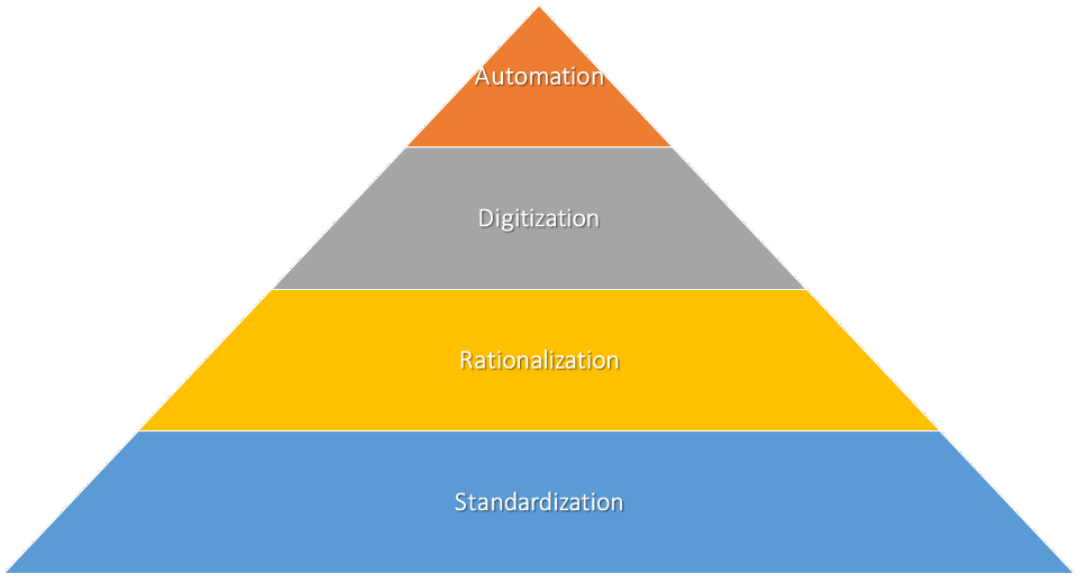

Figure 30. Automation process

a.3. Current Status of Machinery Industry in Chinese Taipei

Chinese Taipei is the 7th producer and 5th exporter in the world, in the Machine tools and machine components. As shown in the image 3.

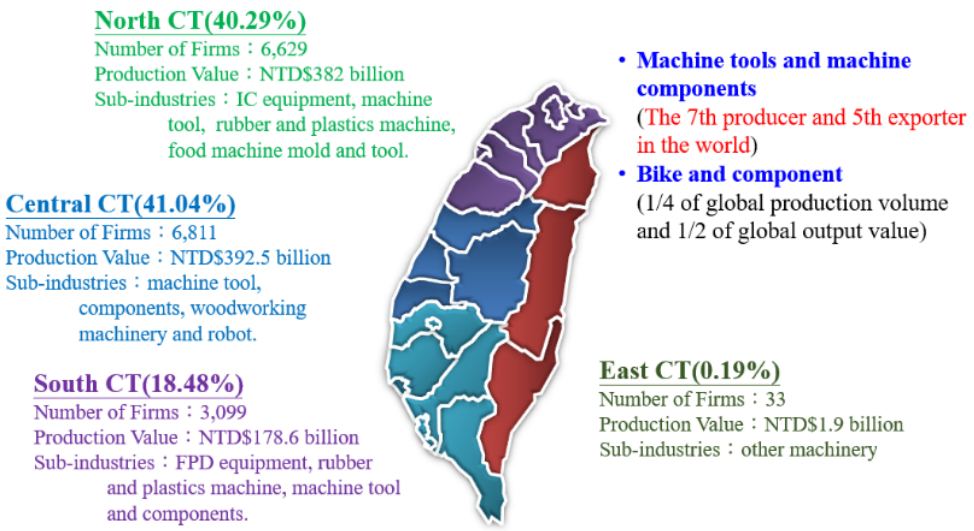

Figure 31. Current Status of Machinery Industry in Chinese Taipei

a.4. Industry 4.0 Challenges of Manufacturing

Industry 4.0 is a new revolution, and is facing challenges some of them are:

- Violent fluctuations in human Resource and material from Restrictions in response to COVID-19 outbreak.
- Bullwhip effect in Supply Chain: High variance and short deliver time.
- Competition in Quality, Cost and Delivery.
- Skill of precision machining needs longer Training.
- Low employment intention of the 90 generation results the challenges for Staff recruitment

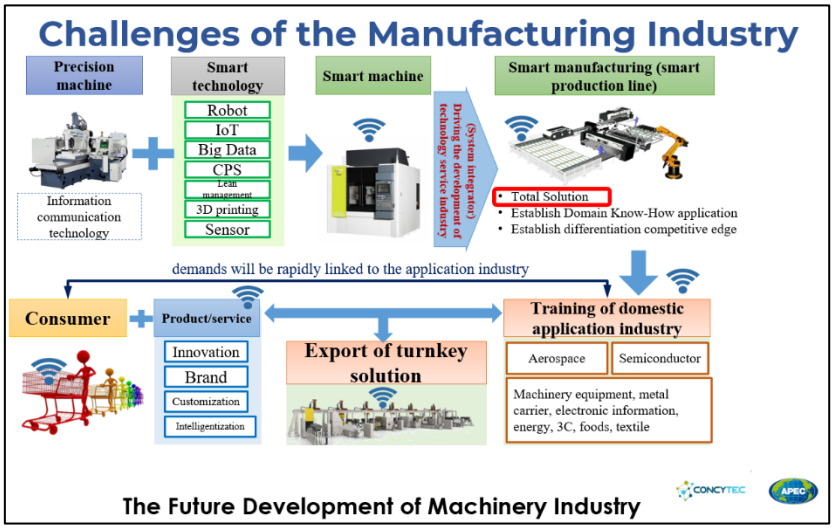

Figure 32.Future Development of Machinery Industry

a.5. Intelligent Manufacturing System and implementation in Industry

Intelligent Manufacturing Systems are the result of the combination of Cyber and Physical systems, as shown in the image 4.

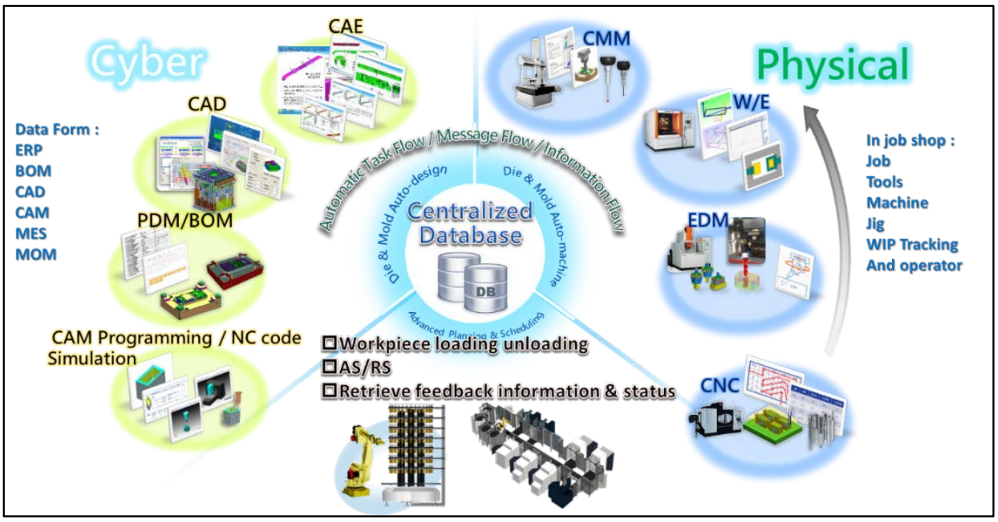

Figure 33. Concept of Industry 4.0 for Intelligent Manufacturing Solution

a.6. Advantages of Intelligent Manufacturing

Intelligent Manufacturing System has different advantages and some of them are:

- ✓ Highly flexibility for Uncertainty
- ✓ Reduce errors to improve quality and delivery
- ✓ Reduce manufacturing costs
- ✓ Maximize equipment resource utilization
- ✓ Easily inheritable experience makes newbie handle the job
- ✓ Systematized keep the tacit knowledge for corporate sustainability

a.7. Cases in Chinese Taipei

Case: Mold manufacturing

This case of study was executed in a Fastener manufacturer in the south of Chinese Taipei, Tainan. Before an Intelligent Manufacturing system was implemented the number of employees were 19 in the factory (as shown in the image, after the implementation were a total of 8 employees (reducing manpower usage), a total of 60 hours of continuous operation was achieved and the utilization rate was over 85%.

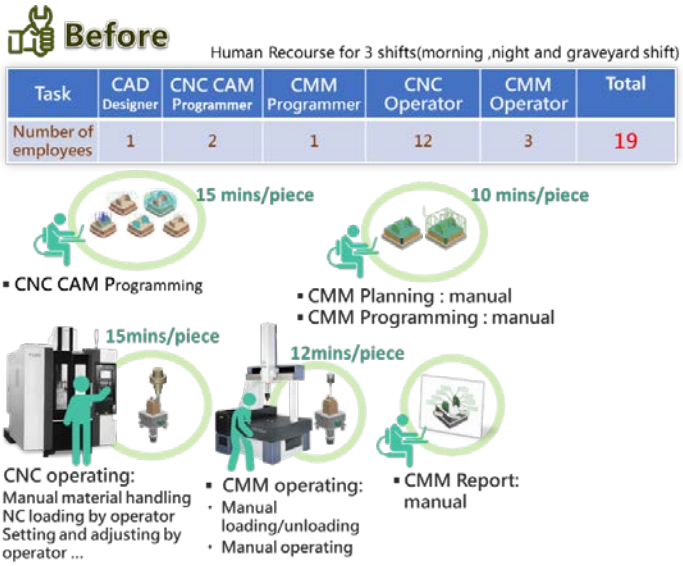

Figure 34. Case: Fastener Manufacturing (Tainan) – Results before the implementation

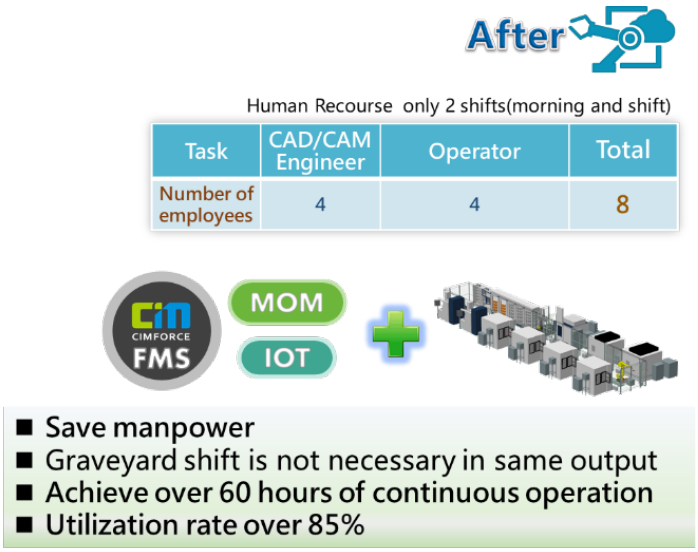

Figure 35. Case: Fastener Manufacturing (Tainan) – Results after the implementation

B. Session 2: Industry 4.0 and Artificial Intelligence

This session aimed to provide basic knowledge of Artificial Intelligence and its potential uses; the topics covered in this session are:

- Definition and Introduction to AI
- The importance of AI
- How this technology can be used for APEC Economies affected by Covid-19?
- Applications of this technology in Commerce, Tourism, Hospitality (Restaurants) Education and Healthcare
- Recommendations to face challenge applying AI

b.1. About the Speakers

b.1.1. Dr. Jonathan Blandchard

He is chairman of the Natural Resources Forum, adviser to a humanitarian charity; and retains several private clients. He has recently been co-speaker at a series of events on Brexit's implications in Europe, including at the Diplomatic Academy of Vienna and the Austrian Competition Authority.

Jonathan has held chairmanship roles in the private and third sectors, including Chairman of the Reform Club, London. He founded his first firm, a publishing company specializing in government and defense, when he was 26, and has remained engaged in both sectors. He was London Managing Director of the New York Institute of Finance, and subsequently their global CMO; and has lectured on cross-border merger and acquisitions.

As a corporate troubleshooter, he has held leadership, management, and advisory positions for and within companies ranging from Pearson PLC to boutique London firms.

b.1.2. Dr. Gisella Bejarano

Gissella Bejarano holds a PhD and a Master in Computer Science from Binghamton University. She studied Informatics Engineering at Pontificia Universidad Catolica del Peru and received a Fulbright grant to study in the USA in 2015. She has experience in Academia and Industry on Data Management, Data Science and Artificial Intelligence. She has been a member of the Committee of experts designing the Artificial Intelligence Strategy of Peru. She is co-director of REPU-Computer Science, a program that offers research experience in the USA to Peruvian Students. Currently she works as a Postdoctoral Researcher at Baylor University in Texas-USA and as a lecturer at Universidad Peruana Cayetano Heredia, in Lima-Perú.

b.2. Definition and Introduction to AI

The concept of Artificial intelligence was coined around 1950s. But the boom started in 2010s (deep learning). It also involves:

- Computational Capabilities (GPUs, TPUs)
- Big Data
- Complex Models

b.3. The importance of AI

The importance of AI from 4 perspectives: (1) Influence in our lives, (2) Increment the productivity, (3) Extend Human Capabilities, (4) Make Data Base decisions.

Influence in our lives

- Personalization

- Entertainment
- Creativity

● Increment productivity

- Efficiency - automation
- Data-based decisions ○ Scheduling and Planning

● Extend Human capabilities

● Make data-based decisions

b.4. How this technology can be used for APEC Economies affected by Covid-19?

Before and while developing AI capabilities

- ● Digitalization
- ● Data organization
- ● Infrastructure
- ● IoT

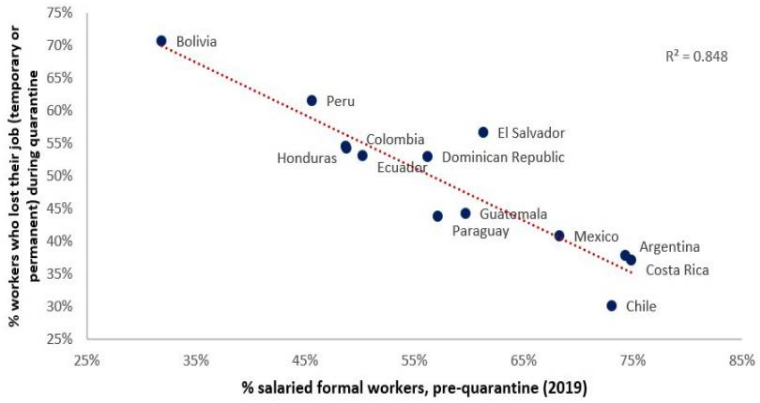

Figure 36. Loss of Jobs (temporary/permanent) and % of formal workers prior to the lockdown [84]

Many value chains can be positively affected by the Artificial Intelligence technology, such as:

- Logistics

[84] High Frequency Phone Surveys (HFPS) – Round 1 (World Bank) and World Development Indicators (World Bank)

- Deal with several variables
- Reduction of costs

- Automation
  - Scheduling
  - Monitoring

- Entertainment
  - Personalization
  - Virtual Reality

b.5. Applications of this technology in Commerce, Tourism, Hospitality (Restaurants) Education and Healthcare

In Commerce

- Dynamic Pricing
- Personalization & Recommendations
- More intelligent leads for sales

In Tourism

- 3-D Reconstruction of Monuments

Restaurants: Improving experience

- Personalization of menu
- Automatize orders

Education: let the AI oversee workload

- Chatbots: most common and repetitive questions
- Human in the loop for more complicated questions

Education: complement the human

- Personalize learning experience
- Propose learning routes

Health: improving facilities

- Chatbots: answer administrative questions

- Optimize schedules and resources

Health: improving treatments

- Support diagnostic
- Medical Imaging
- Personalized treatment

b.6. Recommendations to face challenge applying AI

Apply Ethics Standards

- Design of Automated Systems
- Datasheets for Datasets
    - Data of people (representation)
    - Data labeled by people
- IEEE Standards
- OECD Standards

The Cost of Productivity

- Dehumanize productivity:
    - Proper time for eating
    - Proper time for going to restrooms
    - Proper insurances

b.7. The Future of AI

Socio-economic Impact

- Interdisciplinary analysis
- Digital Humanities
- Upskill and reskill of human labor
- Evaluate basic rent

C. Session 3: Industry 4.0 and Internet of Things

This session aimed to provide basic knowledge of Internet of Things and its potential uses; the topics covered in this session are:

- The concept of Internet of Things
- The advantages of Blockchain
- The disadvantages of Blockchain

- Uses Cases of Block Chain
- How to start the implementation of Block Chain

c.1. About the Speaker

Andrés Arias is an Electronic Engineer, Master in Innovation, with more than 15 years of experience in the design, management, and execution of high impact strategies in different sectors and industries such as telecommunications, automotive, and manufacturing. Important achievements in linking new technologies for process automation, data network connectivity and associated management systems. Deeply committed to training, management and development of technological ecosystems that can transform society in a positive and sustainable way. He currently works as a senior consultant on matters related to the use of technologies for the implementation of smart and circular city strategies.

c.2. The concept of Internet of Things

Technologies that allow us to extend human capabilities and broaden the perception of the environment that we have as human beings, this is how the sensors used would emulate different organs to measure intensity scales of different variables such as temperature, humidity, lighting, presence, among others.

The cyber-physical convergence, the fast expansion of the Internet at its edge, and tighter interactions between human users and their personal mobile devices push towards a data-centric Internet where the human user becomes more central than ever. We argue that this will profoundly impact primarily on the way data should be handled in the Next Generation Internet. It will require a radical change of the Internet data-management paradigm, from the current platform-centric to a human-centric model.

c.3. Advantages of Internet of Things

More competitive industry expanding beyond its natural areas of influence implies better preparation of its infrastructure, developed human talent and economic benefits that guarantee continuity in business models and allow it to evolve at the same speed that the market demands. The image 10 shows IoT can be involve in different sectors.

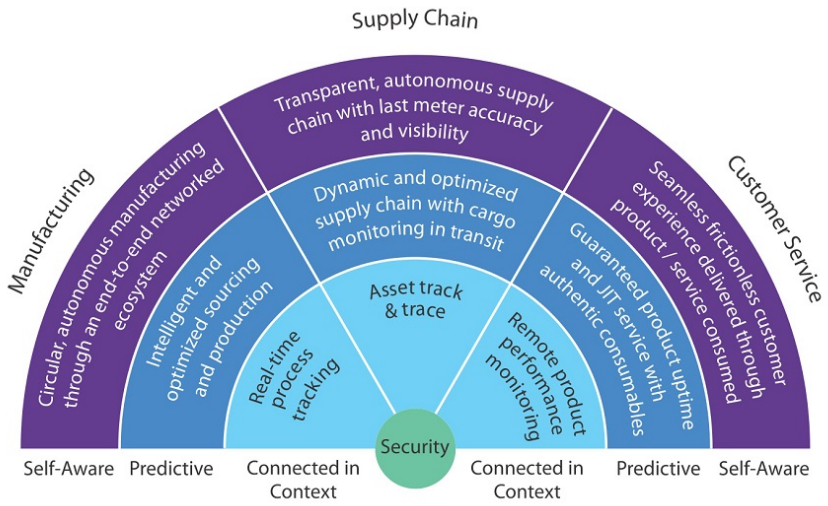

Figure 37. Improving Business Models: IoT framework[85]

c.4. Uses of Internet of Things

Internet of Things has many uses in different value chains, as shown in the Figure 38

- IoT in Consumer & Home

IoT applications for the elderly have the potential to improve and increase quality of life.

- IoT in Retail

IoT technology is used in restaurants and commercial kitchens to monitor food service equipment, ensure compliance and regulatory standards, and manage inventory

- IoT in Transport & Logistics

Passenger Flow Management enables the airport to see how travelers, processes and airlines interact and interconnect, to better plan and improve productivity, respond to customer needs faster and tap into revenue growth opportunities

- IoT in Health & Life Science

IoT sensors and connected devices help ambulance medics to transmit patients' vital signs to the hospital while in transit. Hospital staff can then prepare for the patient's needs ahead of intake and start treatment more quickly with the relevant data.

- IoT in Transport & Logistics

IoT applications for ports include monitoring trade flows and the destination of goods, expected delivery times and loading of cargo. IoT-enabled GPS and geo-referencing alert warehouses for pick up and deliveries and handling requirements.

[85] Ayyaswamy R., (February 2020) IoT Is Enabling Enterprise Strategies for New Beginnings. https://www.tcs.com/perspectives/articles/digital-business-model-iot-strategies

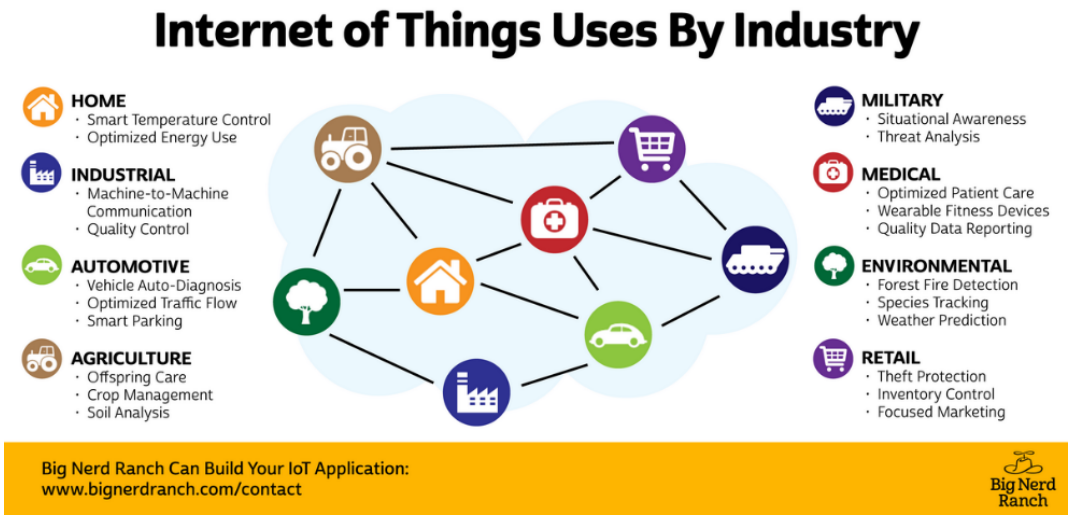

Figure 38. Internet of Things uses by Industry [86]

D. Session 4: Industry 4.0 and Block Chain

This session aimed to provide basic knowledge of Block Chain and its potential uses; the topics covered in this session are:

- The concept of Block Chain
- The advantages of Blockchain
- The disadvantages of Blockchain
- Uses Cases of Block Chain
- How to start the implementation of Block Chain

d.1. About the Speaker

Msc. Willson Deng is an industrial engineer by trade, Willson has implemented improvement projects in manufacturing industries ranging from aeronautics to smart meters, wineries, gourmet chocolates, glass production and pharmaceuticals. He founded Arcstone in 2013, after he had been designing production simulation software for the world's largest bio-manufacturers.

Focused on blending machine and human operations, he developed the Arcstone Operations Platform to efficiently provide visibility, control, and optimization to a massive range of industries. The platform enables companies to automate, integrate and streamline entire processes within a facility at fractions of market cost.

[86] Hill J. - Big Nerd Ranch, (February 2020) What the Internet of Things Means for Your Business https://bignerdranch.com/blog/what-the-internet-of-things-means-for-your-business/

He continues to drive a data-centric manufacturing revolution in Southeast Asia, encouraging like-minded companies to upend the status quo for manufacturing enterprise solutions through the Singapore Manufacturing Consortium (SIMCO).

Mr. Deng holds a MSc from INSEAD Business School and a BS in Industrial Engineering from UC Berkeley. He received Forbes' 30 Under 30 Asia Award in 2016 and is heavily active as an Industry 4.0 and Smart Manufacturing Transformation speaker globally.

d.2. The concept of Blockchain

Industry 4.0 is a fusion of the new production methods that allow manufacturers to achieve their target more speedily.

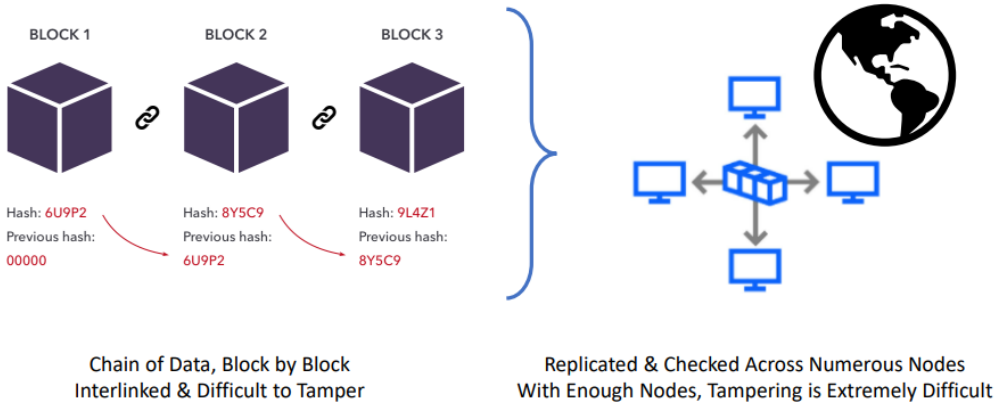

Figure 39. The concept of Blockchain

d.3. The advantages of Blockchain

Industry 4.0 is a fusion of the new production methods that allow manufacturers to achieve their target more speedily.

- Immutable – very difficult to tamper with as nodes scale up.
- Transparent – everyone sees changes in near real-time.
- Simple – a simple ledger, appending data.
- Scalable – scale as many nodes as needed.
- Reliable – multiple nodes can go down, but the whole system will still run.

d.4. The disadvantages of Blockchain

- Hardware Intensive – multiple systems required distributed to support.
- Power Hungry – not the most sustainability friendly of solutions.
- Not Designed for Privacy – data replicated across all nodes for transparency.
- Difficult to Run Fast Analytics – ledger-based chain of data not ideal for analytics.

- Compliance & Regulatory Conditions Limitations – transparent and exposed data may not be allowed (defense/medical/etc.)

d.5. Uses Cases of Blockchain

This technology can be applied in many value chains, as shown in the image bellowed.

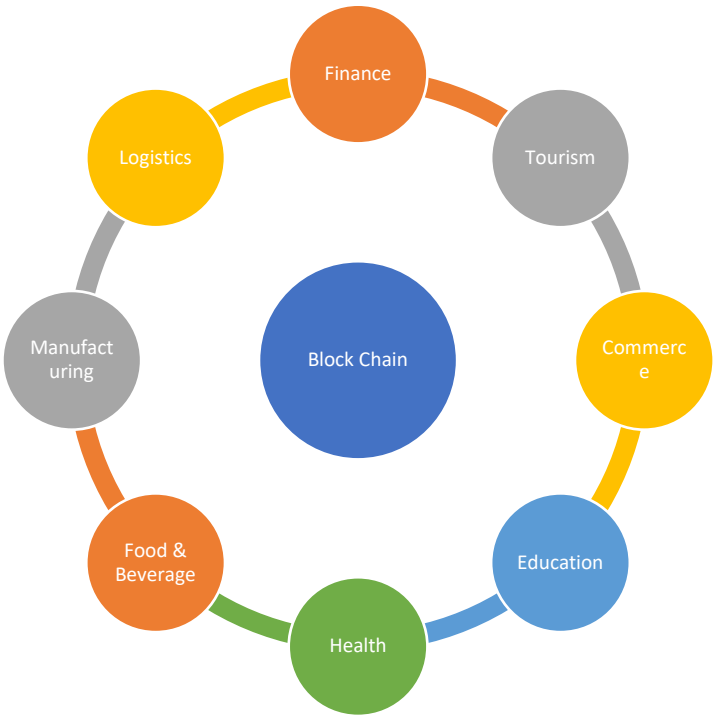

Figure 40. Blockchain and different value chains applications

d.5.1. Tourism

In case of the Tourism, Block Chain has three critical areas:

- Digital ID for Identification
  - Customs & Immigration
  - Check-in/Check-out
- Trip Planning & Integration
  - Multi-Agent Coordination
  - Multi-Company Coordination
- Payments & Cryptocurrency
  - Virtual Coin Payments

d.5.2. Commerce

In case of the Commerce, Block Chain has three critical areas:

- Payments & Cryptocurrency

- Virtual Coin Payments
- Transactions Validation
  - Distributed Ledger
  - Transparent Suppliers
- Smart Contracts
  - Supplier & Customer Interactions and Transparency

d.5.3. Food and Beverage

In case of the Food and Beverages, Block Chain has three critical areas:

- Food & Material Safety
  - Temperature Spikes
  - Improper Handling
- Transactions & Origin Validation
  - Farm to Table Tracking
  - Regulatory & Compliance Records
- Payments & Cryptocurrency
  - Virtual Coin Payments

d.5.4. Healthcare

In case of the Healthcare, Block Chain has three critical areas:

- Medical History & Records
  - Private Network for Patient
  - History Updating & Sharing
- Medicine Production Tracking
  - Cross Economy Blockchain Traceability over Production with Safety & Regulatory Data
- Medicine Supply Chain & Safety
- Temperature, Vibration, etc. Logistics Tracking and History

d.6. How to start the implementation of Block Chain

It is necessary to include 3 stages for the implementation of this technology and they are: evaluation, integration and trial, as shown in the image 17.

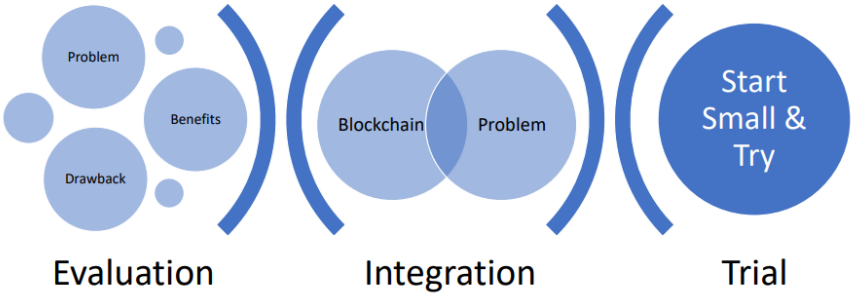

Figure 41. Process for the implementation of the Block Chain

E. Session 5: Industry 4.0 and Cloud Computing

This session aimed to provide basic knowledge of Cloud Computing and its potential uses; the topics covered in this session are:

- Definition and Introduction to Cloud Computing
- The importance of Cloud Computing
- How can this technology be used for APEC Economies affected by Covid-19?
- Applications of this technology in Commerce, Tourism, Hospitality (Restaurants) Education and Healthcare
- Successful cases of Cloud Computing

e.1. About the Speaker

e.1.1. Dr. Norma Leon

Norma Leon is a Computer and Systems Engineer, with a master's degree in E Business, Master's Degree in Business Administration, Doctorate in Information Systems.

She is currently a professor at the University of San Martín de Porres and at the University of San Marcos, Researcher and Head of the "Software and Interactive Technologies" Research Laboratory at the University of San Martín de Porres (USMP), and also an information systems consultant.

e.1.2. Ms. Lisa Morales-Hellebo

Lisa Morales-Hebello is currently co-founder of The Worldwide Supply Chain Federation, an organization that is changing how supply chain professionals learn about, collaborate, and adopt supply chain innovation around the world. She is also co-founder and general partner of REFASHIOND Ventures — an NYC-based, early-stage supply chain technology venture fund that invests in startups refashioning global supply chains.

She is an active advocate for organizations that help minorities gain access to opportunities for funding, championship, and growth. She serves on the Advisory Board of Puerto Rican accelerator, Parallel18; the luxury resale site, Le Prix; and the Board of Directors for The Center for Advancing Innovation. A graduate of Carnegie Mellon University, Lisa has been featured in numerous publications and media outlets and is profiled in the bestselling book; Disrupters: Success Strategies from Women Who Break the Mold.

A distinguished speaker, she has keynoted numerous events and participates in panels covering technology, supply chain, logistics, venture capital, fashion tech, women in tech, and diversity.

e.1.1. Msc. Andres Arias

Andrés Arias is an Electronic Engineer, Master in Innovation, with more than 15 years of experience in the design, management, and execution of high impact strategies in different sectors and industries such as telecommunications, automotive, and manufacturing. Important achievements in linking new technologies for process automation, data network connectivity and associated management systems. Deeply committed to training, management and development of technological ecosystems that can transform society in a positive and sustainable way. He currently works as a senior consultant on matters related to the use of technologies for the implementation of smart and circular city strategies.

e.1. Definition and Introduction to Cloud Computing

Cloud computing allows remote access, from anywhere in the world and at any time, to computing resources such as: software, file storage and data processing through the Internet, without the need to connect to a local or personal server.

In other words, cloud computing uses the connectivity and large scale of the Internet to host the most varied resources, programs, and information, and allows the user to access them through any device (tablet, cell phone, etc.).

Cloud computing supports the potential growth that the company may have and the volatility of the market.

From the client side: it is the opportunity to have, as a service, theoretically unlimited computing capacities, and a great variety of computing resources provided through the internet by a cloud provider (IBM, AWS, Google Cloud, Microsoft Azure, Alibaba, Huawei). among others).

From the provider side: Allows to offer standard resources to clients through the internet. Customers configure and adapt these resources to their needs. With this the provider offers the following advantages to customers.

Figure 42. Cloud computing representation Diagram

e.2.The advantages of Cloud Computing

Cloud computing represents the opportunity to have, as a service, theoretically unlimited computing capabilities and a wide variety of computing resources over the Internet, provided by a cloud provider. The advantages of Cloud Computing are (as shown in the image):

- Flexible cost or pay per use: The price of the service varies according to the needs of the client. Change from fixed to variable cost.
- Market Adaptation: it allows the acceleration of the business (time that elapses since a product or service is conceived until it is launched on the market), or Fast "Time to market", it also supports experiments.
- Hidden Complexity: the control and optimization of resources are automated by the service provider, this process being transparent to the user. The concern of anticipating the purchase of more equipment, software or hiring personnel for maintenance is lost. The maintenance of the platform is transparent to the client; therefore, more effort is devoted to business management.
- Elasticity: It allows to grow and shrink automatically vertically or horizontally.
    - Vertical: The ability to dynamically increase CPU, MEMORY, DISK service capacity.
    - Horizontal: The ability to increase the number of instances or servers, called NODES, that are serving a given solution at the same time.
- Allows Scalability: It is the ability to increase the size of the existing infrastructure (with software or applications), grow and adapt to the performance needs of a company, considering the growth in the number of users and transactions. A business can resize the contracted resources at any time and effectively and immediately. If the need for resources increases, we can get it quickly and if the need for infrastructure decreases, that will be done automatically. That ensures payment for the exact use of resources.
- Connectivity: Access to resources from anywhere. It fosters new value networks. Lead to potential new business. Varies according to the context: Allows to provide experiences to the user. Increases the relevance of the product.

- Varies according to context: the information and applications are stored in the cloud and in different locations. if a disaster occurs, the information is available.

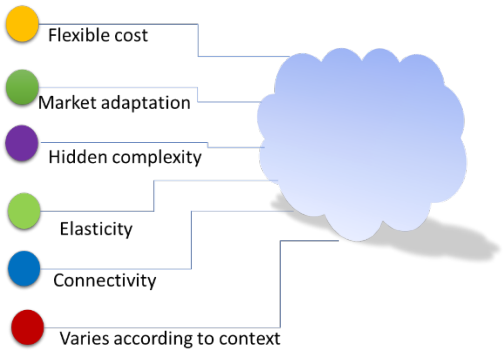

Figure 43. Advantages of Cloud Computing

e.3. How can this technology be used for APEC Economies affected by Covid-19?

The pandemic has forced people, households, health systems, education systems, companies, and economies to digitize, accelerating digital transformation.

Cloud computing has become a model that allows companies, cities, regions, and economies to innovate technologically.

Cloud computing has become an outstanding facilitator element, which offers means to innovate around it. It has also become an essential element to consider improving the performance of people and companies in the use of technology. Here is the importance of cloud computing since it makes available ubiquitous, cheap, easily accessible, and flexible infrastructure, which allows the training of human resources in basic digital skills to training and mentoring for owners and managers. It is going through the digitization of processes and digital transformation.

One of the strengths of cloud computing is to improve business processes and elements, supporting the cultural change towards digitization. This strength can be used for companies to use innovative and disruptive technologies that support the trends and new digital habits created in the pandemic and obtain efficiency, flexibility, agility, and innovation in the business.

Digital training is another opportunity, and it is essential to take advantage of the full potential that digital products and services offer. The number of users with basic and advanced digital skills should be increased. Positive indicators of success in adopting the new business model are improved by improving digital skills.

e.4. Applications of this technology in Commerce, Tourism, Hospitality (Restaurants) Education and Healthcare

Cloud-to-cloud has emerged as a savior that has helped organizations of all sizes adopt digital transformation overnight and quickly switch to a remote working model, as shown in the image bellowed.

Figure 44. Cloud in Commerce, Tourism, Hospitality , Education and Healthcare

e.4.1. Commerce

The change in consumer habits from in-store shopping to online shopping in emerging economies has accelerated and created an excellent opportunity for retailers to build their online presence and business.

Cloud computing, in the pandemic, allowed them to maintain business, drive sales, and accelerate growth, saving time and resources.

Figure 45. Example of apps using cloud computing

In global trade, cloud computing has made it possible to streamline processes throughout the production chain. Cloud scalability Allows to build an e-commerce presence as fast as the business grows the stability provided by the cloud allows it to withstand very high traffic peaks produced by new advertising campaigns or the launch of a new product.

The cloud provides speed that very little on-premises infrastructure could. Enables a reliable e-commerce site, which will translate into positive sales for the business. Enables crucial savings. Because people only pay for what they need and use, profits can be reinvested in creative ways to grow the business.

Allows trust; customers trust not only that the product is accurately described but also that the correct product was sent to them. And the one that the payment is processed securely. Cloud computing enables PCI-DSS-certified hosting (in the image bellowed the process of global traded supported by cloud computing).

Figure 46. Global traded supported by cloud computing

e.4.2. Tourism

Tourism before the pandemic was one of the fastest-growing economic sectors because, as an industry, it needs to stay up to date and in tune with the latest technologies, and the cloud is a key factor in sustaining confidence in good service. However, the tourism sector was one of the most affected value chains by the pandemic.

Cloud computing makes it possible to support the characteristics of this sector, which is the existence of a lot of bidirectional interaction between companies and consumers. In the image bellowed is shown how the digitalization can improve different shapes of tourism.

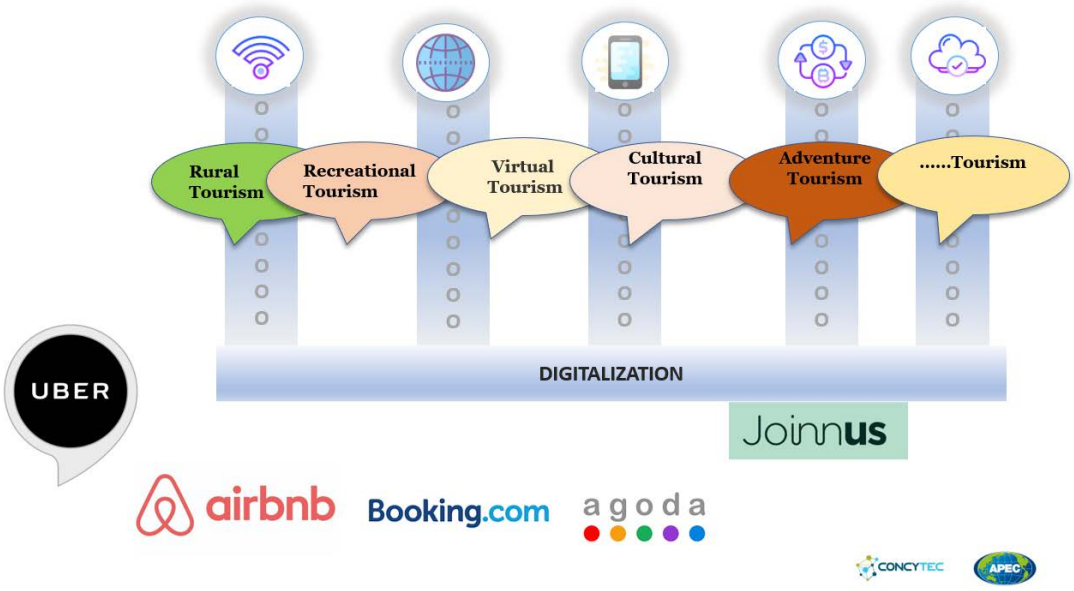

Figure 47. Digitalization in Tourism

Cloud computing has allowed more and more services to be published every day to satisfy the personal travel needs of tourists, allowing correct communication between requesting agents, weather forecast services, online translation web services, transportation services, etc., accommodation services, entertainment activities support services, destination management, among other services required by the various existing types of tourism.

e.4.3. Hospitality

Implementing cloud-based software enables direct login in a web browser, accessing the application from anywhere and from any device, helping more efficient operations, saving time for employees, and creating more positive experiences for guests.

Gone is the traditional software that is installed on hotel computers. A change to a cloud-based model must be made to create innovation at all levels of the value chain. In the image bellowed, it is showed the key stages of the hospitality value chain.

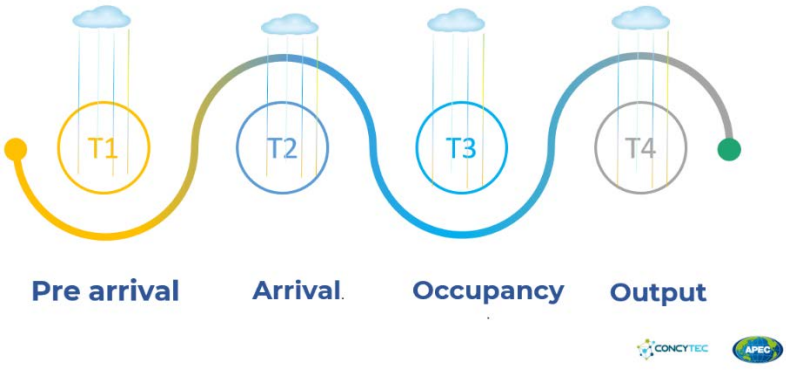

Figure 48. Stages of Hospitality Process

- Pre-arrival

From the moment the guest begins making hotel arrangements until they are on their way to the hotel, the cloud helps the guest select an appropriate hotel and receive the desired service and amenities.

- Arrival

The cloud empowers hotel staff to be ready to greet guests and start delivering a personalized hotel stay.

- Occupancy

The cloud helps ensure a personalized and comfortable stay for the guest

- Output

The cloud helps facilitate an easy check-out for the guest, allows the hotel to show appreciation to the guest, and provides hotel staff with the information they need

Cloud computing in the hospitality industry is transforming the customer experience, from a welcoming and surprise-free arrival to a fast and efficient check-out, providing detailed service information, creating a "pleasant experience" for visitors, and providing greater insight to hotel organizations.

e.4.4. Education

Cloud computing supported the abrupt shift from traditional face-to-face teaching to a virtual approach, as shown in the image 15.

Cloud computing allowed the continuity of classes and gave a modern approach to the teaching-learning process. Teachers can now share notes and lesson plans quickly and efficiently. Students can access various resources such as grades, discussion forms, and access to simulations. Administrators can easily collaborate and save money on data storage. It allowed simulators and virtual reality laboratories.

e.4.5. Healthcare

Public health in many emerging economies did not support telemedicine, and the few existing cases had a very short range of influence; the pandemic tested the ability of the cloud to support a large amount of data from a wide range of internal sources, such as electronic medical records (EHR), radiology images, pharmacy sales, prescription information, lab tests, and insurance claims data. Generated by health care providers.

Cloud computing enables all big data operations through the provision of large storage and processing capacity. Additionally, cloud-based analytics tools help providers better manage patients by transforming health data into actionable insights.

e.5. Successful cases of Cloud Computing

Case 1

A Chilean company transformed its business. Still a digital model, he migrated to the cloud in 2020 and increased his monthly sales by 500%, becoming the most important digital pharmacy in the economy in just two years. The company's digital model allows it to save 15% on general expenses. The process of migrating to the cloud was “easy and comfortable, we multiplied our profits 10 times. We went from 30 thousand dollars in the month of March, to 40 thousand in August. Then 50 thousand, 60 thousand, consecutively. The growth curve is exponential.

It has more than 45,000 monthly e-commerce users, who benefit from savings, on average, of 20% for the fractional purchase of medicines. Similarly, the digital model has allowed Fracción to strengthen alliances with various insurance companies and compensation funds.

Case 2

A business creates algorithms based on artificial intelligence in the cloud to prevent blindness in newborns, uses (AI) to determine Retinopathy of Prematurity (RoP) in time and, consequently, avoid blindness in premature babies.

The project began in 2019, through the cloud, they use the deep learning neural network algorithm, they trained Machine Learning, with 3,000 photographs, which specialist doctors helped to classify between sick and healthy eyes. In this way, the AI uses the images collected for the recognition of common patterns of sick eyes, compared to healthy eyes.

The second component of the solution is an application for mobile phones. The app allows specialists to take a picture of babies' eyes from their cell phones. The image is automatically sent to the web service and processed by APEC's artificial intelligence algorithm.

Case 3

It is a developed a cloud telemedicine platform that brings together psychology professionals to care for clients remotely, through an online service that guarantees confidentiality and security. has allowed people who do not feel so comfortable attending therapy, to do so from the comfort of their home and in their own time and conditions,

The business has grown by 600%, because of the increased demand for psychological care, caused by the emotional and physical difficulties resulting from the impact of COVID-19.

F. Session 6: Industry 4.0 and Robotics

This session aimed to provide basic knowledge of Robotics and its potential uses; the topics covered in this session are:

- Industry 4.0: Robotics Technology
- Pandemic Recovery and Robotics
- Applications of Robotics Technology

f.1. About the Speakers

Msc. Ganaventhan Thiagarajah is Assistant Manager at the Industrial Solution Department in OMRON Asia Pacific Pte Ltd, Singapore. He is a postgraduate in Artificial Intelligence and Internet of Things from University of Singapore. He has 10 years of industry experience focusing on digital manufacturing, Industrial automation and Robotic.

He currently steers the data utilization services business development of OMRON's Industrial Automation business across the Asia Pacific region and focuses on sustainable and innovative industrial automation solution to solve social issues.

f.2. Industry 4.0: Robotics Technology

Robotics involves design, build, operation, and use of robots. The aim of robotics is to design machines that can help and assist humans.

End of arm tooling (EOAT) is a crucial aspect of robotic technology. It refers to the equipment that interacts with parts and components, typically at the end of a robotic arm. For example, the welding torch on a robotic welding system. In the following image some types of robots are presented.

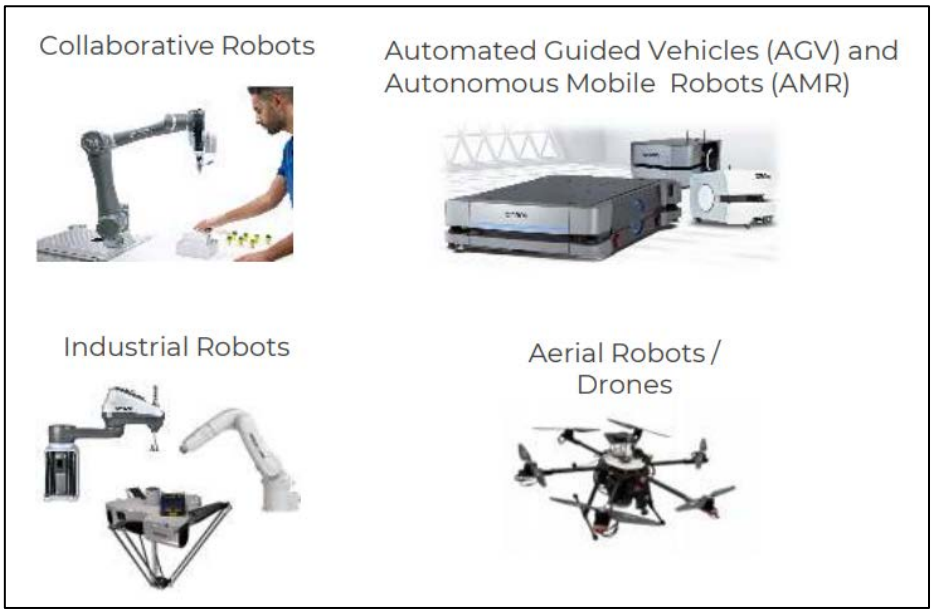

Figure 49. Types of robots

f.3. Pandemic Recovery and Robotics

The robots are part of the recovery during the pandemic, offering the following advantages:

- Improving overall business efficiency
- Replace workers in mundane tasks
- Shortage of skilled workforce
- Low contact eco system

In the following image it is presented the taxonomy of reported robot uses for covid-19.

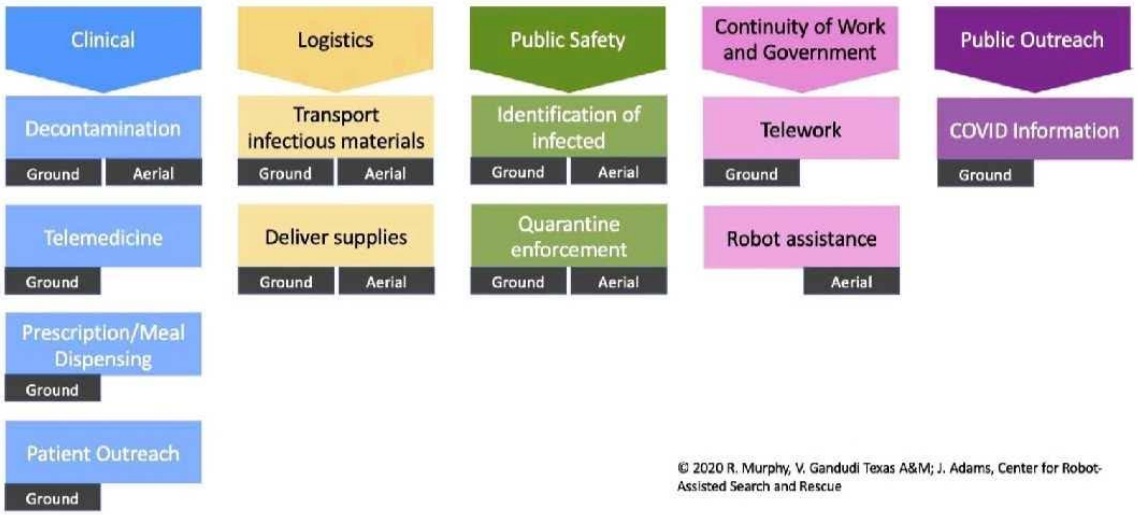

Figure 50. Taxonomy of Reported Robot Uses for Covid-19

(March 30,2020)[84]

f.4.Applications of Robotics Technology

There are many jobs in industries like logistics, manufacturing, entertainment, agriculture, etc. which require monotonous work that also requires a lot of precision. There are also tasks like space exploration that are very unsafe for humans. And for those tasks, robots are the best fit because there is no chance of a robot to have an accident. Because of these advantages, there are many applications of robots in almost all the industries, as shown in the image bellow.

Figure 51. General Applications of Collaboration Robots (Cobots)

VI. RECOMMENDATIONS

- This technology toolkit involves two concepts, value chain and industries 4.0, and how those concepts can promote the dissemination of Industry 4.0 solutions for increasing technical and commercial capabilities in APEC economies value chains most affected by COVID-19.
- One of the essential lessons for the industry 4.0 Technologies is, is the emphasis on human involvement, as “main actors” and the subjects of this new revolution. This human-centric vision of Industry 4.0 was a common concept constantly highlighted by speakers along the Symposium.
- The second essential lesson is that Industry 4.0 is about connectivity. This goes further on data collection, digitalization or infrastructure is the main feature of this new technologies.
- Developing the value chains of the different sectors provides a transversal and systemic vision of the characteristics, advantages and barriers that can arise in a productive cycle and in the economic development of the industries, new actors and generation of business models that increase the efficiency of the flows between suppliers and consumers
- In this document the key technologies studied were Artificial Intelligence, Internet of Things, Block Chain, Cloud Computing and Robotics and six case studies had been conducted to analyses, and respective solutions with the technology adoption had been presented.
- The importance of the strategic view. Industry 4.0 technologies is not only an operational tool, could and should be used for strategic purposes and it must be discussed in the strategic conversations of the company. Also is very important re-skilling or upskilling the “talent” and the value of learning by doing in this process.
- When these technologies are implemented in a value chain it is necessary to measure the impact, but it is necessary to measure the “real” impact of the investment in Industry 4.0, including environmental, social, safeness, economic impact, etc.; and the need to take this into consideration while assessing an Industry 4.0 technologies implementation

- Finally, the technological toolkit document can be used as a guide of case of study, with potential solutions, to help developing economies to support their value chains in the era of post-Covid 19.

- As best practices for the adoption is considered to: (1) conceive an adoption strategy, (2) educate and train resources, choose the right model (3) and security (4), beside the type of technology consider to adopt.

- As future works, it is proposed to start projects implementation of Industry 4.0 technologies in developing economies to generate more competitive advantage to their more affected value chains.

VII. ANNEX

ANNEX 1: “Diagnosis of the Value Chains Most Impacted by Covid-19 in the APEC Region”

EXECUTIVE SUMMARY

The present document has as objective present solutions based in real case of study founded, to support developing economies affected by COVID-19, in the current stage of recovering response to the pandemic. These solutions can help developing economies from APEC region to understand, learn and implement Industry 4.0 technologies.

The new technologies are applied in various business operation procedures such as customer relationship management, restaurant robotization, digital sales-platform construction, and product innovation. Industry 4.0 is a fusion of the new digital technologies, such as artificial intelligence (AI), big data, internet of things (IoT), cloud computing, blockchain, robotics and 5G, have effectively assisted many economies in the pandemic emergency, response, and recovery.

The cases of study collected, belong to three different value chains, which are tourism, commerce, and restaurants. The value chain selected were very affected by the COVID-19 pandemic. The value chains were selected based on the Analytical Hierarchy Process (AHP).

I. INTRODUCTION

This document reports on the project “Industry 4.0: Enabling Technologies and Inclusive Digitization for Post-COVID-19 Economic Recovery in APEC Value Chains” first deliver and comprises:

1. A preliminary evaluation, ‘Diagnosis to identify the Value Chains most Impacted by Covid-19 in the APEC Region’, to present solutions using 4.0 technologies such as Artificial Intelligence; Internet of Things; Machine learning; Big Data, Blockchain; Robotics; and inclusive digitization.
2. The evaluation will include recommendations for at least three (3) selected value chains, identifying suggested preliminary solutions from two (2) case studies for each value chain, to be discussed at the Virtual Symposium.

II. VALUE CHAIN

According to Michael Port's study in 1985, the value chain concept is based on the process approach for organizations studies, to see an organization as a system made up of subsystems, each with inputs, transformation processes, and outputs[87]. These involve acquiring and consuming resources such as money, human capital, materials, equipment, buildings, land, administration, and management[88]. These activities can be classified generally as either primary or support activities, as shown in Image 1[88].

Scott (1998) indicates that all the firms whether industrial or services have a value chain, and each part requires a strategy to ensure that it drives value creation for the firm overall. If the manager is clear about the firm capabilities means each part of the value chain have strategy and therefore an effective market impact is delivered[89].

It is very common to confuse the concept of Supply Chain with Value Chain. The concept of Supply chain is the process between producing and distributing the product, dealing with the suppliers and logistics of getting the product to market; on the other side Value chain is a set of activities carried out by the company which maximizes the competitive advantage.

Value Chain Analysis is a management tool that identifies sources of Competitive Advantage. The purpose of analyzing the value chain is to define the potential differentiation sources that can add value to the product or service, making the customer willing to pay for the product or service offered. Being able to take advantage of these opportunities will depend on the ability of the company to develop along the value chain better offers than its competitors, in the crucial competitive activities. Value Chain is a sequence of productive activities that create value. For each activity or process in the chain the product or service is worth more[88]. In this way, the price paid by the customers is divided into three parts: (1) costs of the products brought by the producer or costs of the raw materials; (2) value added by the producer and (3) producer's margin [88].

The Value Chain becomes an integral component in strategy process. Strategy is the art of creating value and the way a firm defines its business and links together with the only two resources: knowledge and

[87] Porter, Michael E., "Competitive Advantage". 1985, Ch. 1, pp 11-15. The Free Press. New York.

[88] Gabriel, E. (2006). Value Chain for Services, A new dimension of Porter's Value Chain. The IMS International Journal, 1-26.Retrieved from http://www.olegabriel.com

[89] Scott M. (1998), Value Drivers, Wiley, Chichester.

relationships on an organization`s competencies and customers[90]. All firms, requires a strategy to ensure that it drives value creation for the firm overall.

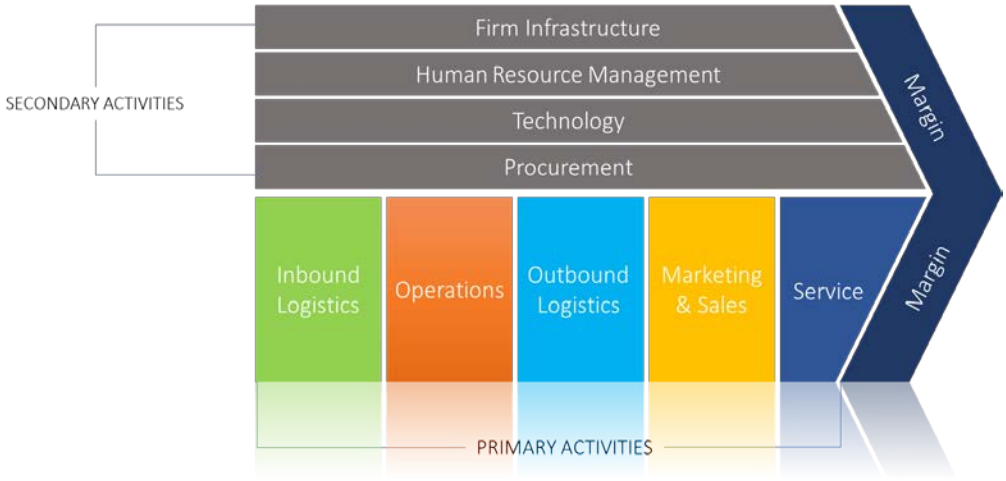

Image 1. Porter's Value Chain Model [91]

According to Porter[88], the activities of a value chain are divided in two groups, primary and secondary activities.

2.1. Primary Activities

Porter's value chain consists of five primary activities and four supporting activities. The primary activities are inbound logistics, operations, outbound logistics, marketing, and sales, and service[88].

- ✓ Inbound Logistics includes all the activities required to receive, store, and disseminate inputs.
- ✓ Operations – Are all the activities required to transform inputs into outputs (products and services).
- ✓ Outbound Logistics – All the activities required to collect, store, and distribute the output are considered.
- ✓ Marketing and Sales – All activities inform buyers about products and services, induce buyers to purchase them, and facilitate their purchase.
- ✓ Service - Includes all the activities required to keep the product or service working effectively for the buyer after it is sold and delivered.

2.2. Secondary Activities

The support activities consist of infrastructure, human resource management, technology development, and procurement.

[90] Norman, R. and Ramirez. R. (1993), " From value chain to value constellation: 'designing integrative strategy", Harvard Business Review, July/August

- ✓ Infrastructure - serves the company's needs and ties its various parts together; it consists of functions or departments such as accounting, legal, finance, planning, public affairs, government relations, quality assurance, and general management.
- ✓ Human Resource management - Consists of all activities involved in recruiting, hiring, training, developing, compensating, and (if necessary) dismissing or laying off personnel.
- ✓ Technological Development - pertains to the equipment, hardware, software, procedures, and technical knowledge brought to bear in the firm's transformation of inputs into outputs.
- ✓ Procurement – This activity includes the acquisition of inputs, or resources, for the firm.

But the point is the service industry has some differences from the manufacturing industry. For example, the service industry does not have the entire operation of inbound or outbound logistics. Therefore, it is necessary to have a different version of the value chain that can well describe the service industry, especially the higher education sector[89].

When the activities are maximized allows the company to have a competitive advantage over its industry competitors. To achieve a successful value chain, it is necessary needs connections between consumer demand and what a company produces. Value chains focus is on product testing, innovation, research and development and marketing.

III. COVID 19 AND THE AFFECTED VALUE CHAINS

This APEC project will promote the use of Industry 4.0 technologies (Artificial Intelligence; Internet of Things; Machine Learning; Big Data, Blockchain; Robotics) and inclusive digitization in a post-COVID-19 context, focusing on the reactivation of the most affected strategic value chains across the APEC region. This first output focus on a preliminary evaluation ('Diagnosis to identify the Value Chains most Impacted by Covid-19 in the APEC Region').

The impact of the pandemic on world GDP growth is massive. The COVID-19 global recession is the deepest since the end of World War II. The global economy contracted by 3.5 percent in 2020 according to the April 2021 World Economic Outlook Report published by the International Monetary Fund (IMF), a 7 percent loss relative to the 3.4 percent growth forecast back in October 2019. While virtually every economy covered by the IMF posted negative growth in 2020 (IMF 2020b), the downturn was more pronounced in the poorest parts of the world[91].

This APEC project addresses the serious impact of COVID-19 on value chains in the APEC region, with many businesses from a wide range of sectors either bankrupt or on the verge of default.

The unprecedented outbreak of the 2019 novel coronavirus, termed as COVID-19 by the World Health Organization (WHO), has placed numerous governments around the world in a precarious position. The impact of the COVID-19 outbreak, has now become a matter of grave concern for virtually every economy in the world.

The scarcity of resources to endure the COVID-19 outbreak combined with the fear of overburdened healthcare systems has forced most of the economies into a state of partial or complete lockdown. The number of laboratory-confirmed coronavirus cases has been increasing at an alarming rate throughout the world, with reportedly more than 247 million confirmed cases as of 01 of November 2021. Adding to these woes, numerous false reports, misinformation, and unsolicited fears regarding coronavirus, are being circulated regularly since the outbreak of the COVID-19[92].

In addition to the value chain affected by the COVID-19, this study explores the use of technologies such as the Internet of Things (IoT), Blockchain, Robotics, Artificial Intelligence (AI) and Robotics, among others, to help in the era of post-COVID 19.

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91 Yeyati E & Fillippini F., Social and economic impact of COVID-19. Available Online: https://www.brookings.edu/research/social-and-economic-impact-of-covid-19/ (Accessed on 8th of November 2021)

92 V. Chamola, V. Hassija, V. Gupta and M. Guizani, "A Comprehensive Review of the COVID-19 Pandemic and the Role of IoT, Drones, AI, Blockchain, and 5G in Managing its Impact," in IEEE Access, vol. 8, pp. 90225-90265, 2020, doi: 10.1109/ACCESS.2020.2992341.

3.1. Identification of the value chains more affected by the Covid-19 pandemic

Beside the health and human tragedy of COVID-19, the pandemic triggered one of the most serious economic crises. Most economic sectors are affected, whether through lockdown measures, disrupted global supply chains, weaker domestic and foreign demand for goods and services, subdued worldwide tourism[93] and a decline in business travel. Measures to contain the virus' spread have hit SMEs and entrepreneurs particularly hard [94]. Unemployment levels and the number of job seekers have increased, sometimes dramatically.

The regional and local impact of the crisis is highly heterogeneous within economies. Some economies, particularly the more vulnerable ones, such as deprived urban areas, have been harder hit than others. Certain vulnerable populations, too, have been more affected. In economic terms, the impact of the crisis is differing across regions. Differentiating factors include a region's exposure to tradable sectors, its exposure to global value chains and its specialization in exposed industries, such as tourism, accommodation and food services, and mining and oil and gas extraction. In social terms, access to health and educational services as well as commodity rates also exhibit regional disparities with a strong territorial dimension[95].

It is a global phenomenon, affecting every economy in the world, although with different intensities. Every economy in the region is experiencing consequences associated with domestic demand and supply, as well as global demand and supply. Economic Commission for Latin America and the Caribbean ECLAC based on official information classified the activities that were more affected by Covid-19, as shown in Image 10.

93 OECD (2020), Covid-19: Tourism Policy Responses (as of 25 March 2020), https://read.oecd-ilibrary.org/view/?ref=124_124984-7uf8nm95se&title=Covid-19_Tourism_Policy_Responses.

94 OECD (2020), Covid-19 : SME Policy Responses (as of 16 March 2020), https://www.oecd.org/cfe/leed/COVID-19-Italian-regions-SME-policy-responses.pdf.

95 OECD (2021), The Territorial Impact of COVID-19: Managing the Crisis and Recovery across Levels of Government , https://www.oecd.org/coronavirus/policy-responses/the-territorial-impact-of-covid-19-managing-the-crisis-and-recovery-across-levels-of-government-a2c6abaf/

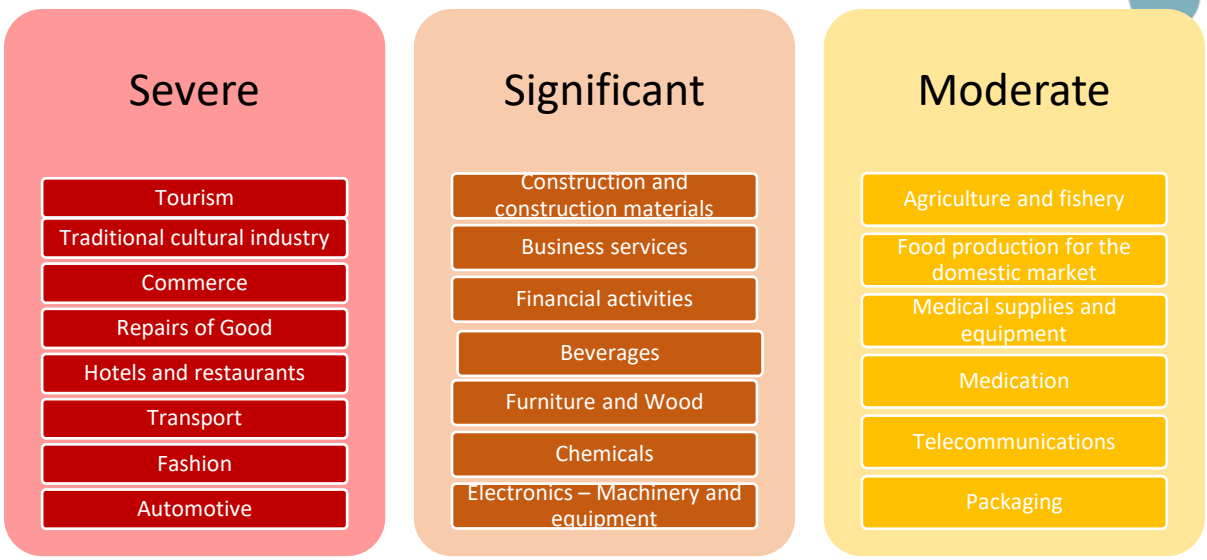

Image 2. Activities more affected by Covid-19 based on ECLAC study [96]

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

The economic crisis has its origins in both supply and demand. Social restrictions have led to the total or partial interruption of productive activities. This effect has been stronger in value chains whose activities involve agglomeration and physical proximity (tourism, entertainment, hotels and restaurants, transport, personal services), and less so in those deemed essential (food, disinfectants, cleaning supplies, medicines, and medical supplies and equipment).

The interruption of many productive activities has also generated problems with the supply of inputs, both domestic and imported, for companies that have continued to operate.

On the demand side, reduced consumer incomes and uncertainty have led to a drop in consumption and a change in consumption patterns. This has affected consumer durables segments (cars, furniture, household appliances, housing, clothing, and footwear, for example), while sales of other types of goods and services have suffered less or even benefited (cleaning and disinfectant products, durable foods, Internet television services, telecommunications) [96].

3.2. Selection of the value chains more affected by the Covid-19 pandemic

One of the main challenges that organizations face today resides in their ability to choose the most correct and consistent alternatives in such a way that strategic alignment is maintained. Given any specific

[96] ECLAC (2020). Sectors and businesses facing COVID-19: emergency and reactivation https://repositorio.cepal.org/bitstream/handle/11362/45736/5/S2000437_en.pdf7

situation, making the right decisions is probably one of the most difficult challenges for science and technology [97].

The analytic hierarchy process (AHP) method, proposed by Saaty [98] https://www.mdpi.com/2227-9717/7/3/161/htm - B47-processes-07-00161, is a multi-criterion decision-making tool. This method involves structuring criterion into a hierarchical structure to help to take the best decision[99].

In the following lines, the solution process of the AHP method has been explained in 5 steps.

Step 1. Identification of the decision problem. The first step consists of clearly defining the problem to be solved and consequently defining the goal to achieve or expected to achieve after the method will be implemented.

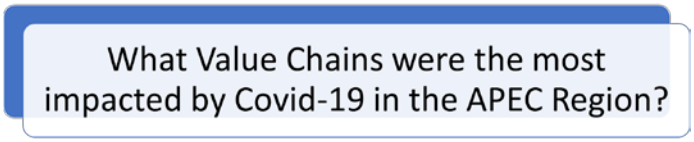

Image 3. Decision Problem

Step 2. Construction of the hierarchical structure. This structure is defined with the goal (problem to be solved) at the top of the diagram, followed by the criterion or factors affecting the problem. In case the hierarchy has possible alternatives the levels of the structure can continue been defined, as is shown in Image 4.

[97] Triantaphyllou, E., & Mann, S. H. (1995). Using the analytic hierarchy process for decision making in engineering applications: Some challenges. International Journal of Industrial Engineering: Applications and Practice, (2)1, 35–44. Available at http://www.csc.lsu.edu/trianta/Journal_PAPERS1/AHPapls1.pdf.

[98] Saaty, T.L. The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation; McGraw-Hill: New York, NY, USA, 1980. 48.

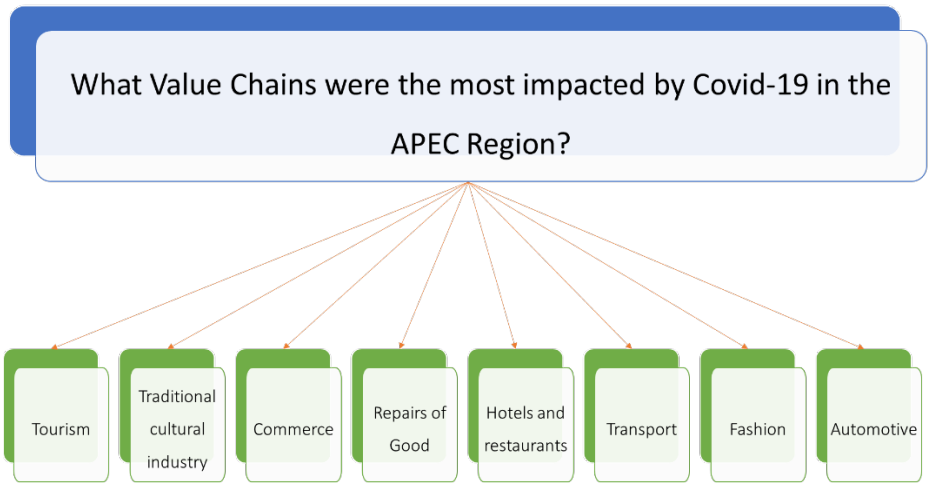

Image 4. Hierarchical structure for this diagnosis

Step 3. Calculation of the weight (priority) of each criterion. This step starts with the development of pairwise comparison matrices between the criterion and alternatives, with the main purpose of determining the importance weights by binary comparisons; the pairwise comparison involves one-on-one comparisons between each of the factors and derives the relative weight for the criterion[99].

The application of this tool can be seen in the different sectors: Moraes[100] applied AHP in project portfolio management; also has been applied to identify the barriers to renewable energy also medical and healthcare sector and many other sectors.

The 9-points scale created by Saaty[101] (Table 2) is used to measure the relative weight of each criterion and is assigned for the pairwise comparison. After deriving the weights of each criterion, it is necessary to review the consistency of judgments.

Table 2. Scale for pairwise comparison, adopted from Saaty [102].

Scale	Description	Consideration
1	Equal Importance	Two activities represent the same level of importance.
2 3	Slightly more important	In case the judgment is between equal and slightly more important (the value is 2)

[99] Mu, E.; Pereyra-Rojas, M. Understanding the Analytic Hierarchy Process. In Practical Decision Making: An Introduction to the Analytic Hierarchy Process (AHP) Using Super Decisions V2; Springer International Publishing: Cham, Switzerland, 2017; pp. 7–22.

[100] Moraes, E.; Bernanrdes, R.; Camanho, R. Project Portfolio Management Using AHP; Centro Universitário da FEI: São Paulo, Brazil, 2019.

[101] Saaty, T.L. How to make a decision: The analytic hierarchy process. Eur. J. Oper. Res. 1990, 48, 9–26.

4 5	Moderately more important	In case the judgment is between slight and moderate more important (the value is 4)
6 7	Considerably more important	In case the judgment is between moderately and considerably more important (the value is 6).
8 9	Extremely more important	In case the judgment is between considerably and extremely more important (the value is 8).

Cells in comparison matrices use a value from the numeric scale shown in Table 2, to show the relative preference in each of the compared pairs [102]. For example, if is considered that factor A is extremely more important than the factor B, the A–B comparison cell will contain the value 9, and this implies that B–A has the reciprocal value 1/9, as is presented in the following example (Table 2).

Table 3. Example of how to complete the pairwise comparison matrix.

CRITERIA	A	B	C
A	1.00	9	B
B	1/9	1.00	C
C	1/B	1/C	1.00

In this case of study, the comparison will be defined by the number of articles founded by value chain, as is shown in Table 3.

Table 4. Pairwise comparison matrix for this study.

ARTICLES FOUND	TOURISM	TRADITIONAL CULTURAL INDUSTRY	COMMERCE	REPAIRS OF GOOD	HOTELS AND RESTAURANTS	TRANSPORT	FASHION	AUTOMOTIVE

[102] Islam, M.; Jantan, A.; Binti Hashim, H.; Chong, C.W.; Abdullah, M.M.; Rahman, M.; Hamid, A.B. Fourth Industrial Revolution in Developing Countries: A Case on Bangladesh. J. Manag. Inf. Decis. Sci. 2018, 21, 1–9.

TOURISM	1.00	8	4	9	4	8	8	8
TRADITIONAL CULTURAL INDUSTRY	0.13	1.00	0.20	2.00	0.13	0.25	0.50	0.50
COMMERCE	0.25	5.00	1.00	3.00	0.25	7.00	5.00	4.00
REPAIRS OF GOOD	0.11	0.50	0.33	1.00	0.11	0.33	0.20	0.33
RESTAURANTS	0.25	8.00	4.00	9.00	1.00	5.00	6.00	8.00
TRANSPORT	0.13	4.00	0.14	3.00	0.20	1.00	2.00	1.00
FASHION	0.13	2.00	0.20	5.00	0.17	0.50	1.00	0.50
AUTOMOTIVE	0.13	2.00	0.25	3.00	0.13	1.00	2.00	1.00

After the pairwise comparison matrix has been developed, the next step is the creation of normalized matrices. First, the sum of each column is calculated as shown the Table 4.

Table 5. Example of completed pairwise comparison matrix.

CRITERIA	A	B	C
A	1.00	9	B
B	1/9	1.00	C
C	1/B	1/C	1.00
Total	T1 = 1+1/9+1/B	T2=9+1+1/C	T3=B+C+1

Then, the normalized matrix is obtained by dividing each column value by the respective column sum, as shown in the example presented in Table 5.

Table 6. The normalized matrix of the example presented in Table 2.

CRITERIA	A	B	C
A	1/T1	A/T2	B/T3
B	1/(T1*A)	1/T2	C/T3
C	1/(T1*B)	1/(T2*B)	1/T3

After obtained the normalized matrix; the priority of each criterion (priority vector, column W of Table 6) is obtained by simply calculating per each row the average value.

Table 7. Normalized matrix for this study.

ARTICLES FOUND	TOURISM	TRADITIONAL CULTURAL INDUSTRY	COMMERCE	REPAIRS OF GOOD	HOTELS AND RESTAURANTS	TRANSPORT	FASHION	AUTOMOTIVE	PRIORITY VECTOR (W)
TOURISM	0.47	0.26	0.40	0.26	0.67	0.35	0.32	0.34	38.4%
TRADITIONAL CULTURAL INDUSTRY	0.06	0.03	0.02	0.06	0.02	0.01	0.02	0.02	3.0%
COMMERCE	0.12	0.16	0.10	0.09	0.04	0.30	0.20	0.17	14.8%
REPAIRS OF GOOD	0.05	0.02	0.03	0.03	0.02	0.01	0.01	0.01	2.3%
RESTAURANTS	0.12	0.26	0.40	0.26	0.17	0.22	0.24	0.34	25.0%
TRANSPORT	0.06	0.13	0.01	0.09	0.03	0.04	0.08	0.04	6.1%
FASHION	0.06	0.07	0.02	0.14	0.03	0.02	0.04	0.02	5.0%
AUTOMOTIVE	0.06	0.07	0.02	0.09	0.02	0.04	0.08	0.04	5.3%

Step 4. Evaluating the consistency ratios of the comparison matrices. First, multiply the pairwise matrix by the weight vector (C × W = WS) obtaining a new vector called weight sum (WS), as is shown in the Equation (1), where n is the size of the comparison matrix.

$$\begin{pmatrix} C_{11} & C_{21} & C_{31} & \dots & C_{n1} \\ C_{12} & C_{22} & C_{32} & \dots & C_{n2} \\ C_{13} & C_{23} & C_{33} & \dots & C_{n3} \\ \vdots & \vdots & \vdots & & \vdots \\ C_{1n} & C_{24} & C_{34} & \dots & C_{nn} \end{pmatrix} \times \begin{bmatrix} W_1 \\ W_2 \\ W_3 \\ \vdots \\ W_n \end{bmatrix} = \begin{bmatrix} WS_1 \\ WS_2 \\ WS_3 \\ \vdots \\ WS_n \end{bmatrix} \quad \dots\dots\dots (1)$$

In a way to calculate the values of the WS vector, first it is needed to multiply each value in the column of the comparison matrix by each value of the weight vector, then the result of each multiplication must be added and that will be the weight sum value, as is shown in Equation (2).

$$WSi = (C1i \times W1 + C2i \times W2 + C3i \times W3 + \dots + Cji \times Wn) \quad \dots\dots\dots (2)$$

After this process has been completed, it is needed to divide each value of the weighted sum vector (WS) by the corresponding weight of each criterion, in a way to obtain λ vector, represented in Equation (3).

$$\begin{bmatrix} WS_1 \\ WS_2 \\ \vdots \\ WS_n \end{bmatrix} \div \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \vdots \\ \lambda_n \end{bmatrix} \quad \text{..... (3)}$$

$$\lambda_i = \frac{WS_i}{W_i},$$

Table 8. Obtaining WS and λ vector for this diagnosis

ARTICLES FOUND	TOURISM	TRADITIONAL CULTURAL INDUSTRY	COMMERCE	REPAIRS OF GOOD	HOTELS AND RESTAURANTS	TRANSPORT	FASHION	AUTOMOTIVE	Pri Ve
TOURISM	1.00	8	4	9	4	8	8	8	0
TRADITIONAL CULTURAL INDUSTRY	0.13	1.00	0.20	2.00	0.13	0.25	0.50	0.50	0
COMMERCE	0.25	5.00	1.00	3.00	0.25	7.00	5.00	4.00	0
REPAIRS OF GOOD	0.11	0.50	0.33	1.00	0.11	0.33	0.20	0.33	0
HOTELS AND RESTAURANTS	0.25	8.00	4.00	9.00	1.00	5.00	6.00	8.00	0
TRANSPORT	0.13	4.00	0.14	3.00	0.20	1.00	2.00	1.00	0
FASHION	0.13	2.00	0.20	5.00	0.17	0.50	1.00	0.50	0
AUTOMOTIVE	0.13	2.00	0.25	3.00	0.13	1.00	2.00	1.00	0

With λ vector calculated is easy to calculate λmax, which is the average of the values of λ vector, as shown in Equation (4):

$$\lambda max=\lambda 1+\lambda 2+\lambda 3+\cdots+\lambda n \text{ ..... (4)}$$

In a way to calculate the consistency of the diagnosis developed, λmax in Table 8.

Table 9.Calculation of λmax for this diagnosis

ALTERNATIVES	λ
TOURISM	9.75

TRADITIONAL CULTURAL INDUSTRY	8.33
COMMERCE	9.57
REPAIRS OF GOOD	8.88
HOTELS AND RESTAURANTS	9.67
TRANSPORT	8.54
FASHION	8.09
AUTOMOTIVE	8.71
λmax	**8.94**

With the value of λmax calculated, the consistency index (CI) is obtained as follow:

$$CI=(\lambda max-n)/(n-1)\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

$$CI=(8.94-8)/7 = 0.13$$

After calculating the CI value, the random index (RI) needs to be obtained. This value is tabulated for different matrix sizes [103]. The RI values for different matrix sizes are shown in Table 9.

Table 10. Values of Random Index

n	Index
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
n=size the comparison matrix	

[103] Tripoli, M., & Schmidhuber, J. (2018). Emerging opportunities for the application of blockchain in the agri-food industry. FAO and ICTSD: Rome and Geneva Licence: CC BY-NCSA 3.

Finally, the “consistency ratio (CR)” is obtained, defined as:

$$CR=CI/RI \quad \text{.....(6)}$$

A CR of less than 0.1 indicates that the application is consistent. If this value is exceeded, the judgments should be reviewed again.

CR=0.13/1.41 = 0.0954

Step 5. The final decision. After obtaining the composite weight, the alternatives should be ranked to decide which one is more important.

In the Table 10, is presented the priority vector to select the value chain chosen for this study.

Table 11.Ranking of the value chains to be selected

ALTERNATIVES	PRIORITY VECTOR	RANK
TOURISM	38.4%	1
TRADITIONAL CULTURAL INDUSTRY	3.0%	7
COMMERCE	14.8%	2
REPAIRS OF GOOD	2.3%	8
RESTAURANTS	25.0%	3
TRANSPORT	6.1%	4
FASHION	5.0%	6
AUTOMOTIVE	5.3%	5

After the analysis was completed three value chains were selected: Tourism, Commerce and Restaurants as part of this preliminary diagnosis.

IV. VALUE CHAINS SELECTED

The pandemic has been an unwelcome surprise globally. As COVID-19 has spread worldwide, the services industry that relies on direct human interaction has suffered a great deal. Services such as hospitality, aviation, commerce, and tourism, are some of the impacted industries. The worry factor and the

subsequent melancholic atmosphere have been psychologically influencing people worldwide, and this will continue in the future, even after a potential cure for the disease is found [104, 105, 106].

According to the WHO, the quick outbreak has caused an unusual situation in all markets. Remarkably, the service sector has been affected the most, as human involvement is more present there than in the goods market due to empathy. So, where threats to human health are present, the industry must bear the brunt of the global situation[107].

Considering psychological evidence, COVID-19 will indeed lead to a reform of the service delivery, consumer engagement, and delivery sectors [108] has been the most affected service, as the human element has the full implications in this sector. All tourism establishments are contemplating an alternative plan to tackle the aftermath of the pandemic, as tourists will almost certainly not immediately begin to travel again as there is always an element of risk. From aviation to hospitality and wellness, the industry will have to look for a strategy that will sustain them after COVID-19. It will take time to reenergize the sector. Internal tourism may bloom slowly, but external tourism still needs a detailed makeover plan [108].

4.1. Tourism Value Chain

Tourism is a social, cultural, and economic activity that requires the movement of people (called visitors) to places outside their usual environment for different (personal, business, professional) purposes—these visitors who may be either excursionists or tourists; residents or non-residents [109].

In the field of tourism, Covid-19 has led to the fact that the primary content of the specialized tourist offer can no longer assure tourist demand. It is expected that post-Covid, the fundamental dilemmas of tourism

[104] Arpaci, I.; Karataş, K.; Baloğlu, M. The development and initial tests for the psychometric properties of the COVID-19 Phobia Scale (C19P-S). Personal. Individ. Differ. 2020, 164, 110108.
[105] Yıldırım, M.; Güler, A. Factor analysis of the COVID-19 Perceived Risk Scale: A preliminary study. Death Stud. 2020, 44, 1–8.
[106] Chandu, V.C.; Marella, Y.; Panga, G.S.; Pachava, S.; Vadapalli, V. Measuring the Impact of COVID-19 on Mental Health: A Scoping Review of the Existing Scales. Indian J. Psychol. Med. 2020, 42, 421–427.
[107] Van, N.T.T.; Vrana, V.; Duy, N.T.; Minh, D.X.H.; Dzung, P.T.; Mondal, S.R.; Das, S. The Role of Human–Machine Interactive Devices for Post-COVID-19 Innovative Sustainable Tourism in Ho Chi Minh City, Vietnam. Sustainability 2020, 12, 9523. https://doi.org/10.3390/su12229523
[108] Addo, P.C.; Jiaming, F.; Kulbo, N.B.; Liangqiang, L. COVID-19: Fear appeal favoring purchase behavior towards personal protective equipment. Serv. Ind. J. 2020, 40, 471–490
[109] World Tourism Organization (UNWTO), 2018, Tourism Definition, https://www.unwto.org/glossary-tourism-terms

supply development will focus on the importance of designing and accomplishing the actual or perceived value of the specialized content offered [110].

4.1.1. Tourism Value Chain

In the tourism value chain, the product is a service process. Value-added through tourism arises through the networking of many different actors and their services. To create a broad offering that meets requirements, the individual services must be coordinated and, ideally, the interfaces designed so that guests do not notice them. In the tourism context, it is thus crucial to coordinate service providers and manage interfaces. Efficient destination management organizations ideally control this. Development cooperation can provide support and impetus[111].

A tourism value chain can simply be defined as a system that describes how private sector firms in collaboration with government and civil society receive or access resources as inputs, add value through various processes (planning, development, financing, marketing, distribution, pricing, positioning, among others) and sell the resulting products to customers. A tourism value chain approach can be used as the methodology for analyzing the process and identifying opportunities to increase value through positive action or the elimination of barriers or constraints [112].

To apply the tourism value chain properly, governments and businesses need to establish and enforce[113]:

- ✓ Inclusive and integrated policy frameworks for sustainable tourism development.
- ✓ Enterprises need to demonstrate their commitment to sustainability in core business models and value chains with enhanced action.
- ✓ Individuals and civil society need to advocate for and adopt, consciously sustainable practices and behaviors.

In the Fig. 8, is presented the Tourism Value Chain Creation System proposed by Kai (2020)[114].

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110 H. Zhang, H. Song, L. Wen, C. Liu: "Forecasting tourism recovery amid COVID-19", Annals of Tourism Research, 87, 103149, 2021.

111 Partale K, (2020).The Tourism Value Chain: Analysis and practical approaches for development cooperation projects. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. https://www.switch-asia.eu/site/assets/files/2460/giz_tourism_value_chains_en.pdf

112 Miličević K, Tourism value chain and sustainability certification. Integration of sustainability labels into Mediterranean tourism policies (2021). https://sustainablelabels.eu/wp-content/uploads/2021/07/2_Value-chain_K.Milicevic.pdf

113 World Tourism Organization (2018). Tourism for Development – Volume I: Key Areas for Action, UNWTO, Madrid. DOI: https://doi.org/10.18111/9789284419722.

[114] Kai, P. (2020). The Tourism Value Chain: Analysis and practical approaches for development cooperation projects, GIZ.

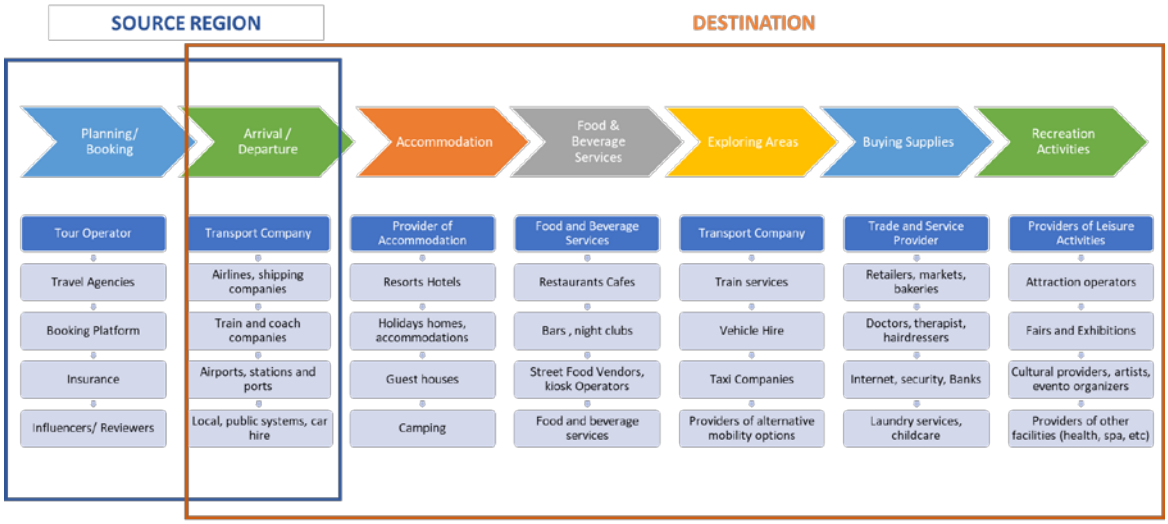

Image 5. Tourism Value Chain [113,114]

4.1.2. Case of Study 1: A blockchain application to a Smart Tourism Region

The study presented by Baralla et al. has as objective present a blockchain-oriented platform to guarantee the origin and of food items in a Smart Tourism Region context. In a way to attract tourists and to promote an area provided local food and beverage, can become a good combination, a need of certification of these products become necessary [27].

Blockchain is a new emerging digital technology allowing omnipresence financial transactions among distributed untrusted parties[26].

In this study, a blockchain-based system to manage an agri-food supply chain for tracking food items was designed by using smart contracts; the platform guarantees efficiency, transparency, and trustworthiness[27].

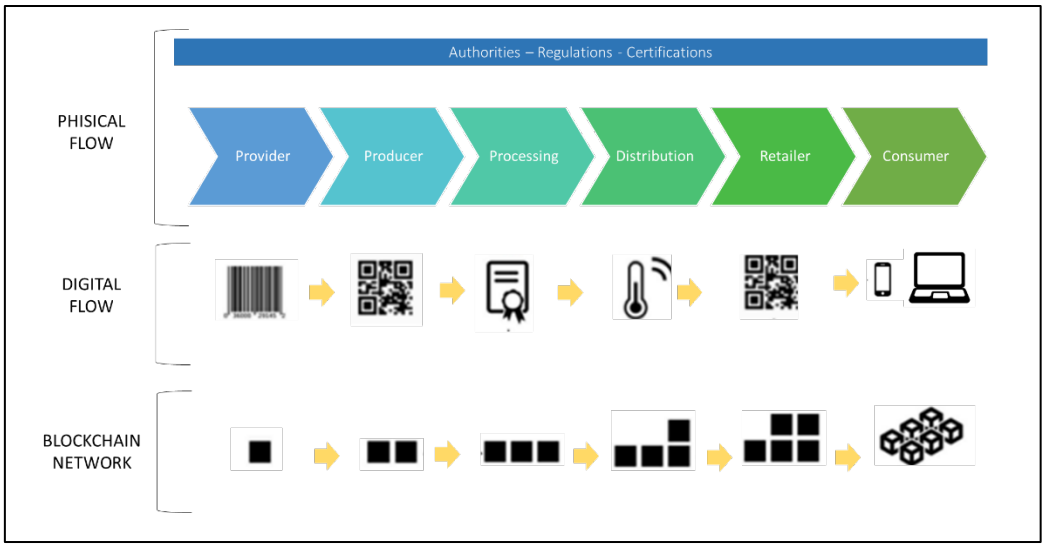

Image 6.Food supply chain Blockchain System [27]

An example of the digitization of the food supply chain, supported by blockchain technology, is depicted in Image 9 Under the physical flow (top layer), there is the digital flow layer (middle layer), consisting of various digital technologies (i.e., QR codes, RFID, NFC, online certification and digital signatures, sensors and actuators, mobile phones, etc.). The Internet serves as the connecting infrastructure. Every action conducted along the food chain, empowered using digital technologies, is documented to the blockchain, which serves as the fixed means to store information that is accepted by all participating parties. The information caught during each transaction is validated by the business partners of the food supply network, creating an agreement between all participants. After each block becomes validated, it is joined to the chain of transactions, becoming a perpetual record of the whole process. At each stage of the trajectory of food, different technologies are required, and different information is written to the blockchain, as described beneath for each of these stages[26].

- ✓ Provider: Information about the crops, pesticide, and fertilizers used, the machinery involved. The transactions with the producer/farmer are documented.
- ✓ Producer: Information about the farm and the farming practices employed. Also, information about the crop cultivation process, weather conditions, or animals and their welfare are also possible to be added.
- ✓ Processing: Information regarding the equipment and the factory, the processing methods used. The financial transactions that take part with the procedures and with the distributors are recorded too.
- ✓ Distribution: This stage is about trajectories followed, storage conditions (e.g., temperature, humidity), time in transit at every transport method, shipping details, etc. All transactions between the distributors and final recipients are written on the blockchain.

- ✓ Retailer: Information about each food item, very detailed, its current, expiration dates, quantity, storage conditions, quality, and time spent on the shelf are listed on the chain.
- ✓ Consumer: The final stage, where the consumer can use a mobile phone connected to the Internet to scan a QR code associated with some food item and see in detail all information regarding the product, from the provider and producer until the retail store.

4.1.3. Case of Study 2: A new perspective of tourism, TaipeiPass

In a post-pandemic era, Chinese Taipei is transitioning from the current situation to the new normal, making all the industries review their status. Because every corporation has the potential to become a technological company and join the digital industry, the government must collaborate with non-government sectors to anticipate the lifestyle and industry conditions in the post-pandemic era and propose transformation strategies[28], accordingly, as shown in Image 7 .

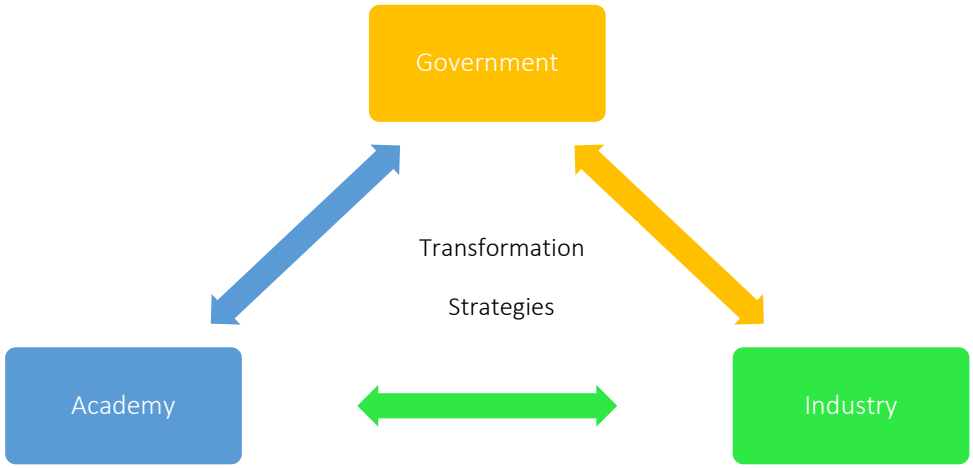

Image 7. Entities collaboration

Taipei City has constructed digital infrastructure to promote digital transformation and cooperate with private and corporate sectors to provide innovative services that meet citizens. With an open attitude and steady progress, Taipei City endeavors to evolve into a citizen-centric smart city through innovative governance[28].

In the cyber-physical world, people's online and real identities are of comparable importance. Taipei pass application developed by the Taipei City Government serves as a digital ID for Taipei citizens as well to deliver city government services; it was designed as a one-stop solution for municipal services, from paying taxes and parking tickets to utility bill payments and access to the library resources. In addition, citizens can

file a complaint, report an offense, and enjoy exclusive dining and shopping discounts at stores. The Image 8 also presents the Taipei pass main goals[115].

Since the origin of the pandemic in 2020, the tech-savvy among the city government have delved into digital technology initiatives to stop the spread of the virus[30].

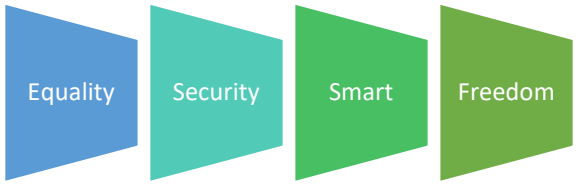

Image 8. Taipei Pass offered features [116].

After one year, the service has been adapted for COVID check-ins that enable contact tracing. In addition, QR codes are displayed at business and event registration counters, making it easier for people to check-in and for the City Covid Response team to record the footprint of the coronavirus. The image 9 shows the English version of the TaipeiPASS [30].

Image 9. Taipei Pass – English version[30]

TaipeiPASS has also contributed into the economy's COVID-19 vaccination system (registration and reservation), streamlining the process of scheduling a vaccine[30].

[115] OPEN GOV ASIA. Available online: https://opengovasia.com/taiwans-taipeipass-permit-system-makes-travel-and-work-safer/ (Accessed on 10 November 2021)

[116] Taipei Pass. Available online: https://id.taipei/tpcd/about/what-is-taipeipass (Accessed on 06 November 2021)

In addition, individuals who have lost their job or their business have been affected since the start of Chinese Taipei's first major COVID outbreak in mid-May 2021 have been able to apply for pandemic relief subsidies through the platform. This helped to reduce the risk of vulnerability to the virus by circumventing a trip to government agencies. With the service portal, users can pay local taxes, water bills, parking, medical, and tuition fees. The platform also supports various forms of digital payment, including Easy Wallet, JKOPAY, and ezPay [30].

Image 10. Taipei Pass web platform [117]

In the case of tourism, because of the travel restrictions in response to the pandemic, most citizens have turned to domestic traveling. However, Taipei City tourism has not enjoyed the benefits of this rising trend because this city mainly remains foreign tourists; consequently, the tourism and accommodation industries in Taipei have been the most impacted in the pandemic [28].

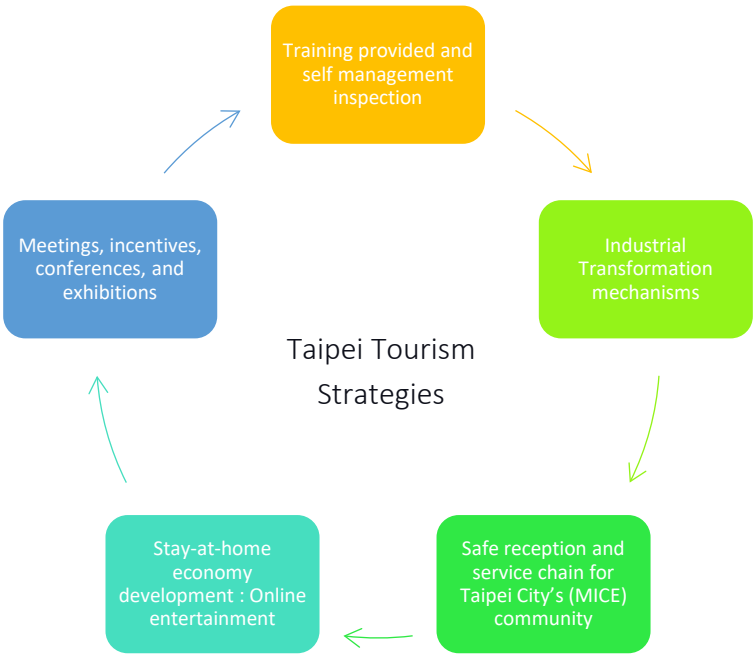

Image 11. Improving Taipei Tourism Strategies

2. Training provided and self-management inspection

Taipei City has established 16 items for the self-management inspection and 35 items for optimization of accommodation. Before October 12, 2020, 387 hotel operators in Taipei City were listed as safe lodging. Taipei City has held professional seminars for hotel operators to assist them in improving their hotel environment and service quality as well as in a high-quality accommodation environment for tourists [28].

3. Industrial Transformation mechanisms

In addition to holding tourism events to connect potential tourism attractions and unique local shops in Taipei City and neighboring counties, Taipei City Government has combined these events with tourism festivals and experience activities to provide tourists who visited Taipei City with a new traveling experience. Taipei City Government implemented a trial program to provide reward mechanisms for tour agencies that bring tourists to Taipei City. The program encouraged tour operators to plan tours with a focus on Taipei City's features and ultimately increasing tourist numbers[28].

4. Safe reception and service chain for Taipei City's (MICE[117]) community

The Safe Travels stamp plan promoted by the World Travel and Tourism Council (WTTC) is aimed at helping travelers identify destinations and businesses that have adopted global health and hygiene standards, thereby ensuring that consumers and tourists experience a safe journey. To promote Taipei City's MICE industries, Taipei City Government established the safe reception service chain mechanism and supported related industries in connecting to the chain. Additionally, the government has applied to the WTTC for a Safe Travels stamp for Taipei City to ensure a safe traveling environment for tourists[28].

5. Stay-at-home economy development: Online entertainment

Introduce digital technology to enable citizens to experience large-scale tourism events or tourism attractions: The city government has incorporated digital technology with large-scale events, such as Taipei City New Year's Eve and Taipei Lantern Festival, to provide tourists with a new entertainment experience through technology. Similarly, AR guiding systems can be applied for tourists to experience offline-to-online unification[28].

4.2. Commerce Value Chain

Before the COVID-19 pandemic, many retailers concentrated on investing in e-commerce as a strategy to raise their profitability and last competitive. It turned out to be an opportune decision, as it kept a line of revenue open during confinement restrictions[118].

[117] Meetings, incentives, conferences, and exhibitions

[118] How e-commerce is disrupting the traditional retail landscape in Australia. Available online: https://www.jll.com.au/en/trends-and-insights/research/how-e-commerce-is-disrupting-the-traditional-retail-landscape-in-australia (accessed on 06 November 2021).

In the early months of 2020, retailers from all over the world witnessed the first adverse consequences of the COVID-19 outbreak. Thousands of companies had to stop their operations while others experienced unprecedented supply chain disruptions caused by increased demand coupled with the emergence of new shopping behaviors. During an economic downturn and strong turbulence in consumption, the pandemic appears to be an opportunity to hasten the speed of change in the retail industry[36].

Since the COVID-19 pandemic started, retailers have continued to expand their online platforms, including IT infrastructure, processes, customer analytics, and supply chains. The COVID-19 crisis accelerated the growth of e-commerce towards new customers, firms, and sorts of products. It has provided customers with entrance to a remarkable variety of products from the convenience and safety of their homes and has allowed firms to continue operating despite contact restrictions and other confinement measures[119].

Despite persevering cross-economy differences, the COVID-19 crisis has intensified dynamism in the e-commerce landscape across economies and has expanded the scope of e-commerce through new firms, consumer segments (e.g., elderly), and products (e.g., groceries). Currently, e-commerce transactions in many economies have partly shifted from luxury goods and services towards everyday necessities, relevant to many individuals [120].

Some of these changes in the e-commerce panorama will likely be of a long-term nature, considering the likelihood of new waves of the epidemic, the ease and convenience of the new purchasing habits, learning costs, and the inducement for firms to capitalize on investments in new sales channels [120].

E-commerce is a term that refers to commercial transactions such as the buying and selling of products and services conducted only through electronic means [34]. It can be subdivided into consumer-to-consumer (C2C), business-to-business (B2B) and business-to-consumer (B2C) activities.

4.2.1. Commerce Value Chain

Eichener and Heinze (2005) highlighted that most processes in e-commerce that directly involve the customer are virtual. They suggested dividing the value chain into procurement, purchasing process, and fulfillment, with procurement and fulfillment as underlying operations and the purchasing process as the main interaction between the customer and the intermediary[120]., as depicted in image 17.

[119] OECD. E-commerce in the time of COVID-19 Available online : https://www.oecd.org/coronavirus/policy-responses/e-commerce-in-the-time-of-covid-19-3a2b78e8/ (accessed on 06 November 2021).

[120] Eichener, V.; Heinze, R. (eds). 2005. Beschäftigungspotentiale im Dienstleistungssektor (Dusseldorf, Hans-Böckler-Stiftung).

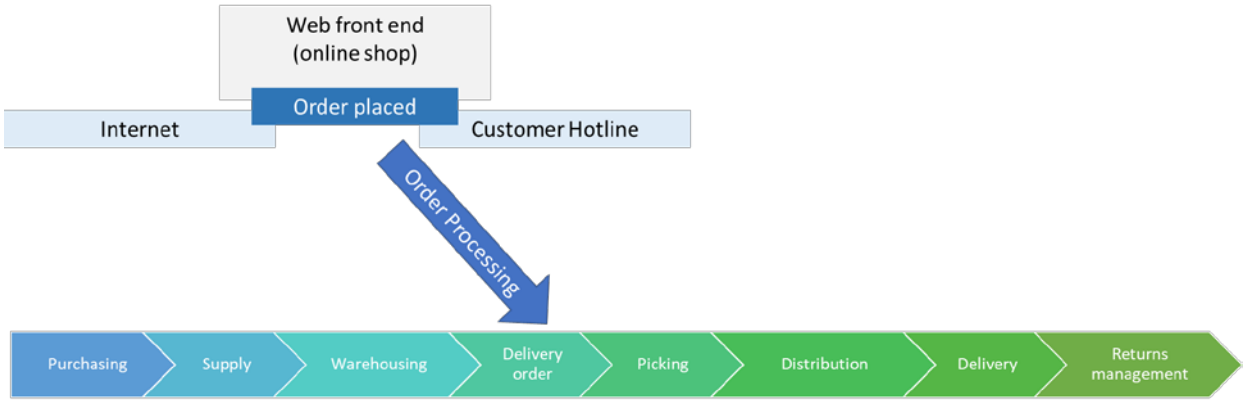

Image 12. E-Commerce Value Chain

a. Procurement refers to the steps that precede the appearance of a product or service in the online shop or platform, as well as the delivery and storage of these goods before they are ordered by the customer [121].

b. The purchasing or ordering process by the customer includes the web shop and customer support, and the technological infrastructure for accessing the web shop, finding information on the product, and completing the transaction. Amazon has several departments dealing with marketing, web front end, and background IT, as well as customer support[122].

c. The fulfillment phase begins when an order is placed and passed on from the online shop. Amazon calls its warehouses and logistic centers "fulfillment centers." Tasks in the fulfillment centers are divided into four stages: "receivers" are responsible for registering goods as they arrive; "Stowers" store these goods in the huge warehouses; "pickers" are sent to collect the desired products after a delivery order; and "packers" prepare them for delivery. All steps are planned in detail and monitored through electronic devices that provide the most worker efficiency. Work in the fulfillment centers is, again, characteristic of a hierarchical governance pattern with a high degree of control and ownership – even if hiring and other operational services (e.g., security) are partially outsourced to agencies [122].

4.2.2. Case of Study 1: Australia a top market for e-commerce and online platforms

Australian e-commerce grew 22.3% in 2020, and the grew in multiple sectors: food and personal care sales grew 30.4%, fashion and beauty e-commerce sales grew 20.6%, digital music sales grew 25.9%, and video games sales grew 24% [33].

[121] Birner K. One click to empowerment? Opportunities and challenges for labour in the global value chain of e-commerce. (2015). International Journal of Labour Research. 7. 153-175.Volume 7. 54-73

Profitability is driven by delivery logistics and improvements in digital infrastructure. The delivery logistics has reduced costs for companies, improving customer service experience and lowering shopping times. Moreover, therefore, global tech firms consider expanding and establishing a physical presence [33].

An encouraging regulatory and financial system has helped Australians become leaders adopting new payments technology. Contactless such as 'tap and go' payments were introduced in 2006.According to the Reserve Bank of Australia, the COVID-19 pandemic has further accelerated the move to cashless payments. Commonwealth Bank of Australia (CBA) indicates that 8.3 million Australians made digital-enabled payments in 2020. CBA also reported that monthly digital wallet transactions doubled from March 2020 to March 2021[33].

4.2.3. Case of Study 2: Thoughts on the Role of Emerging Retail Technologies Post-COVID-19

Prior the coronavirus outbreaks a called shopping revolution[43] was already well underway. Building on prior academic studies. It is noting several forces that are converging to change the retail industry since the beginning of the twenty-first century [43,44,45], as shown in Image 13.

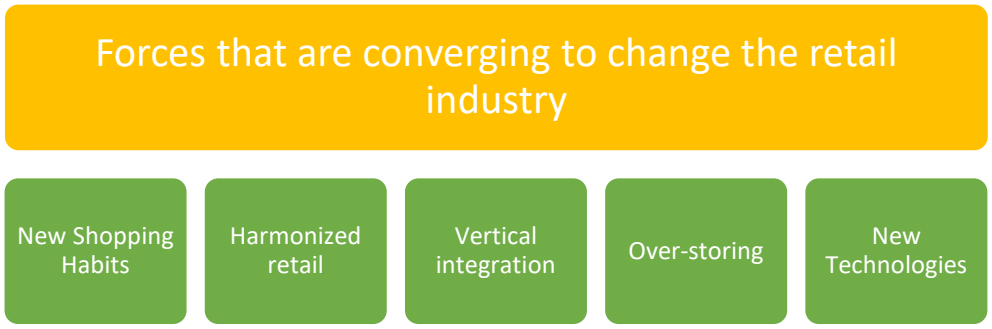

Image 13.Forces converging the retail industry

Díaz-Martín et al, reflects in this study the technological advancements that retail companies could adopt to deliver superior value to customers, while supporting their long-term economic goals as the economic and health implications of the coronavirus crisis unfold [48].

4.2.3.1. Forces that are converging to change the retail industry[48].

(1) New shopping habits. Customers are no longer compliant clients but rather savvy shoppers. They compare prices and purchase merchandise through multiple platforms. They use personalized recommendations streamed via social media to gather and curate pre-purchase information and are frequent online shoppers. Digitally native consumers are achieving greater relevance and power. For them, the price comes with comfort, pleasure, and sustainability when choosing a retailer[48].

(2) Harmonized retail. The customer journey is no longer considered a linear experience [122]. Customers are always connected and use all channels interchangeably or even simultaneously, expecting a seamless experience regardless of whether they shop at the physical store, online, or through social media. This implies that the client is the channel. In addition, the increasing popularity of virtual retailers forces traditional retail companies to develop and improve their online presence[48].

(3) Vertical integration. Many brands sell directly to consumers through their own physical and online stores. Showrooms, flagship, and pop-up stores managed by direct-to-consumer brands or digital native brands coexist with multiple brand retailers, increasing the level of competition [48,123].

(4) Over-storing. Up until very recently, the retail offer was on the rise in terms of the number of stores and selling area in square meters. Some retailers opened new shops to attract proximity customers. Others inaugurated flagship stores in commercial streets to strengthen the brand and generate loyalty through better shopping experiences [48,124].

(5) New technology. Advancements in technology bring tremendous changes in terms of shopping behavior and retail management [125], [126]. Customers seek information through conversational platforms, digital catalogs powered by augmented reality, and social media. Retailers digitize their stores and incorporate advancements like in-shop navigation, geofencing, facial recognition, smart dressing rooms, mobile payments, and automated checkout solutions [127],[130]. Data mining techniques, together with advances in artificial intelligence (AI) and machine learning, enable retailers to gather and utilize an enormous amount of information, and blockchain-based processes increase retailers' productivity and transparency [48].

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122 Verhoef, P.C., Bijmolt, T.H.A.: Marketing perspectives on digital business models: a framework and overview of the special issue. Int. J. Res. Mark. 36, 341–349 (2019) 8

123 WARC. The evolving dynamics of the direct-to-consumer market (2020). Available on : https://www.warc.com/content/paywall/article/admap/the_evolving_dynamics_of_the_directtoconsumer_market/124575

124 Jahn, S., Nierobisch, T., Toporowski,W., Dannewald, T.: Selling the extraordinary in experience retail st8ores. J. Assoc. Consumer Res. 3(3), 412–424 (2018)

125 Flavián, C., Gurrea, R., Orús, C.: Combining channels to make smart purchases: the role of webrooming and showrooming. J. Retail. Consum. Serv. 52, 1–11 (2020) 11.

126 Goode, M., Main, K.: Introduction to the special issue—The brave new world:how shopping and consumption is evolving with technology. Can J. Admin Sci. 1–4 (2019) 12.

127 Grewal, D., Noble, S.M., Roggeveen, A.L., Nordfalt, J.: The future of in-store technology. J. Acad. Mark. Sci. 48(1), 96–113 (2020) 13.

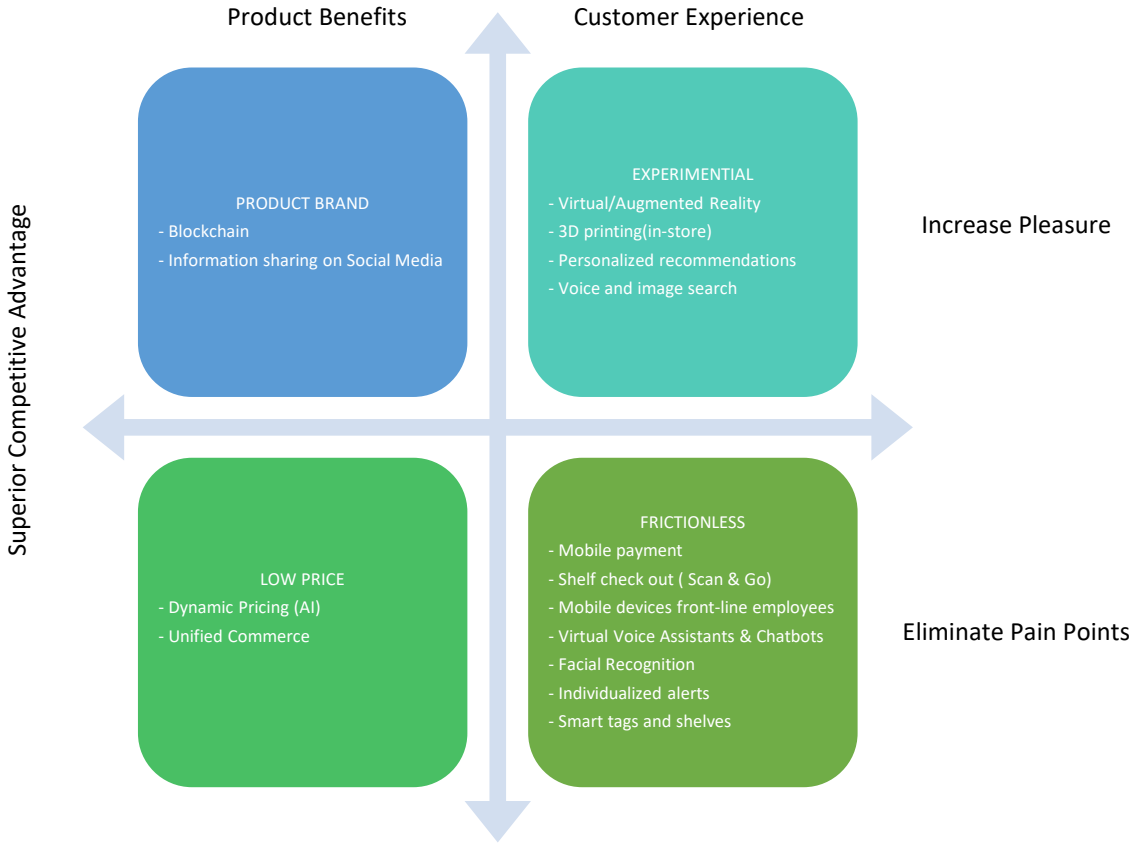

Image 14. Kahn Retailing Success Matrix[131]

Retailers that excel in customer experience work hard to add experiential components to the shopping tasks. Thus, they provide more pleasure, more excitement, and more fun than other retailers can provide[43]. The pandemic and the subsequent lockdown altered consumers' expectations, activities, and motivations regarding the shopping experience. Health and safety rapidly became one of the factors that mattered most to customers as they planned their purchases. When visiting physical stores, shoppers had to wait in line to comply with hygiene and social distance measures and had to sacrifice many of the hedonic benefits of shopping. As a result, retailers have begun to adopt technological solutions to satisfy those customers who want to spend less time in the store [48]. For example:

- An italian app allows customers to skip queues and instead join a virtual system that sends them a message when they can enter the shop, or it is their turn for a personal one-to-one appointment [128].
- A portuguese Retailer: launched a self-scanning mobile app to scan and pay for items without waiting in line. The app also creates and manages shopping lists using voice, text, and barcode reading. Virtual (VR) and augmented reality (AR) technologies can also play a key role in either

[128] Alimarket. ¿Qué acciones está realizando el retail internacional ante el Covid-19? (2020). Avaliable on: https://www.alimarket.es/alimentacion/noticia/314050/-que-acciones-esta-realizando-el-retail-internacional-ante-el-covid-19- 30. (Accesed on 06 November 2021)

enhancing the in-store customer experience or in bringing the in-store experience to consumers' homes while limiting the need for physical interaction[48].

Before the virus outbreak, many vertical brands (e.g., Nike, Adidas, Ikea, Gap, Sephora, among others) were already using augmented reality to enable customers to virtually try on products or view how a product looks in their home [129,130].

During the COVID-19 crisis, Ikea's online sales reached double what they were a year ago. Experts credit innovations such as a recently launched advanced virtual showroom with mobile and deep learning.

When shops reopen, retailers will likely invest in AR and VR to replicate the in-store experience at home, allowing customers to examine their intended purchases in advance while protecting employees and enabling them to work remotely. In the longer term, VR/AR could also help them navigate through the store from home, displaying endless virtual shelves with a curated selection of product and advertising content based on their past purchase history[131].

Table 12. Evolving retailing landscape [48]

Pre-pandemic retail trends	Changes retail triggered by the COVID-19 outbreak	Post-pandemic challenges
New shopping habits	Surge in demand of essential product categories and changes in customer behavior	New safety and economic concerns. .
Harmonized retail	Consumers change to e-commerce and new delivery options	Full integration of online and offline shopping. Data capture and data analytics are crucial
Vertical integration	Many firms cannot adapt due to clack of skills and budge needed	New competitors and technology partnership
Over-storing	Non-essential, physical stores closed during lockdown	Many stores will never reopen Bankruptcies
Emerging technologies	Technology plays a major role in enabling efficiency and keeping retail business running	Digitization accelerates. In physical stores, contactless operations are key,

[129] Retail Dive. https://www.retaildive.com/news/10-retailers-leading-the-way-in-ar/52052 31

[130] Pantano, E., Viassone, M.: Demand pull and technology push perspective in technology-based innovations for the point of sale: the retailers evaluation. J. Retail. Consum. Serv. 12(1), 43–47 (2014)

[131] Nielsen. https://www.nielsen.com/us/en/insights/article/2019/augmented-retail-the-new-con sumer-reality/ 33.

4.2.3.2. Frictionless Shopping Experience

Retailers that choose to lead on frictionless shopping experiences prioritize offering customers the easiest and most convenient way to shop [43].

Most of the technological innovations that have emerged in the last decade contribute to eliminating pain points in the shopping experience.

Retail experts who participated in our study identified new payment methods, facial recognition, virtual voice assistants, geo-localization, and smart devices (lockers, tags, shelves, employee tablets) as technological solutions aimed at making the shopping journey easier. In a post-pandemic, fearful-of-touch world, automated activities, and processes, which operate without active human input or control[132], can clearly contribute to offering self-serve, contactless options for shoppers and store operators.

Before the coronavirus outbreak, several leading retailers had already implemented automated solutions in order to improve convenience and eliminate pain points from the customer journey (e.g., Scan & Go, self-checkouts, automated pickups, and returns systems) [48].

4.3. Hospitality (Restaurant) Value Chain

The COVID-19 pandemic is one of the worst global health emergencies unseen nowadays. Like many other industries, the restaurant industry has been extremely hard hit by the current pandemic. Restaurants in many cries have been forced to close or operate at reduced serving capacity due to government pandemic containment measures. Even as governmental imposed standards were slowly loosened up, the industry continued to suffer from consumers' perceived risks, lack of confidence, and pervasive loss of safety induced by the pandemic[59].

4.3.1. Restaurant Value Chain

In the case of the Restaurant Value Chain, the competitive advantage refers to one or more qualities, attributes, or aspects that the restaurant's food, beverages, service, and ambiance make the customers a preferred choice within the market compared to other existing competitors or options.

There are many different types of restaurants, but generally, the industry considers the activities presented in Image 19.

[132] Linzbach, P., Inman, J.J., Nikolova, H.: E-Commerce in a physical store: which retailing technologies add real value? NIM Market. Intell. Rev. 11(1), 42–47 (2019)

Image 15. Restaurant Value Chain- Primary Activities

4.3.1.1. Primary Activities

Inbound Logistics

- Operations: Activities that help the organization transform raw material into finished products. As shown in Image 15, inventory Management and Distribution and Store Operation are the fundamental operations activities for a restaurant.

Outbound Logistics

The restaurant undertakes these activities to distribute the finished products to channel partners and final customers. Outbound logistics activities include wholesalers and retailers' order fulfillment, processing, warehousing, distribution network, and scheduling.

- Marketing and Sales: To create means to buy a firm's products. These activities include – marketing, sales force management, pricing, advertising and promotion, channel selection, etc.
- Customer Service: Restaurants need to provide after-sales services and maintenance for successful usage of the product. Service activities can include – delivery services in general of the cases.

4.3.1.2. Support Activities

- ✓ Firm Infrastructure: activities such as – finance and accounting, quality management, general management, legal services, and planning.
- ✓ Firm Infrastructure: activities such as – finance and accounting, quality management, general management, legal services, and planning.
- ✓ Human Resources Management: This activity is key to the success of any organization. These support activities include – Recruiting, Skill Assessment, Selection, People Planning, Training & Development, Hiring and Compensation.
- ✓ Technology Development: This activity supports almost all activities in modern-day organizations. Nowadays, technology development has become a source of competitive advantage. A Restaurant could include activities such as - process engineering, component design, feature design, or technology selection.
- ✓ Procurement Activities: Include activities undertaken to purchase inputs used by Accounts Restaurant's value chain. It does not include purchase inputs themselves. Purchased inputs could include raw materials, supplies, machinery, office equipment, and buildings. Like all other value chain activities, procurement also employs technology for procedures, vendor management,

information system, and supply chain partner qualification rules, and ongoing performance evaluation.

4.3.2. Case of Study 1 : AI in the Japanese Restaurants, Servi and Touch Point BI

Japan's Artificial Intelligence sector has been at the vanguard of hardware development, including the production of robots and automobiles. Although, companies from Europe and the United States continue to lead when it comes to software development [59].

The pandemic changed people's interests and priorities relating to AI. For instance, AI that supplements human labor was previously limited to specific outlets because people tended to prefer face-to-face interaction in business. Nevertheless, nowadays, technological solutions that offer reduced physical interaction are preferred [59].

4.3.3. Case of Study 2: Business resilience and innovation of the restaurant industry in China

The COVID-19 pandemic is one of the worst global health emergencies experienced in modern history. Like many other industries the restaurant industry has been extremely hard hit by the current pandemic. Restaurants in many economies have been forced to close or operate at reduced serving capacity due to government pandemic containment measures. Even as governmental imposed standards were slowly loosened up, the industry continued to suffer from consumers' perceived risks, lack of confidence, and pervasive loss of safety induced by the pandemic[59].

The author considers two critical that necessitate studying the restaurant industry's business strategies and recovery in a crisis.

First, the restaurant industry is highly integrated and valuable in an economic system. The size of the global foodservice market reached 3.5 trillion U.S. dollars in 2020. The revenue is forecast to grow to 4.2 trillion U.S. dollars in 2027, showing an annual growth rate of 2.7% from 2020 to 2027[133]. In China, the annual sales value of the foodservice market has kept a compound annual growth rate of 10.1 percent from 2014 to 2019[134].

Second, the restaurant industry has experienced severe damage during the current COVID-19 pandemic. In China alone, restaurant sales have decreased by 44.3% to CNY 602.6 billion (around $86 billion USD) in the first quarter of 2020, according to China's Bureau of Statistics[135]. Although the food and beverage (F&B)

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133 Lock, S. (2021). Food service industry: Global market size 2020-2027. Statista. Retrieved June 26, 2021, from: https://www.statista.com/statistics/1095667/global-food-ser vice-market-size/.

134 Foresight Industrial Research Institute. (2020). The analysis of development status and market segmentation of China's restaurant industry in 2020. Retrieved April 1, 2020, from https://www.sohu.com/a/425683992_473133

135 Zhang, A. (2020). How is China's catering industry evolving under the impacts of COVID-19? The Pig site. Retrieved June 26, 2021, from: https://www.thepigsite.com/articles/h ow-is-chinas-catering-industry-evolving-under-the-impacts-of-covid-19.

market in China has been severely hit by COVID-19, the restaurant industry has shown great resilience. In 2021, the revenue of this industry is expected to hit US$176 billion, which represents 63% of the global F&B revenue. The annual revenue growth rate of China's food and beverage market is projected to reach 8.38% between 2021 and 2025[136].

Understanding effective ways for restaurants to survive, adapt, innovate, and recover from a health-related crisis like the current COVID-19 pandemic poses tremendous value for the industry's long-term viability[59].

The authors, Li B.et al, of this study consider two critical stages that necessitate studying the restaurant industry's business strategies in the emergency response and recovery [59].

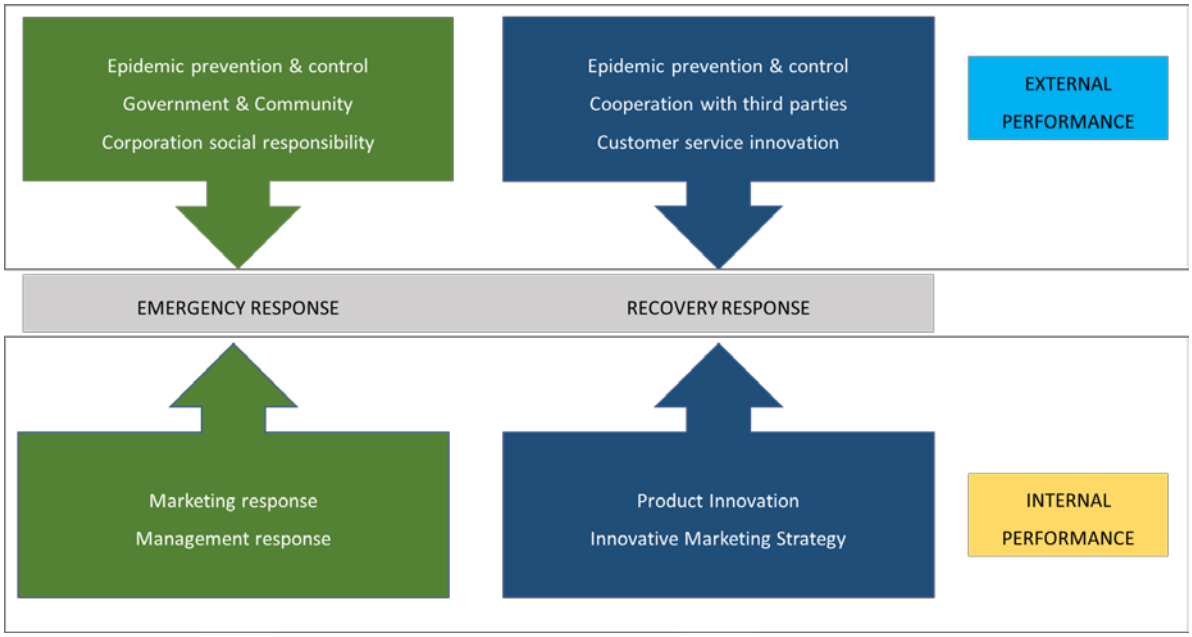

Image 16. Emergency Response and Recovery Response in the Restaurant Industry [59]

The main goal of this case of study is to explore restaurant value chain business practices developed during and after the major COVID-19 outbreak in China, a data-driven approach was applied by adopting the grounded theory [137]. In a way to analyze the collected data, the memoing[138] technique was adopted, which consist in take memos to record the critical points detected from the data and then found key themes by further synthesizing and analyzing the recorded memoing [59,139].

[136] Yu, N. (2021). China: 3 trends driving the food and beverage industry. Eastspring investments. Retrieved June 26, 2021, from: https://www.eastspring.com/insights/asian-expert -series/china-3-trends-driving-the-food-and-beverage-industry

[137] York, Q. Y., & Zhang, H. Q. (2010). The determinants of the 1999 and 2007 Chinese golden holiday system: A content analysis of official documentation. Tourism Management, 31(6), 881–890.

[138] Memoing: Memoing is the act of recording reflective notes about what the researcher (fieldworker, data coder, and/or analyst) is learning from the data. Memos accumulate as written ideas or records about concepts and their relationships. (SAGE, Research methods https://methods.sagepub.com, March 2022)

[139] Zhang, T., Bufquin, D., & Lu, C. (2019). A qualitative investigation of microentrepreneurship in the sharing economy. International Journal of Hospitality Management, 79, 148–157.

In the restaurant industry, there are three main threads in crisis management research[59].

- ✓ The first thread focuses on the guests' risk perceptions and behavior changes[141].Guests may have higher risk perceptions when dining in restaurants compared with take away from the restaurants[140]. Risk perceptions may be affected by demographic and social factors.
- ✓ The second thread tends to focus on restaurant practitioners' response practices related to the pandemic[59]. In a study carried on by Kim et al. (2021) [141], on small and medium-sized restaurants in China, indicated that three main operational attributes (delivery, service type, and discount) and brand play an essential role on maintaining the sustainability of restaurants' financial turnaround.
- ✓ The third thread emphasized the study of crisis management and business resilience in the restaurant industry from a stakeholder view. Employees are considered as an essential stakeholder for the restaurant industry. They suffered high levels of psychological distress, which resulted in drug and alcohol use, and they preferred to seek new jobs in alternate industries during COVID-19[142].
- ✓ Several conceptual crisis management frameworks identified the response corresponding to the crisis's life cycle for the tourism sector[143]. The study detected two main stages of the crisis management process: Emergency reaction and recovery period [59].

4.4. Other Value Chains

The COVID-19 pandemic opens an opportunity to restructure many value chains in the whole world, and two critical were health and education systems and tackle the critical situation that these sectors are going through, especially in developing economies.

Health and Education are very complex systems that involve different and many value chains depending on the category they are focused on; this document provides a general vision of possible solutions already implemented considering the new technology solutions applied in these sectors in a way to recover from the era of Covid-19.

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140 Byrd, K., Her, E., Fan, A., Almanza, B., Liu, Y., & Leitch, S. (2021). Restaurants and COVID-19: What are consumers' risk perceptions about restaurant food and its packaging during the pandemic? International Journal of Hospitality Management, 94, 102821.

141 Kim, J., Kim, J., & Wang, Y. (2021). Uncertainty risks and strategic reaction of restaurant firms amid COVID-19: Evidence from China. International Journal of Hospitality Management, 92, 102752

142 Bufquin, D., Park, J. Y., Back, R. M., de Souza Meira, J. V., & Hight, S. K. (2021). Employee work status, mental health, substance use, and career turnover intentions: An examination of restaurant employees during COVID-19. International Journal of Hospitality Management, 93, 102764.

143 Ritchie, B. W. (2004). Chaos, crises, and disasters: A strategic approach to crisis management in the tourism industry. Tourism Management, 25(6), 669–683.

4.4.1. Health Value Chain

COVID 19 (Coronavirus) pandemic has created a surging demand for essential healthcare equipment, medicines, and the requirement for advanced technologies applications. This fourth industrial revolution can fulfill customized requirements during the pandemic crisis. This industrial revolution has started with the applications of advanced manufacturing and digital information technologies[144].

The Health Value Chain was particularly affected by the COVID-19 outbreak regarding products, services, infrastructure, and labor directly involved with the containment of the pandemic and those supporting other health treatments[145].

According to WHO, difficult decisions are being made to stabilize the demands of responding directly to the COVID-19 pandemic with the need to keep the delivery of other essential health services. Many daily services have been discontinued or suspended, and existing delivery approaches are being adjusted to the evolving pandemic circumstances as the risk-benefit analysis for any given activity switches. When the delivery of critical health services comes under threat, productive governance and coordination mechanisms, and protocols for service prioritization and adaptation, can mitigate the risk of outright system failure [146].

In the case of the HealthCare value chain, the patients are the customers. The patients have value needs that are met by specific services and resources. Healthcare has its own marketing channels and has specialist infrastructures that deliver value.

4.4.1.1. Significant benefits of Industry 4.0 technologies for Health Value Chain

Industry 4.0 technologies have the capability of supplying better digital solutions for our daily lives[139, 147, 148].Various benefits of Industry 4.0 technologies, as being foreseen by us for mitigating effects of COVID-19 pandemic, such as[137]:

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144 Mohd Javaid, Abid Haleem, Raju Vaishya, Shashi Bahl, Rajiv Suman, Abhishek Vaish, Industry 4.0 technologies and their applications in fighting COVID-19 pandemic, Diabetes & Metabolic Syndrome: Clinical Research & Reviews, Volume 14, Issue 4, 2020, Pages 419-422,

145 Guilherme L. Tortorella, Flavio S. Fogliatto, Tarcísio A. Saurin, Leandro M. Tonetto, Duncan McFarlane,Contributions of Healthcare 4.0 digital applications to the resilience of healthcare organizations during the COVID-19 outbreak, Technovation, 2021,102379, ISSN 0166-4972, https://doi.org/10.1016/j.technovation.2021.102379.

146 WHO Interim guidance (2020). Maintaining essential health services: operational guidance for the COVID-19 context. Accessed online: https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-essential_health_services-2020.2 (Accesed online on 12 November 2021)

147 Grasselli G, Pesenti A, Cecconi M. Critical care utilisation for the COVID-19 outbreak in Lombardy, Italy: early experience and forecast during an emergency response. Jama 2020 Mar 13.

148 Ahmed SF, Quadeer AA, McKay MR. Preliminary identification of potential vaccine targets for the COVID-19 coronavirus (SARS-CoV-2) based on SARSCoV immunological studies. Viruses 2020 Mar;12(3):254.

- Planning of activities regarding COVID-19
- Providing a better experience without imposing the risks to healthcare and other workers
- Manufacturing of precautionary item related to this virus
- Provide medical part in time using smart supply chain.
- Used for better risk assessment and global public health emergency of this virus.
- Used robotic based treatment of the infected patient to reduce doctor's risk.
- Used virtual reality for training purpose.
- Promote a flexible working environment of treatment.
- Researchers can employ these technologies for social media platforms to identify unusual information.

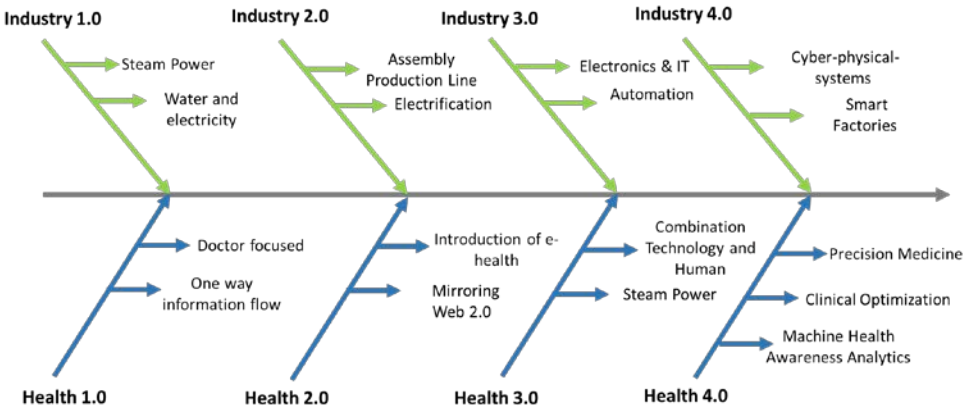

Image 17. Health revolution compared with Industrial Revolution [149].

4.4.1.2. Big Data Analysis and the impact in containing the Covid-19 outbreak in Chinese Taipei Economy

Big Data for analytics allows the creation of an abundance of information from around the world that can be made available to scientists, doctors, and epidemiologists. Big Data has proven to be a helpful instrument for rapid real-time evaluations as a result [150].

[149] Amrita Sisodia, Rajni Jindal, A meta-analysis of industry 4.0 design principles applied in the health sector, Engineering Applications of Artificial Intelligence, Volume 104, 2021, 104377, ISSN 0952-1976, https://doi.org/10.1016/j.engappai.2021.104377

[150] Tsikala Vafea, M., Atalla, E., Georgakas, J. et al. Emerging Technologies for Use in the Study, Diagnosis, and Treatment of Patients with COVID-19. Cel. Mol. Bioeng. 13, 249–257 (2020). https://doi.org/10.1007/s12195-020-00629-w

Big Data Analytics has the prospective to play a crucial role in preventing COVID-19 associated hospital outbreaks[151]. The repository and provision of accurate personal travel and contact history allow disease screening and detection to be driven for all patients and visitors before entering a hospital or medical facility.

In Chinese Taipei, the government has integrated and analyzed several Big Data from National Health Insurance Administration (NHIA), National Immigration Agency (NIA), and Centers for Disease Control. This has provided real-time information for the exterior quarantine station of each clinic and hospital in the economy. As a result, all the people that get in are screened through personal identification cards, and any suspicious carrier is further examined before entering the building [152].

This model could serve to limit disease transmission further. This same structure can be applied to allow for quicker immigration clearance at airports. For example, in Chinese Taipei, launched the Entry Quarantine System. A system that uses the past 14-day travel history of an individual and their NHIA identification card data to screen them for COVID-19. Travel history data is generated at the time of departure or arrival at a Chinese Taipei Airport. Nowadays, visitors or travelers are required to scan a QR code and fill a health declaration form. A mobile health statement pass is then sent via SMS to phones using a local operator. This system has allowed for faster immigration authorization for those with minimal risk[151].

Chinese Taipei's government learned from the 2013 SARS experience and established a public health response mechanism for enabling rapid actions for the next crisis. Well-trained and experienced officials quickly recognized the problem and activated emergency management structures to address the emerging outbreak [153].

In a crisis, governments often make difficult decisions under uncertainty and time restrictions, and these decisions must be appropriate and sensible to the population. Through early recognition of the emergency, daily briefings to the public, and simple health messaging, the government reassured the crowd by delivering timely, precise, and transparent information regarding the evolving epidemic. Chinese Taipei is an example of how a society can react quickly to a crisis and protect the interests of its citizens.

[151] Wang, C. J., C. Y. Ng, and R. H. Brook. Response to COVID-19 in Chinese Taipei: big data analytics, new technology, and proactive testing. JAMA 2020. https://doi.org/10.1001/jama.2020.3151.

[152] Chen, F. M., M. C. Feng, T. C. Chen, M. H. Hsieh, S. H. Kuo, H. L. Chang, et al. Big data integration and analytics to prevent a potential hospital outbreak of COVID-19 in Chinese Taipei. J. Microbiol. Immunol. Infect. 2020. https://doi.org/10.1016/j.jmii.2020.04.010.

[153] Chinese Taipei News. Launches new QR code for real-name registration system. (2021). Access online: https://www.taiwannews.com.tw/en/news/4206312 (Accessed on 13 November 2021)

4.4.1.3. Australia Case study (COVIDSafe app and QR Check-In apps for Australian States and Territories (QR Check-In Apps)

Australia is one of the economies with success regarding pandemic management. Death rates have significantly been contained, particularly when compared with other economists [154]. Effective real-time data has acted as a vital tool in managing the pandemic [155,155]. According to McKinsey,[156], data-driven decision-making is a specific factor in Australia's successful response.

In response to the pandemic, Australia developed two digital mobile applications that facilitated the tracking of positive coronavirus cases: the COVIDSafe app and QR Check-In apps. Both exhibit merit as emerging technologies in managing the COVID-19 pandemic[157].

The COVIDSafe app is a contact tracing tool that helps identify people who have been exposed to the coronavirus (COVID-19). The COVIDSafe app works by using Bluetooth signals to record encrypted data about close contacts with other users. It does so by creating a "digital handshake" between phones which have installed the COVIDSafe app. The digital handshake consists of the other user's encrypted reference code and the date, time, Bluetooth signal strength, phone model, and proximity of the contact on the user's phone. When a user tests positive for COVID-19, they have the option of uploading the encrypted data on their device to the COVIDSafe Data Store (NCDS)[158]

The COVIDSafe app does not record the user's location[159], but stores digital handshake information on the phone for 21 days, allowing for a 14-day SARS-CoV-2 incubation period, plus the time taken to confirm a positive test result. The rolling 21-day window allows COVIDSafe to continuously note only those contacts that occur during the coronavirus incubation window. It automatically deletes digital contact information which is older than 21 days. State and territory contact tracers can use the uploaded digital handshake data in the NCDS, via the Health Portal, to notify the positive user's close contacts that they may have been

[154] Cave D. One Case, Total Lockdown: Australia's Lessons for a Pandemic World, The New York Times (2021), https://www.nytimes.com/2021/02/01/world/australia/perth-lockdown.html, Google Scholar

[155] Moe T.Lin., Pathranarakul P. An integrated approach to natural disaster management: Public project management and its critical success factors. Disaster Prevent. Manag. Int. J., 15 (3) (2006), pp. 396-413.

[156] McKinsey Collaboration in crisis: Reflecting on Australia's COVID-19 response (2020)

[157] Javid Moosavi, Javad Bakhshi, Igor Martek, The application of industry 4.0 technologies in pandemic management: Literature review and case study, Healthcare Analytics, Volume 1,2021, 100008, ISSN 2772-4425,https://doi.org/10.1016/j.health.2021.100008.

[158] Health AGD of 2020, April. COVIDSafe application Privacy Impact Assessment [Text]. Australian Government Department of Health; Australian Government Department of Health.

[159] Health AGD of 2020, April. COVIDSafe application Privacy Impact Assessment [Text]. Australian Government Department of Health; Australian Government Department of Health.

exposed to COVID-19. This allows contact tracers to inform people at risk of COVID-19 about what to do next, such as getting tested[160].

Whilst blockchain was not utilised with the COVIDSafe mobile application, its design aligns with some primary industry 4.0 features. For example, the use of transparent peer-to-peer ad-hoc data transfer using Bluetooth as an IoT process. Industry standard encryption technologies were used for data encryption in transit and at rest. The app extensively utilised the strength of cloud computing platforms and modern development paradigms such as serverless (Functions as a Service) design to allow for demand-based scalability without the need to manage physical or virtual compute resources.

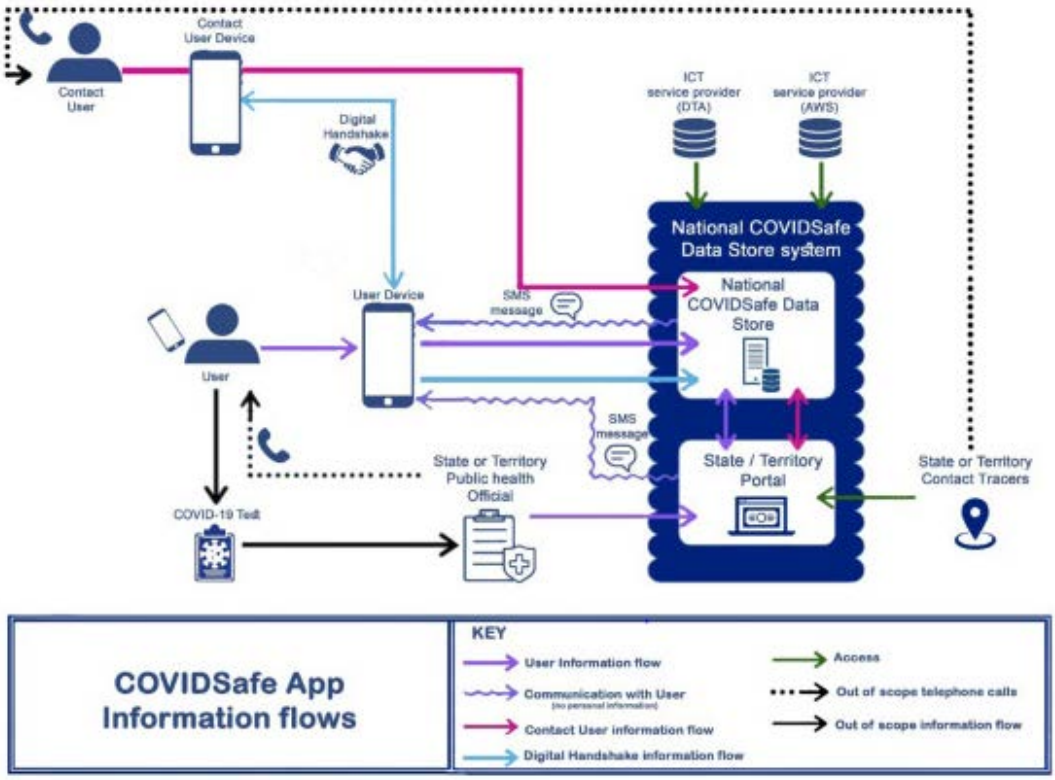

Image 18. COVIDSafe Mobile Application Information Flow[161, 162]

The QR Check-In apps allow individual Australian states and territories to offer an easy electronic registration tool for people to self-check-in at venues. This tool provides a quick check-in for people visiting public places: Two million people have already installed these apps, with 100,000 business-registered

[160] Barua Z., Barua S., Aktar S., Kabir N., Li M. Effects of misinformation on COVID-19 individual responses and recommendations for resilience of disastrous consequences of misinformation. Progr. Disaster Sci., 8 (2020), Article 100119

[161] Australian Government Department of Health, H. (2020, the 24th of April).COVIDSafe app. Australian Government Department of Health; Australian Government Department of Health. https://www.health.gov.au/resources/apps-and-tools/covidsafe-app.

[162] Health AGD of 2020, April. COVIDSafe application Privacy Impact Assessment[Text]. Australian Government Department of Health; Australian GovernmentDepartment of Health

customers through the apps, and 32 million check-ins recorded[163]. People are asked to check in by scanning the QR code displayed on a business or facility entrance and uploading contact information. If the subject tests positive, health authorities contact whoever has been in the same location during the contact window. This data-driven tool accelerates the speed of reaching and tracing people exposed to the virus, which is vital to pandemic management [155]

4.4.2. Education Value Chain

UNESCO indicates that at one year into the COVID-19 pandemic, close to half the world's students are still affected by partial or full school closures, and over 100 million additional children will fall below the minimum proficiency level in reading because of the health crisis. Prioritizing education recovery is crucial to avoid a generational catastrophe[164].

UNESCO is supporting economies in their efforts to mitigate the impact of school closures, address learning losses and adapt education systems, particularly for vulnerable and disadvantaged communities[158].

The COVID-19 outbreak, along with post-pandemic impact has prompted *Internet Plus* education to re-examine numerous facets of technology-oriented academic research. However, the unexpected transition from face-to-face offline education to online lessons has urged teachers to introduce educational technology into teaching practice, which has had an overwhelming impact on teachers' professional and personal lives [165].

4.4.2.1. Blockchain in Education: Opportunities, Applications, and challenges

The research presented by Steiu in 2020 presents the opportunities and challenges of applying blockchain technologies in the education sector[166].

COVID accelerated the reliance on digital tools that allowed students to continue learning when early education centers were closed. Students everywhere have been faced a situation where their education institutions were open one day and closed the next, causing massive disruption to their learning. Consequently, many education systems are still struggling, and the situation is constantly evolving.

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163 A. Barbaschow, 2021. Over 30 million COVID safe check-ins through the Service NSW app. ZDNet. https://www.zdnet.com/article/over-30-million-covid-safe-check-ins-through-service-nsws-app/.

164 UNESCO. Education: From disruption to recovery (2021). Access online: https://en.unesco.org/covid19/educationresponse . (Accessed on 13 of November 2021)

165 Li Jia, Jiang Yuhong. The Research Trend of Big Data in Education and the Impact of Teacher Psychology on Educational Development During COVID-19: A Systematic Review and Future Perspective. Frontiers in Psychology. Volume 12 (2021), https://www.frontiersin.org/article/10.3389/fpsyg.2021.753388

166 Mara-Florina Steiu. Blockchain in Education: Opportunities, Applications and challenges. Volume 25, Number 9 - 7 September 2020 doi: http://dx.doi.org/10.5210/fm.v25i9.10654

Blockchain is an immutable, decentralized database. It is a chain of "blocks" which store information such as amounts, transactions' times, and/or participants. There are different kinds of blockchains: public, private, and permissioned [167].

Using blockchain in education, as Tapscott and Kaplan indicate, the processes of teaching and learning can be improved across key dimensions[168], as shown in Image 19:

- Empowerment for learners (self-sovereignty): Through blockchain, credentials or skills learned associated with students' identity is not owned by an entity such as a university but by the student. They will have an opportunity to store their lifelong learning data. This way, learners can demonstrate that the credentials in their resumes are correct and have control over what can be accessed by their future employers.

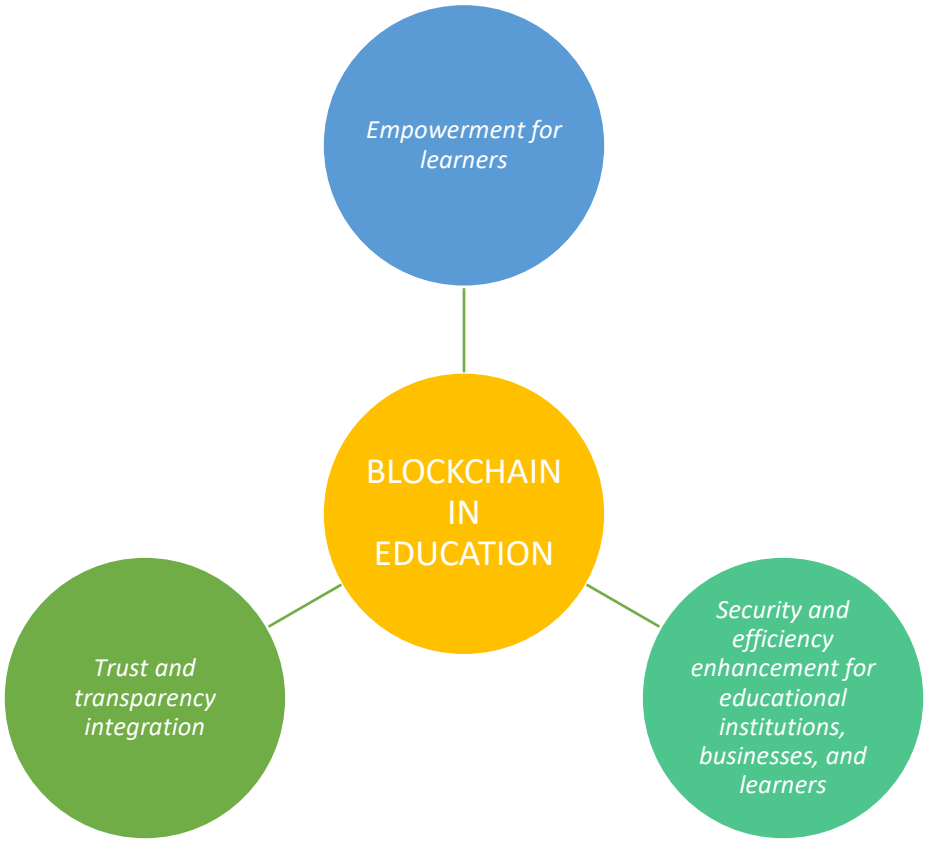

Image 19. Key dimensions of Blockchain in Education

[167] Z. Zheng, S. Xie, H. Dai, X. Chen, and H. Wang, 2017. "An overview of blockchain technology: Architecture, consensus, and future trends," 2017 IEEE International Congress on Big Data (Big Data Congress). DOI: https://doi.org/10.1109/BigDataCongress.2017.85, accessed 6 June 2020.

[168] D. Tapscott and A. Kaplan, 2019. "Blockchain revolution in education and lifelong learning: Preparing for disruption, leading the transformation," Blockchain Research Institute and IBM Institute for Business Value, at https://www.ibm.com/downloads/cas/93DDVAKE, accessed 28 April 2020.

- Security and efficiency enhancement: This technology has the potential to ensure the identity, security, and privacy of students' data. Blockchain offers validity and security by ensuring invariability through its hash chain. For instance, students cannot modify past educational certification stored on the blockchain, while they may easily do that with paper records. Also, privacy is ensured through blockchain, not storing the data but rather a hash of the data. Alternatively, the data may also be encrypted before being stored on the blockchain.

- Trust and transparency integration: Blockchain helps to ensure that students cannot modify their grades, degrees, and certification, thus offering employers the guarantee that the job applicants have the necessary skills to quality as the right candidate. It helps to create a better pairing between job seekers and employers.

4.4.2.1.1. Applications of blockchain in education

Devine (2015) indicates that through blockchain, the academic records of students will become easy to share with employers and universities for personal development opportunities. This application will benefit students by offering them an empowering tool to trace and share their academic progress and letting them rely on accurate, true representations of students' potential based on academic achievement (trusted verification) [169].

a. MIT is an institution that has historically developed other blockchain applications to streamline the educational accreditations process.
   MIT Media Lab and Learning Machine's Blockcerts is an open standard for blockchain credentials, a platform that permits educational institutions to implement blockchain accreditations within their programs[169].
b. Another example is the platform created by the start-up ODEM; by using the ODEM Token (ODE), students interact with academic professionals who offer customized learning experiences. The ODEM Trust Network proposes solutions for students/professionals, employers, educators, and educational organizations, connecting them by taking out any intermediaries[169]. More clearly:
   - Students can find work on the ODEM Employment Network, discover education opportunities adjusted to their interests and talents, or store their credentials securely.
   - Educators create programs, teach, and are rewarded through ODE tokens on the ODEM Marketplace, which is managed through smart contracts secured on the blockchain.

[169] P. Devine, 2015. "Blockchain learning: Can crypto-currency methods be appropriated to enhance online learning?" at http://oro.open.ac.uk/44966/, accessed 28 April 2020.

- Employers can corroborate candidates' credentials (*e.g.*, education, previous employers, and educators) in a reliable and easy way.
- Educational organizations can manage and deliver accreditations for their students by using the ODEM platform.

In conclusion, these cases prove that private initiatives' goal is to make the learning and teaching processes for learners and content providers more functional and engaging through blockchain (*e.g.*, eliminating unnecessary middlemen, bureaucracy, and using educational tokens as rewards).

V. RECOMMENDATIONS

- ✓ *This* document shows that technology has been applied in various business operation procedures such as customer relationship management, restaurant robotization, digital sales-platform construction, and product innovation. Industry 4.0 is a fusion of the new digital technologies, such as artificial intelligence (AI), big data, internet of things (IoT), cloud computing, blockchain, robotics and 5G, have effectively assisted many economies in the pandemic emergency, response, and recovery.
- ✓ *In this preliminary diagnosis were identified 3 value chains affected by the Covid-19, Toursim, Commerce and Hospitality (Restaurants).*
- ✓ *In case of tourism value chain,* Covid-19 has led to the fact that the primary content of the specialized tourist offer can no longer assure tourist demand. It is expected that post-Covid, the fundamental dilemmas of tourism supply development will focus on the importance of designing new strategies to specialize the content offered.
- ✓ The conduct of travelers and the public, in general, is changing very fast. Travelers are increasingly inclined to actively participate in the processes that affect them, in this era is also key using social media tools to confirm their reputation as an identity.
- ✓ The new technologies can enhance the travel experience throughout the cycle (virtual visits to natural and cultural sites, planning, booking, experience, and information exchange) and open new avenues for more responsible and sustainable consumer behavior. The new digital ecosystem for tourism has also changed as companies and destinations embrace innovation in marketing and communication processes, use a new digital language, adapt digital marketing strategies, and incorporate sustainable principles into their business.
- ✓ In case of the commerce value chain, it is recommended the integration of online-offline channels for retailer success in the current environment due to changing consumption patterns.

  Before the COVID-19 pandemic, many retailers concentrated on investing in e-commerce as a strategy to raise their profitability and last competitive. It turned out to be an opportune decision, as it kept a line of revenue open during confinement restrictions.
- ✓ In case of the commerce value chain, it is recommended the integration of online-offline channels for retailer success in the current environment due to changing consumption patterns.
- ✓ *In case of Hospitality (Restaurant) value chain,* has been extremely hard hit by the current Covid-19 pandemic. Restaurants in many economies were forced to close or operate at reduced serving capacity due to government pandemic containment measures. Even as governmental imposed standards were slowly loosened up, the industry continued to suffer from consumers' perceived risks, lack of confidence, and pervasive loss of safety induced by the pandemic.
- ✓ In case of the restaurant value chain, it is recommended to assess their technological needs and adopt the relevant technologies to accelerate innovation's pace and scope.