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Digitalization and innovative Management of traditional manufacturing industry

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Abstract

Purpose- This study seeks to investigate the collaboration between Digitalization and traditional manufacturing industry and investigate, how digitalized management brings new chances and challenges of management.

Design/methodology/approach - The author designed a content analytical study researching the role of digitalization in traditional manufacturing industries. The article presents a selective but systematical review of recent digitalization trend and digital twin to be applied for innovative management in Industry 4.0 era.

Findings– Digitalization is highly correlated with traditional manufactory in Industry 4.0 era. The study brings a new outlook on the next wave of Digitalization and review of associated challenges and opportunities for management and innovation in traditional manufacturing industries.

Research limitations/implications – The research focuses on two branches of traditional industries only: machine tools building and metalworking industries. Future research needs to examine other traditional industries. The research is limited to 2 high related traditional manufacturing industries, machine tools and metalworking industry.

Practical implications – The study and application of digitalization should be highly recommended and launched in traditional manufacturing industries. Universities, institutes and vocational schools should update, optimize their courses systems according to prediction of future industry.

Originality/value – The paper enhances understanding about the collaboration between digitalization and traditional manufacturing industry. This paper analyzes an important issue the digitalization serves traditional industries. It is unique in its broad analysis of the related terms – Digitalization, Machines 4.0, Industry 4.0 and innovative management in Industry 4.0 era.

Keywords – Industry 4.0, Digitalization, Digital production, Digital Twin, 5G, innovative management

1. Introduction

Industry 4.0 takes over production with robots that communicate with each other, detect the environment with surveillances, control and operate through data interchange and analysis with the propose of higher productivity, lower cost and higher quality. Industry 4.0 allows monitoring of cyber physical systems and physical processes in modular structured smart factories, allowing objects and human to communicate with each other, applying fuzzy logic and innovating algorithm, resulting in decentralized collaborative strategy. Especially during the COVID 19 period and post COVID 19 period, organizations need to apply Industry 4.0 for sustainability in competition. And the real Industry 4.0 is digitalized, and digitalization is the core technology to realize upgrade industrialization.

1.1 Background of Study

Industry 4.0 is integration of complex physical machines and devices. They are networked monitoring, software and programs with the goals and tasks to predict, process, control, and plan commercial and social outcomes" or bring a new dimension of value chain and innovative management throughout the life cycle of products". Industry 4.0 itself offers a wide range of innovation, processing, communication and production and service capabilities. Meanwhile, data classification and conversion algorithms and software, which are known as digitalization, support the collaboration and integration. [1]

In Industry 4.0 era, manufactories are equipped with modern machines facilities, so-called machines 4.0. But the machines 4.0 are still operated without high-level digitalized collaboration. The daily operation stays conventional. If the operation and management are not optimized

through digitalization, the machines 4.0 will result waste of resources, and will lead the firms to lose their competition in market.

1.2 Current Problem to be stated

The current study of digitalization focuses enormously on the supporting technologies themselves, e.g. Cloud Computing, Bid Data, algorithm, software, 5G, etc. The trend motivates the more talents to study IT technologies and mathematics, especially Cloud computing, Big Data and Security Technology. Less talents are motivated to study disciplines in Machinery and Electrics. The weak collaboration between physical subjects (machines) and digitalization (advanced IT technology and virtual technology) brings dilemma in traditional manufacturing industry.

In this paper, the implementation of digitalization in manufactories, especially in traditional manufactories industries will be researched and discussed. Also, the paper has an outlook on the next wave of industrialization, e.g. Neural Control and Fuzzy Control System, and the article reviews the associated challenges and opportunities for management and innovation of traditional manufacturing industry.

1.3 Purpose of the Study

This study seeks to investigate the collaboration between Digitalization and traditional manufacturing industry and investigate, how digitalized management brings new chances and challenges to organizational management. This research is aimed to motivate colleges, universities, institutes and vocational schools to correct their cognition of the collaboration between digitalization itself and its significance in traditional manufacturing industries upgrading.

1.4 Research questions

This research attempts to develop a deeper understanding of digitalization for traditional manufacturing industry by addressing the following research questions:

1. Is the ROI (Return on Investment) of smart factories driven by digitalization higher than conventional shops with automation lines?
2. What are the consequences of digitalization? Rising or decreasing unemployment rate?
3. Will post COVID Economy depend more or less on the traditional manufacturing?

These research questions are answered through the use of case analysis to gain insight into enterprise management and strategy, which leads to investigation into the correlation between the classification of digitalization, productivity, efficiency, accuracy and ROI of the plants.

In the following sections, a review of the relevant literature is provided, followed by the sections on research methodology, and discussion of the results. The paper then concludes with a discussion of managerial implications and avenues for further investigation.

2. Literature Review

2.1 Digital Industry 4.0 Learning Factory

Industry 4.0 represents the radical transformation resulted from the integration of emerging technologies. Autonomous Robots, Simulation, Horizontal and Vertical System Integration, Internet of Things (IoT), Cyber- security, the Cloud computing, 5G, Big Data, Digital Twins are technologies, which enable the implementation of Industry 4.0.[2] The supporting technologies are always dynamically changing. Therefore, it is of paramount importance for organizations to track them, so they maintain their operations technologically updated and have full access to the Fourth Industrial Revolution's proposed benefits. [3]

"Industry 4.0" leads to conceptualization of a "digital factory", which is already being realized. Digital Learning factories demonstrating ideas and technologies of Industry 4.0 are currently a trend topic in research. Most publications appeared that describe different factory and education. The concept of the learning factory relies on a previous research project. The goal of the "LogCentre" project was the development and implementation of a learning factory for the German Kazakh University in Almaty, Kazakhstan. [4]

The learning factory represents an environment to teach and evaluate new production control concepts for decentralized systems. The digitalization of the factory allows the planning and testing of new factory structures and control concepts before the user applies them to the real system.

2.2 Machines tools 4.0 in Industry 4.0 era

Cyber-Physical Machine Tool (CPMT) is envisioned as a promising development trend of machine tools in Industry 4.0 era as Machine Tool 4.0. Based on recent advancements in Information and Communication Technology (ICT) such as Internet of Things (IoT) and Cloud technology, Cyber-Physical Systems (CPS), CPMT represents a new generation of complete CPS-based machine tools that are deeply integrated machine tool and machining processes with computation and networking. 5G technology enable the data flow. During machining processing, 5 G makes simulation and process control possible and accessible. Compared to current CNC machine tools, CPMT have a higher level of connectivity, intelligence and autonomy. [5][6]

2.3 Digital Twin and digital production

The concept of Digital Twin was originally introduced in 2003 by Michael Grieves and first put to public by the NASA in 2012. A digital twin is a digital representation of a real-world entity or

system and is bridge between real world and virtual world. The implementation of a digital twin is an encapsulated software object or model that mirrors a unique physical object, process, organization, person or other abstraction. Data from multiple digital twins can be aggregated for a composite view across a number of real-world entities, such as a power plant or a city, and their related processes.[7] Digital Twins integrate all (electronic) information and knowledge generated during the lifetime of a product, from the product definition and ideation to the end of its life. Digital Twin is based on physical object. The goal is to model, predict, stimulate and optimize their corresponding real facility or objects. Therefore, Digital Twins leads synchronize the data through high speed Internet, which allows remote session for on-site diagnostics, prescriptive maintenance or operation optimization.[8] It makes contributes to the traditional manufacturing industry to enhance the efficiency and motivate further innovation.

The creation of digital twins of technological equipment is a complex task connected with the integration of information and manufacturing technologies. The main approach is the systematic which determines the requirements for the mathematical, informational and methodical support of digital production. [8]

With the introduction of robots in the industrial process, machines tools builder aims to turnkey solution. Equipment manufacturers by utilizing the DT can successfully iterate through multiple prototypes required in order to finally arrive at a suitable end product. Meanwhile, the simulated environment of the digital twin would also be able to provide an overview and outlook, how the equipment performs over time, cycle of maintenance and essential upgrade in order to optimize the output of the industrial process. [9]

Industrial processes involve the synchronous working of multiple equipment simultaneously. These machines are used to be designed to act individually for the increment output. The best combination of all equipment can enhance the industrial outputs, therefore digital twin technology can be utilized. Digital Twin can realize the combination, multiple combinations of the equipment can be experimented and simulated to reach the best result with all possible working limitation. In addition to finding an optimum combination, the managers should understand the future costs and outputs, ROI (Return on Investment) to make strategies, which equipment systems work best in the long run. [10][11]

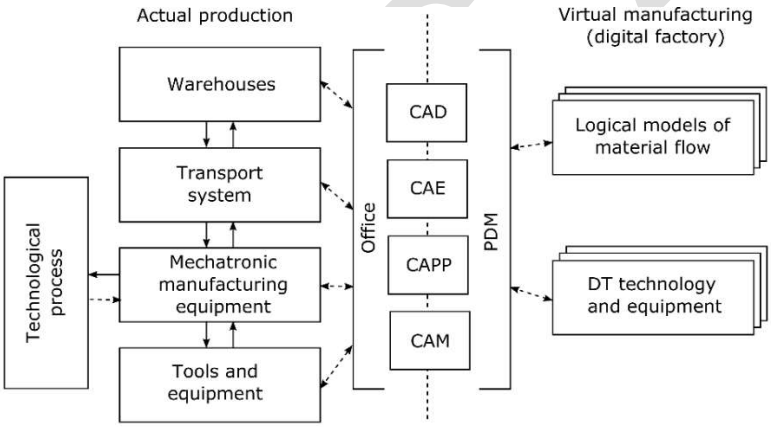

Figure 1. Modelling of technological processes of machining production

Equipments and tools equipped with Digital Twin for solving the problems in production process planning, including the control programs for CNC machines. The methods of CNC machine control, which specify operational features and adapt itself to the requirements of a specific technological process, expand the production possibilities. Digital Twin assures the implementation of new modern digital production technologies.

3. Digital Twin and Digital Manufacturing

3.1 Digital Twin Potential

Digital Twin greater capabilities compared to other growing technologies. These abilities provide a higher value throughout the Product Lifecycle Management. Those abilities provide a higher value and create new value chain throughout the product and service lifecycle Management. It can be sorted by the following sub-disciplines. [12]

1) 3D Representation: The measured features of a physical object can be mapped to a 3D model.
2) Visualization: A graphical representation of the product can be portrayed either on a physical device or in system.
3) Model: The performance and stuffs of a physical device are characterized in digital manner.
4) Data Model: The data model is simulated for visualization, connection and analytics.
5) Model Synchronization: The digital twin model is aligned with some real-world parameters.
6) Simulation: The object is viewed in the simulated environment to record its behavior.
7) Document Management: All the information regarding the Product Lifecycle Management is maintained for future reference.
8) Connected analytics: The measured properties of an object help to compute the algorithm and artificial results.

3.2 Evolution from conventional automation to Smart Factories

The implantation and application of Digitalization in traditional manufacturing industries are still at early stage. The complex of implementation of digital management, the ROI (Return on Investment) of the traditional manufacturing industries, which are facilitated with conventional CNC machine tools, needs to be research furtherly.

The manufactures need investment from financing methods. If the large investment is just from the manufacturer's revenue and net profit, it will make the SME (Small and Middle-sized) hard to make decision to digitalize the facilities. On the other hand, one smart factory needs smart management team.

3.3 The Scope of digital twin technology Connectivity

Growth of IoT has fostered the development of digital twin technology. Nature of IoT supplements the requisite and fundamental infrastructure needed for Digital twins. Hence it is more capable of building connectivity between organizations, manufacturing, production, products, dealers and end-users. Supply chain management and ERP (Enterprise Resource Planning) can also get benefited more from it. All the partners and members are authorized and classified and connected with this link. They can achieve better performance, get better service over integrated digital platform. Some machine tools companies created and development "Virtual Engineering System" online. That means, less service engineers and technical support staffs will be recruited, and the service cost will be reduced. It is applicable and cheaper than investing time on different modes of communication. The following conceptualizations functions and benefit the smart production and technical service process:

Homogenization

Heterogeneous data are defined as data collected from different physical objects flows across digital platform to achieve uniformity in data analytics. The information is retrieved for further feedbacking and processing. It can exam, foresee, and resolve complications malfunctions and judge by using the virtual representations. This approach is wiser rather than validating it on

corporal models and waiting for prevailing reflexes on these products. The data loading will be synchronized time to time with high speed internet connect, eg. 5G. It would facilitate convergence of variant user experience irrespective of the demographics set up. The Machine Learning will be stimulated and upgraded. [13]

Reprogrammable and smart

Utilization of A.I artificial intelligence technologies and predictive analytics, simulation technologies, behavior judgement and functional modification of system features will be optimized. The sensors (both physical and virtual) to be placed on the physical objects will enable automatical reprogramming and reengineering in a reflexive manner. [13][14]

Digital smidgeons

Digital footprints are used in industry makes personnel to keep an eye on downtime, failure, fault analysis and achieving up keeping of assembly during crisis and challenging. Less secondary labor will exist in smart factory. [15] The high-speed internet and Apps on smartphone can bring personnel flexibility to make surveillances and multi-tasks at same time. This would assist manufacturers to alleviate future design and performance of the machines. In order to qualify the personnel, standard process and content of recruitment can be setup. The risk from enrollment of unqualified staff can be minimized. [16]

Modularity

In manufacturing industry, especially traditional manufacturing industries with modern machines, product design encompasses grainer, modular components assembled collectively to brand a product. [14] [17] Customization of products and production modules are variant to achieve better

performance and efficiency. It helps the customer to reach their ROI (Return on Investment). Digital twin technology empowers traditional industrialists to trail the behavior of machines and staffs for possible areas of improvement.

4. Study of current Digital Application – internal SMART System

4.1 EDI- Electronic Data Interchange in Supply Chain

EDI is the transmission of information between people can be fraught with delays, errors, misinterpretations, and security breaches. Electronic Data Interchange (EDI) is the computer-to-computer exchange of documents, offering a secure, encrypted alternative to manual paper processing and supply chain tracking. (www.sme.org)

EDI allows for secure, paperless & fast document exchange. Electronic Data Interchange (EDI) is the virtual exchange of data or business documents in electronic format between trading partners, particularly buyers and their suppliers. By transferring purchase orders, invoices, payments, shipping notices and various other documents via an EDI, users eliminate paper waste, improve operational efficiency and enhance virtual exchanges with new trading partners around the world. [18]

Created to ease the management and flow of transaction information, Electronic Data Interchange systems can handle and transmit any business document data such as purchase order, invoices, order acknowledgement, shipping notices. EDI system is expensive, but the ROI (Return On Investment) can be increased, referring to the following data.

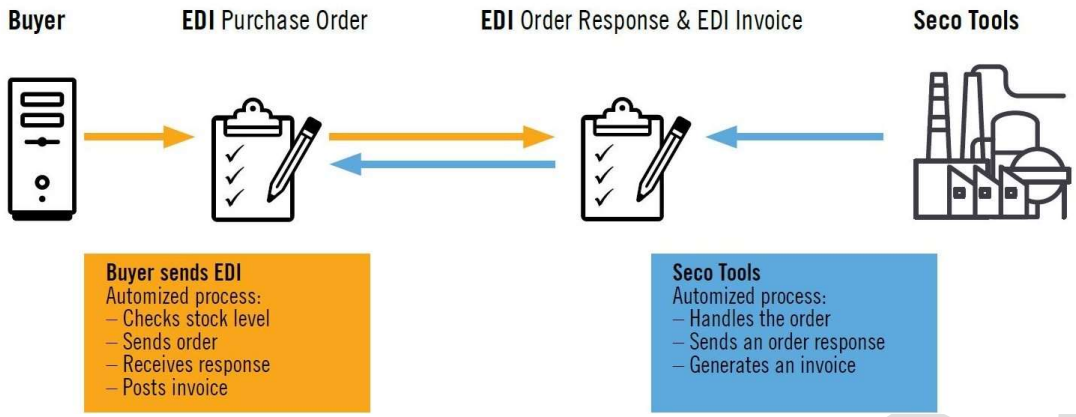

Figure 2. EDI Supply Chain System

Speed up & simplify document flow: EDI allows business to automate processes and speed up document creation and handling by 61%.

- Use own ERP (Enterprise Resource Planning) system.
- EDI is able to handle most type of formats and communication methods.
- Become paperless to save costs & friendly for environment
- Expenses associated with paper and document retrieval are reduced or eliminated.
- Lowering transaction costs
- Example: processing an order manually at $38 can be compared to just $1.35 for an order processed using EDI.

Handle order management efficiently & securely

- Less errors, reducing at least 30 - 40% of errors in transactions.
- Rational handling of large orders. Less re-working of orders, fewer stock outs and fewer cancelled orders.

- Less manual work, automation can free up staff time as much as 65% for more value adding work.
- Delivery times can be improved by 30%.
- Reduce the order-to-cash cycle time by more than 20%.
- 24/7 availability & manage inventory and stock efficiently (just-in-time orders).
- Highly secure solutions using encryption and receipts.
- Audit trails, possible to trace all transactions.
- Archives, everything sent and received archived.

4.2 App "SUGGEST"- Digital Portal-Quick Search System

The CNC Tools builders have developed their own " Tool Search" System, both online via Website and APP on Smart Phone or PAD. APP " SUGGUEST " is APP by SECO Tools, the APP is for a new job or want to explore another tooling option for a recurring project, this comprehensive online metalworking resource can help with process planning 24/7. As part of the digital portal, the APP uses application data to quickly identify a Tools machining strategy (Cutting Path or Cycle time etc) for processing part to the required tolerance. Before machining the workpieces, the program will stimulate the processing to confirm every details. (www.secotools.com)

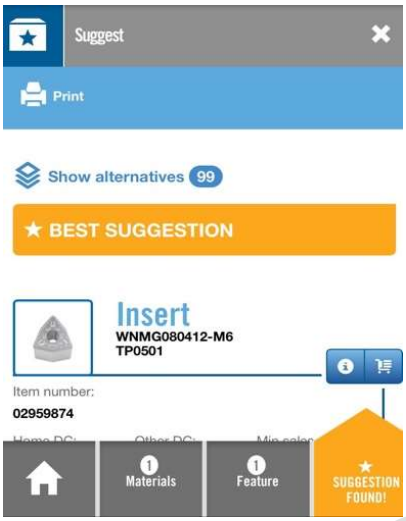

Figure 3. Quick Tool Search APP -SUGGEST

"SUGGEST" offers a free online access to resource that helps parts manufacturers, even those unfamiliar with product line, they can identify productive, cost-effective machining strategies for a specific job. "SUGGEST" aggregates data input to provide complete tooling recommendations.

"SUGGEST" is more than an advanced product selector. It can quickly identifies the tools and sequence of machnining workpieces and meet all specification and tight tolerance. However, the more information a user provides, the more customized the recommendation. Users can adjust their input data and compare information to fine-tune a recommendation. (www.secotools.com)

Advantages of APP: Find the tools and cutting strategies for a specific job within minutes

- Quickly narrow down tooling options for a desired part feature and tolerance
- Recoup the hours it takes to compare products using a print catalog
- Access proven technical competence and process planning expertise 24/7
- Easily share tooling recommendations with colleagues and customers
- Look up product pricing and availability in real-time
- Significantly reduce your overall process planning time

The above features can lead to lower cost of daily routine work. For the tool builders, less technical service engineer need to be hired to handle the "Tool Search" and " Tooling Solution" issue. For the metalworking shops, the managers donot need to invest more time on " On the Job Training" and technical training. The basic training and consualtancy can be executed via "SUGGEST". Also, the more frequently the "SUGGEST" App to be used, the more "SMART" the users will be. The system can offer E-Learning chances to users.

That means, the "secondary labor" with less professional or vocational education background will lose their jobs. Instead, the educated, professional labor will get more chances to work in shops with digital management. In general, the unemployment will decrease much. But the unemployment of "secondary labor" will keep decreasing.

4.3 Tools Data Management System – TDM in digital production

There are many CNC Tools manufactures, who can also offer Tool Data Management system. The data of the tools will be managed with Tool Management Software, which enables a permanent consumption control: Reporting all tool paths and it makes tool costs more transparent. An A-Z Analysis of the tools cashed further light on the tool management, especially on tool lifetime and possibilities for reconditioning. (www.sme.org)

Conventional production is undergoing a profound transformation: Industry 4.0 is expected to connect production with communication and information technology and therefore contribute to increasing productivity and flexibility, and to decrease the dependency on operators. As part of the technical service, Tool Digital Management provides users with the data for a transparent machining process and optimizes the usage and consumption of the tools. (www.sme.org)

The German CNC Tools Builder Gühring has innovated their Tool Management System. They offer both tools and tools cabinet (for tool reconditioning and recycling) together will own

software. Gühring's Tool Management Software (GTMS) is unquestionably an integral component. The newly programmed GTMS is complemented with Gühring tool dispensing systems having a revised user-friendly design. (www.guehring.com)

Figure 4. Tools Vendors + Cabinets – for on-site management

User focused/ customizable dashboard

- Individually designed work area
- Direct call-up of frequently required modules
- Live evaluations
- Higher user-friendliness

Comprehensive planning tools

- Internal news management with commentary and tracking tool
- Component management with nom/act. Comparison of production figures or manufacturing costs
- Item lists with proof of use or availability
- Wear data recording for process optimization
- Production time recording
- Inspection instrument management
- Goods inwards inspection to freely definable criteria

Serial number management

- Managing individual tools by issuing serial numbers
- Permanent, precise depiction of the place of tool application
- Complete tool life cycle is documented and can be assessed for analysis and optimization purposes

- Machine management & reporting
- Picture of machining facility
- Malfunction documentation
- Action planning/control
- Maintenance plans
- Overview of downtime /downtime costs
- Customizable live evaluation
- New graphical possibilities of refurbishment – also including a design response

There is an optional function of the cabinet, which is called "GPS" Tools searching. That means, the operators do not need to spend too much time to go through the shop, waste the time just to find one tool. They can use Smart Phone and Internet access to find the tools very soon. This is also the reason, why 5G is so important for digitalization in Industry 4.0 era. The efficiency is most important KPI.

Digitalization in Industry 4.0 era thanks to smart tool management

There is also one Software Company, who does not supply tools, but only offer users Software- TDM System, so-called Tool Digital Data System. In addition to the central tool database, users can also populate their tool data with TDM System and a Cloud connection, so-called Digital Twin. (www.sme.org) TDM also offers integration options for many CAD/CAM systems, a connection to tool cabinets and several crib systems, as well as shop floor digitalization. That means, the Metalworking Shops can use SECO, Walter, Bilz cutting tools or any other tools from other brands. And they can also use the Tools Cabinet from them, but use the TDM System, it is completely compatible.

The Tool Data Management software does not only just help network production, but also allows users to link several sites across the globe and introduce uniform production standards. This

solution is not just great for big companies. Small and medium-sized enterprises can also benefit from TDM. (www.tdmsystem.com)

Digital manufacturing clearly gives machining shops a competitive advantage. An enormously important basis for every company in machining production is an efficient and customizable Tool Data Management system. The future trend of production should support smart plants in digital management and innovative way.

During COVID 19, the trainings and session are held online via Webinar. Also, the technical service can only be executed online. Many machine tools builders have developed " Virtual Engineer Online" to support the users to solve technical problems. In the post COVID period, the "Virtual Engineer" will be definitely developed further to cut down the cost of service. There are also VR Tools especially for remote session: The service Engineers of machine builder or tool suppliers can make the maintenance even from office or home. Trouble shooting Processes for frequent production problems can be standardized and programmed into database and synchronized with Cloud. This program and database provide the fast Feedback to suggest users to find solution by themselves as possible. That means, the tool builder can motive the users via E-Learning and the users will have high loyalty to the brand, when the E-Learning System is easy to go.

All of the above-mentioned application is based on 5G, High Speed Internet and Cloud Computing Technology. With the perspective, more machining shops can transfer themselves to " Light off " and "SMART" Plants. The mentioned advanced technologies help the plants to minimize the "downtime" of machines and save the labor cost.

In the post COVID stage, our economy will still depend more on traditional manufacturing industries. The COVID has long-term impact on our daily life, traditional service industry and

manufacturing industry, also in aspects of sanitary and hygiene, medical appliance and medicines security code with big data etc. The government invests more on infrastructures and medical departments. All that are supported basically by machine tools, traditional manufacturing industries, eg. metalworking manufacturing industry. The automobile industry is one of the industry pillars in China, which offer us more job positions and talents in globalization. We can conclude, the stronger the traditional manufacturing industries of one country, the more competitive is the country. So, the government will also further emphasize the traditional industries' digitalization and industries' upgrade.

5. Limitations

The research focuses on two highly related traditional industries only: machine tools building and metalworking industries. Future research needs to be examined and executed in other traditional industries. aerospace and engineering machines etc. The paper shows there are limitations due to the qualitative study: logical rather than statistical conclusions and subjectivity of interpretations.

6. Discussions and Conclusion

6.1 Discussions and Results

Digitalization can also contribute to traditional manufacturing industries. It can even change the conventional business mode of traditional industries. Meanwhile, digital production brings new challenges of management. The implementation of digital machines tools in digital production is associated with providing real digital technological systems and influenced by cognition of top managers of enterprises. The innovation of digital twins in technological equipment is a complexity associated with the integration of virtual and physical technologies. [17] [18] Digital

production is highly correlated with mathematical, informational and methodological theories. The capacity and capabilities of digitalization in traditional manufacturing industry result in high productivity, efficiency, accuracy, which will lead to new phase of industrialization.

With digital CNC machines, so-called machine tools 4.0, the advantages and disadvantages of machining programs will be stimulated with high accuracy. According to the Paragraph 4.0, the case study describes the innovative management based on digitalization, so we can answer the 3 research questions mentioned in paragraph 1.4, as followed:

1. Is the ROI (Return on Investment) of smart factories driven by digitalization higher than conventional shops with automation lines?

   Yes. Smart factories have higher ROI. It can be found in paragraph 4.1, EDI allows business to automate processes and speed up document creation and handling by 61%. Less errors, reducing at least 30 - 40% of errors in transactions. Less manual work, automation can free up staff time as much as 65% for more value adding work. Delivery times can be improved by 30%. Reduce the order-to-cash cycle time by more than 20%. In paragraph 4.2, 4.3, the study and explaiation of APP “SUGGUEST” , “ Tool Digital Mangement” System, Tool Searching GPS Technology, Virtual Engineer, Romote Session all investment are focused on less “ Downtime” and less “ labour cost”, which bring high procentage cost of one metalworking shop.

2. What are the consequences of digitalization? Rising or decreasing unemployment rate?

   The consequences are: Factories with digitalization need less “secondary labor”. Nowadays in China, in traditional manufacturing industries and sevice industry, there

are still high percentage of "secondary labor". For example, we point out in paragraph 4.3, for metalworking factories, the management of tools is cruitial. In metalworking shops, the management of tool is very time consuming. With Tool Data Management system, tool digital management harwares and softwares, the efficiency and accuracy can be optimized without hiring "secondary labor". Because the data of the tools will be managed with Tool Digital Management Software, which enables a permanent consumption control: The status of tool consumption and lifetime together with possibilities for reconditioning are recorded and optimized with solution automatically.

Industry 4.0 is expected to connect production with communication and information technology and therefore contribute to increasing productivity and flexibility, and to decrease the dependency on operators. Therefore, we can predict, only the unemployement of "secondary labor" will be higher.

3. Will post COVID Economy depend more or less on the traditional manufacturing?

From paragraph 4.4, we can predict, Post COVID Economy still depends more on the traditional manufacturing industries. During the COVID periode, China government invests more on infrastructures, which is highly correlated with traditional manufacturing industries. COVID requires industrial ugrade- digital transformation. The transformation is based in physical objects.

In paragraph 4.3, we study the cases of Webinar, training online. Also, we explain that many tools builders have developed " Virtual Engineer Online" to support the users to solve technical problems via remote session. It's not temporary solution, because the tool builders have found profit from the "Virtual Engineer" System from

saving cost of real engineers. Trouble shooting Processes and E-Learning System make the tool users smarter, therefore it can enhance the confidence and loyalty of customers. So, even COVID finishes, the Virtual System and E-Learning System will keep developed to optimize customers' salinification. Also, the government will invest more on most important industries' pillars, which will push the development of traditional manufacturing industries.

6.2 Conclusion and Outlook

The study and research of digital twin should be launched in traditional manufacturing industries, academy and institutes in order to explore new discipline construction. Universities, institutes and vocational schools should update, optimize their courses systems according to prediction of future trend- Neural Network and Fuzzy Control System. [19]In the future, the scientists and engineers should cooperate closely with each other in interdisciplinary research. The interdisciplinary co-work will contribute to the digital transformation and upgrade of traditional manufacturing industries and pillar industries, e.g. Smart Machine Tools building, Material science and technology.

The next wave of technological revolution will have prospect in-between Biotechnology and Mechatronics. Machine learning will be supported by new algorithm, which will be innovated by talents with background in traditional manufacturing industries.

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