Model Analysis and Trend Research on Strategy and Development for Siemens in Digital Transformation

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Abstract—Society is experiencing the wave of the fourth industrial revolution. According to Fama-French five factor model, the market is more suitable for small, aggressively risk appetites and poorly profitable companies in the software industry, reflecting the potential of digital development. This research shed light on the strategies of digital transformation and the industry layout of Siemens. For internal strategies, Siemens builds smart factories and disposing of some traditional operations improved the profit margin significantly. As for the external layout, acquiring lots of superior software such as MES and PLM, and completing the framework of the industrial internet industry chain constructed an exhaustive standard for other companies in the manufacturing. The outlook for Siemens is focusing on the development of digitalization. According to the trend of technology, Siemens should enter the preparation for Industry 5.0. Improving profitability, resilience, and sustainability will be the targets in the future. This research evaluates the performance of Siemens in the Industry 4.0 revolution, which provides an example to adapt digital transformation for other companies to learn and illustrates the benefits of Industry 4.0 as well. Especially for many developing countries like China, there are many manufactories facing transformation, Siemens' digitalization is helpful for reference.

Keywords-Siemens; Digital Transformation; Industry 4.0.

1 INTRODUCTION

In the past, the combination of the labor force and automation equipment was the primary type to product in manufacturing. Due to many factors, such as the external volatility and the increase of demands, Industry 4.0 has become a consensus for future development, and digitalization is the key objective. Many companies seized the opportunity and kept up with the era. They survived this challenge and have significant progress, like Siemens and SAP. There are also many traditional companies lost in the competition, such as Baoshan Iron & Steel Co., Ltd.. However, Siemens took up transforming with a forward-looking plan and grew to mature advanced manufacturing successfully.

Digitalization is the tendency of all the business especially in manufactory. There are many convincing literature reviews about Industry 4.0. Morakanyane et al. narrow the gap that the lack of common identification of digital transformation in literature expression, a new extended digital transformation definition is proposed that is "an evolutionary process that leverages digital capabilities and technologies to enable business models, operational processes and customer experiences to create value". Thematic Analysis Technique applied to research the concept centric matrix, which includes the process, the drivers, the value creation of digital transformation [1]. Also, kinds of frameworks are presented. Ziyadin et al. classified the concept of digital

ICEMME 2022, November 18-20, Nanjing, People's Republic of China
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DOI 10.4108/eai.18-11-2022.2326785

transformation, proposed a framework pertaining to the stages, activities and results of digital transformation and structured a picture of digital transformation by examining the data and framework, clarifying their nature and analyzing the practical examples. The framework includes digital reality, digital aspiration, digital integration…and aims to realize the dangers and effects of digital transformation. The external triggers are disclosed, such as the increase of the customer's experience. Digital Transformation Frameworks were recommended to validate proposed methodology plan in the digital era [2]. Meanwhile, Zheng et al. analysed the advanced manufacturing system for industry 4.0, a general framework of intelligent manufacturing systems for Industry 4.0 was proposed with some scenarios described pertaining to smart design, smart machining. The results are that the framework presented related to design, machining control, and scheduling provides a significant reference to scholars to consider the importance of Industry 4.0 from diverse perspectives. Cyber virtualization modelling and Cloud manufacturing were recommended to be emphasized in future research [3].

Some researches on strategies are discussed as well. Matt et al. developed the digital transformation strategies that could coordinate the whole enterprise, prioritize and carry out the digital transformation. Two Perspectives on Digital Transformation Strategies which are operational strategy (Products, markets, processes) and functional strategy (Finance, human resources, IT, ...) were proposed. All elements that should be considered in the company were divided into four parts (use of technologies, changes in value creation, structural changes, and financial aspects). Three topics (elements, responsibilities and convergence of digital transformation and companies) were recommended to research in the future [4]. However, Veile et al. proposed to use hardware components methods such as RFID, network connections and sensors to speed up the process of digital transformation. The research approaches are analyzing some expert interviews that the interviewees all experienced in German manufactory companies as the source of empirical data. Some particular factors are uncovered in the process of industry 4.0, such as assuring financial resources and cooperation with external partners. Managers who carry out the digital transformation within organizations directly should be supported [5].

Scholars investigated the drivers of Industry 4.0, like Balasingham researches the key elements that would affect the procedure of digital transformation. The approach to the investigation is to refer to the past analysis and from different studies and scholars relied on a quantitative approach. The findings are two perspectives. There are two points related to the transformation process positively, which are IT infrastructure and firm size; meanwhile, there are four topics negative related, which are lack of financial resources, skills mismatches of employees, reluctance to change, and Maturity stage. The opportunities that could create value for Germany manufactory, the challenges and benefits of industry 4.0 such as increased competitiveness, increased flexibility, higher quality and efficiency, cost reduction are discussed [6]. Especially for German manufactory, Arnold et al. observed the reasons that drove German manufacturing companies to use digital transformation to facilitate their further development. The massive data were collected by survey and the demographics of respondents were uncovered by SPSS24. There are four key elements that would decide whether industry 4.0 employ or not, and they are relative advantage, top management support, competition, and environmental uncertainty from three perspectives (technology, organization, and environment) [7].

As for the impacts, challenges and opportunities of Industry 4.0, Kagermann investigated it employing the example of recommended policy action. Five key questions were solved, like economic opportunities (customized products and mass-produced products simultaneously) should be seized in Germany and the security and privacy level of data would be accepted by customers. Two crucial aspects of supporting digitalization that are increased platform-based cooperation and dual innovation strategies are uncovered clearly. Because of Industry 4.0, a vision of digitization that centers on the economy in the industry is constructed in Germany [8]. Later in 2018, Müller et al. researched the opportunities and challenges during industry 4.0 in the context of sustainability from different aspects and diverse companies as well. Partial least square structural equation modelling was employed for German manufacturing companies to test the model. The results reveal that strategic, operational, environmental, and social opportunities will trigger the development of industry 4.0 positively, but competitiveness and future viability will prevent the implementation of industry 4.0 [9].

In this context, Siemens started to digitalize from 2007. Cozmiuc and Petrisor researched the key points of Industry 4.0 by Siemens, relying on data analysis of consultancy company and strategy of Siemens, which put forwards the transformation of products, equipment and supply chain based on cyber-physical systems. The detailed and general pictures were investigated to construct the return on investment for Siemens's customers. The results of the research are that Siemens' proposal satisfies the key elements of Industry 4.0 with manufacturing equipment, service and so on [10]. Hubauer et al. present an intelligent knowledge hub built by Siemens in order to generate new knowledge that can be used for the whole business. Four critical steps should be applied to achieve the objective: extend the single database with particular cases; connect all the databases by integrating models; more strict integration for Siemens Data Space for these individual databases; form an active knowledge factory building that can be employed generally. There are also some different user groups such as Building Digital Twin and Risk Management [11]. In the perspective of the effect of digital transformation in Siemens, Cozmiuc et al. analyzed the major impacts that cyber-physical systems technology in Industry 4.0 brings. Peer-to-peer negotiation improves the complexity and flexibility of the product. Lots of evidence about Siemens in their annual report, website and magazines are applied in this research. Industry 4.0 support Siemens to have the ability to stabilize in the volatile market, to produce their products with high quality and more attractive to customers. Germany manufacturing may be disrupted digitally by Industry 4.0 due to Siemens' digital transformation [12].

2 MODEL ANALYSIS

2.1 Fama-French Five Factor Model

Fama-French Five Factor Model is an asset pricing model which is an upgraded model of CAPM, introduced by Fama French to solve anomalies like the unsystematic risk that the CAPM model cannot analyze. Fama-French Five Factor Mode have five factors, $R_m - R_f$ (market risk premium), SMB (size), HML (value), RMW (profitability) and CMA (invest style). Here is the formula.

$$R_i - R_f = \beta_{mkt}(R_m - R_f) + \beta_{SMB}\text{SMB} + \beta_{HML}\text{HML} + \beta_{RMW}\text{RMW} + \beta_{CMA}\text{CMA} \tag{1}$$

R_f is risk-free rate. SMB is small minus big regarding the portfolio return based on size factor. HML is high minus low which means the difference between cheap and expensive stock. RMW is robust minus weak indicts the ability to earn profit. CMA is conservative minus aggressive pertaining to the attitude of investment.

2.2 Data Selection and Processing

The data of five factors are selected from Kenneth R's research [13], the duration is from Jan 1, 2007, when Siemens began to digitalize to Dec 31, 2020. The reason to use the model is to depict the integral tendency of the development for the software industry. Also, the data of R_i are chosen from the most relevant column to digital transformation, software, in Kenneth R's research.

2.3 Results Analysis

The data are collected to process by multiple regression method. The coefficients are obtained as shown in Table 1.

Table 1 Regression of Software Industry from 2007 to 2020

Factors	Coefficients	Standard deviation	t Stat
Intercept	0.043	0.008	5.563
β_{mkt}	0.867	0.007	131.334
β_{SMB}	0.615	0.013	47.234
β_{HML}	-0.225	0.011	-19.788
β_{RMW}	-0.412	0.021	-19.876
β_{CMA}	-0.367	0.026	-14.155

As shown in Table 1, the coefficient of β_{mkt} is 0.867 which is below 1, which indicates the industry is not sensible to the fluctuation of the whole market. These companies keep developing stably during the digital transformation, and will not fluctuate along with the market volatility. The coefficient of β_{SMB} is significant and over 0. It means the development of small enterprises is better than large enterprises during transformation. The general tendency for companies is growth with flourish. The coefficient of β_{HML} is a negative number means to return tends to growth stock instead of value stock. The result is consistent with the explanation of β_{SMB} that the growth of these companies is quick. The coefficient of β_{RMW} is less than 0 demonstrates the markets have an expectation, which believes that the poorly profitable companies will have a great value to invest when they develop arrived at a level. The coefficient of β_{CMA} is significant and negative, shown if a company has an aggressive risk appetite, it will have a better development in the market, such as Siemens. There are several actions like frequent mergers and acquisitions for Siemens during digital transformation. In addition, the coefficient of intercept is significant and positive, which indicates excess income. The considerable return in software industries manifests it has great investment value.

As a result of the model, digital transformation is a curial and necessary tendency for traditional manufacturing companies. Siemens is a typical example to analyze.

3 DIGITAL TRANSFORMATION STRATEGY ANALYSIS INDUSTRY CHAIN LAYOUT AND OUTPUT

As mentioned above, digitalization for manufacturing companies nowadays is a general tendency. But why businesses began to transform their process and product to digitalization? According to Siemens's annual report, the reasons are revealed. As digitalization was purposed in 2007, and "VISION 2020" was proposed in 2014, the data in 2006, 2013 and 2020 are most persuasive.

3.1 Reason Dissert

(1) Net profit margin.

Siemens started to digitalize from 2007, because the net profit margin rate kept decreasing for several years. Especially in 2006, it was only 3.47%. The reason for the decrease is that more and more companies entered the markets to compete with Siemens. As a result, Siemens dismantled and integrated the whole business and began to shift the focus from Manufacturing to Digital Factory. In 2013, although the revenue decreased, the net profit rose, which induced the reduction of cost of sales and the increase of profitability. It means digitalization is a right way to develop. Therefore, "VISION 2020" was put forward and implemented. All the indexes were revealed positively. Hence, a further plan called "VISION 2020+" were carried out in 2018. The net profit rate was 7.35% in 2020 which is over twice as much as that in 2006. The revenue and net profit decreased slightly due to the coronavirus pandemic (COVID-19) and subsequent recession, the deepest since the Second World War.

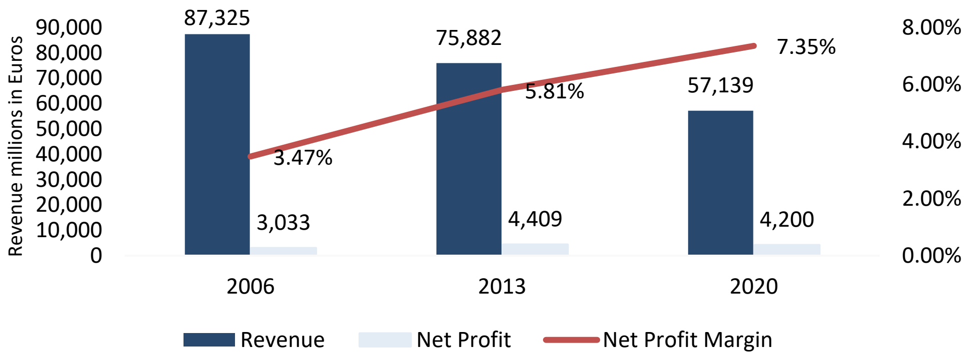

Figure 1. The Revenue, Net Profit and Net Profit Margin of Siemens in 2006, 2013 and 2020

(2) Digital factory creates the highest profit margin.

As shown in Figure 1, the profit margin for the whole company was just 3.47% though with the addition of the most profitable operation, Medical Solutions (Med), which profit rate was 12.90% in 2006. The profit rate of some traditional sectors such as Transportation System (TS) and Siemens Business Services (SBS) were extremely low. Even the profit margin of Siemens Business Services (SBS) was negative (-10.65%).

Accompanied with the business adjustment and reform in 2013, there were just four operations left, but all had a positive profit margin which depicts in Figure 3. The total profit rate increased significantly. Except for Infrastructure and Cities business, the profit margin of industry and Energy business rose distinctly. Among the industry, digital transformation played a vital role.

Later, Siemens built the Digital Factory in 2015. The whole company became more profitable. Digital transformation entered a state of accelerated development.

In 2020, the digital factory had been mature, and it could earn the most profit, its profit margin was 21.68% which even exceeded that of Siemens Healthineers business as shown in Figure 4. It became a significant role in the whole company.

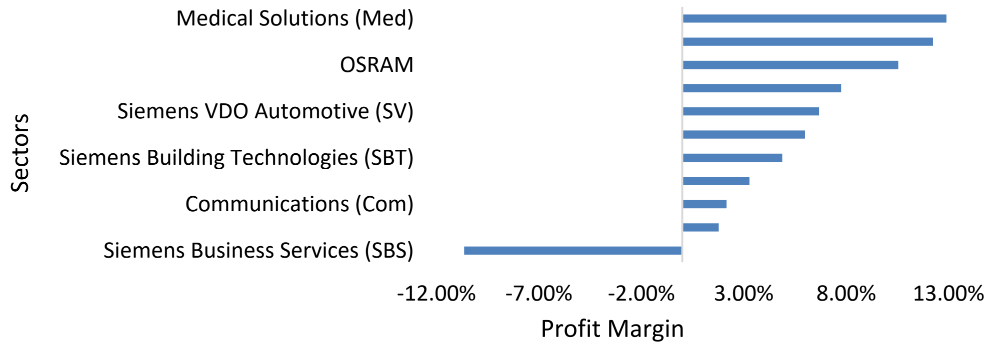

Figure 2. Profit Margin of Each Sector in 2006

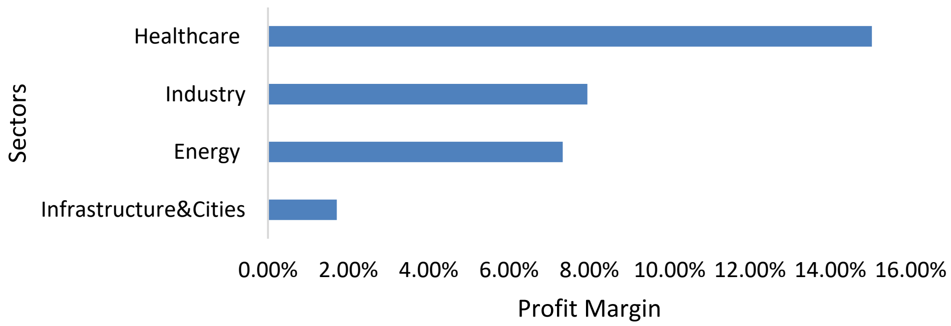

Figure 3. Profit Margin of Each Sector in 2013

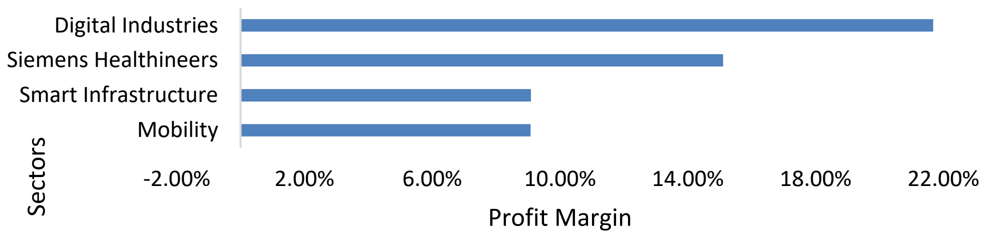

Figure 4. Profit Margin of Each Sector in 2020

3.2 The history of the operations changed during the digital transformation

(1) The change of sectors

Siemens was the world's leading industrial automation technology company in Industry 3.0, CNC system, home appliances and electronic information business were developed vigorously. As shown in Figure 5, there were 11 operations in 2006, including the traditional businesses, such as Siemens Business Services (SBS) and Transportation System (TS). Some prospective sectors, like Power Generation (PG) and Automation and Drivers, were also included in it. Notably, the most efforts were put into Information and Communications, which means managers were bullish on Information and Communications in 2006.

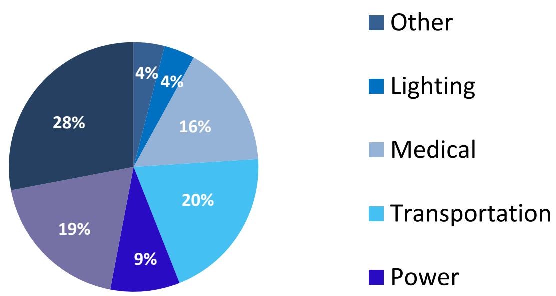

Figure 5. The R&D Investment in 2006

In 2013, 31% of expenses were contributed to the industry revealed in Figure 6. Some businesses were either deleted from 2006 to 2013, such as Lighting, or integrated, such as Automation and Control and Transportation to Industry.

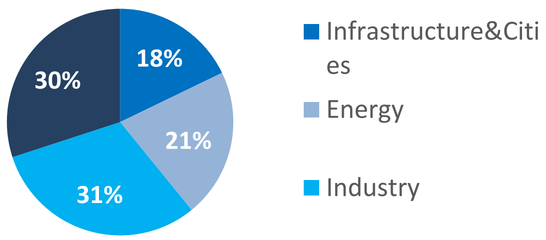

Figure 6. The R&D Investment in 2013

As for 2020, Smart Factory has developed for 12 years and has a significant influence on Siemens. Only four operations left, and some were updated. They were Mobility, Smart Infrastructure, Siemens Healthineers, Digital Industries. Compared with 2006, Siemens shifted its focus from Communications and Automation and Drives business to Smart Factory and Digital Industries gradually.

(2) The change of operations

Siemens decided to sell their mobile devices business to Taiwan's BenQ due to the difficult situation in this business and the low profitability on June 6, 2005, which the mobile devices business lost 2.5 million. Since then, Siemens began to reduce the proportion of Communication operation. As shown above in Figure 2, the profit margin of Communication Business was only 2.16%. Then Siemens sold Enterprise Communications Business to The Gores Group and sold Siemens Home and Office Communication Devices GmbH & Co. KG (SHC) to ARQUES Industries AG in 2008.

Siemens sold Siemens VDO Automotive AG to Continental AG and the planned acquisition of Dade Behring Inc. of Deerfi eld, Illinois (U.S.) in 2007. The purchase of this U.S. healthcare diagnostics company has brought Siemens a step closer to becoming the first integrated diagnostics company in the world. Siemens kept stripping off their operations to make a robust foundation to realize digitalization.

OSRAM is the second largest lighting manufacturer in the world, originally was owned by Siemens. Siemens separated OSRAM and officially listed it independently in 2013 due to its low profit. This action aimed to take focus on Digital Factory.

In 2014, Siemens proposed their strategies of "Vision 2020" officially, positioning to Electrification, Automation and Digitalization. In light of this, they disposed of many layers of the chain of command. Also, they decreased the Sector level and consolidated their business activities into nine operations. The two foundamental changes are to bring their businesses closer to customers and key markets, and increase the speed of decision making.

Table 2 The History of Distribution

Year	Businesses	Affiliation
2005	Mobile Devices Business	Taiwan's BenQ

2007	VDO Automotive AG	Continental AG
2008	Enterprise Communications	The Gores Group
2008	Home and Office Communication Devices	ARQUES Industries AG
2013	OSRAM	Officially Listed Independently
2013	Water Technologies Business	American European Associates Investors LP
2014	Household Appliances Business	BSH Bosch
2018	Process Industries and Drives Division	Publicly Listed Company Alstom
2018	Wind Power Business	Publicly Listed Company Gamesa
2020	Energy Business	Siemens Energy AG

3.3 The development of Digital Factory

Since Digital Factory was built in 2014. Siemens became the first company that bundle all requirements for the future factory under one roof in the world. The expected profit margin range in 2014 is 14%-20% which is the highest one over all other operations. Its major markets are automotive, aerospace, and machine tool and production equipment over the complete product lifecycle of customers, such as chemical industry, food and beverage, robot, and pharmacy.

Siemens set Smart Infrastructure Business in 2019, which integrated the Power and Gas, Building Technologies, and Siemens Gamesa Renewable Energy. Consider this, the data of Smart Infrastructure in 2016 and 2017 are the sum of these three distributions.

Figure 7 indicts that the profit of Digital Factory remains rising from 2016 to 2020 stably. Although with Covid-19 from 2019 to 2020, it had little influence on Digital Factory profit. However, Smart Infrastructure plunged severely from 3231 million to 1302 million with an adverse market environment for the short-cycle activities at the beginning of fiscal 2020 that rapidly became significantly worse due to COVID-19. Revenue for the solutions and services business and for the systems and software business remained close to the prior-year levels. The profit of Healthineers and Mobility did not have a great change, just fluctuant slightly.

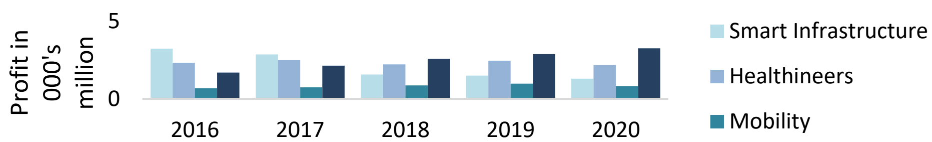

Figure 7. The Profit of Four Businesses from 2016 to 2020

The profit rate of Digital Factory kept rising despite a slight decrease in 2019 due mainly to the systems and software business including adverse effects related to grid control projects early in the year. In 2020 its profit rate was twice more than that of Mobility. As shown in Figure 8, the profit margin of Smart Infrastructure reduced but still higher than the other two sectors. The profit margin of Mobility and Healthineers did not change too much.

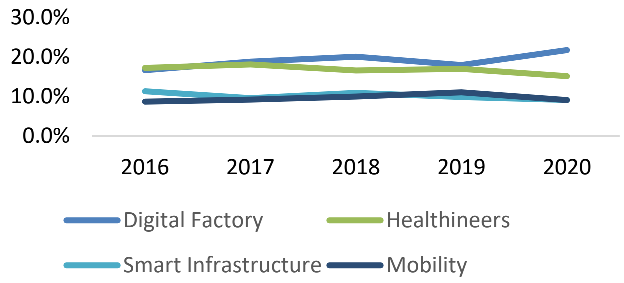

Figure 8. The Profit Margin of Four Businesses from 2016 to 2020

These robust data induce that digital industries are the drivers of industry 4.0 and delivery technologies for the efficient application of energy in the industry. Siemens still invest much in researching integrating technologies such as artificial intelligence (AI), edge computing and cloud technologies to explore more benefit from digitalization.

4 INDUSTRY CHAIN LAYOUT AND OUTPUT

4.1 The mergers and acquisitions of industrial software

As mentioned above, the transformation strategies for inside Siemens have been discussed, such as the adjustments of businesses and the building of Digital Factory. For external expansion, Siemens acquired much digital industrial software to achieve the consecutive improvements of digital transformation in recent twenty years. As the start of the Industry 4.0 strategy in 2001, Siemens purchased Italian company ORSI in February, Simatic IT pertaining to MES (Manufacturing Execution Systems) was launched which helped Siemens become the leader in the world market for industrial MES software.

Afterwards, Siemens purchased UGS Corp. of Plano, Texas (U.S.) in 2007, a vital year. In this acquisition, Siemens bridged the gap between virtual and real-world production in the world's first intelligent factory and further expanded its position as the world leader in automation systems. Siemens benefited greatly from cooperating digital PLM expertise from UGS into its automation technologies, such as higher efficiency and fewer manufacturing errors.

In 2008, the pace of digitalization accelerated. The Industry Automation sector acquired Innotec GmbH of Germany, as well as COMOS software solution which includes the whole lifecycle, like the design, halt, and dismantlement. It optimizes the engineering design process and reduces the running time.

Siemens acquired Camstar Systems, which provided enterprise manufacturing execution systems (MES) software in 2014. It became an essential role in Siemens' product lifecycle management (PLM). The extensive data analysis is a crucial capability for Camstar Systems. Towards this end, Siemens began to get involved in big data and cloud services.

Table 3 The Timeline of Acquisition

Year	Acquired company	Area
2008	Innotec GmbH	Software for safety engineering, Programmable Controllers (PLCs)
2009	Elan Software Systems	Manufacturing execution systems
2011	Vistagy	Engineering software and services focused on the specific requirements of vertical industries
2012	IBS AG	Quality control and production management software systems
2012	Kineo CAM	Automatic motion planning, path planning and pathfinding technology
2012	VRcontext International SA	3D visualization and training software for displaying complex engineering data
2013	Opcenter APS	Advanced Planning and Scheduling software solutions
2016	CD Adapco	A multinational computer software company that authored and distributed applications used for computer-aided engineering
2016	Polarion	End-to-end, enterprise-grade application developmen, ALM planning
2016	Material solutions	Use of selective laser melting (SLM) to manufacture of high-performance metal parts
2019	Mendix	Accelerate enterprise app delivery across entire application development lifecycle, from ideation to deployment and operations.

Siemens is progressively replacing traditional distribution such as Communication and Household Appliances by Digital production. Keeping merger and acquisitions with outstanding external companies is an effective way to speed up this transformation.

4.2 The development layout of the industrial chain

Until 2021, Siemens has involved a wide range of software, like MindSphere and Mentor Graphics. Figure 9 depicts all the elements which an advanced industrial internet company needs. Except for ERP that Siemens is planning to cooperate with SAP, all the other factors are satisfied by Siemens. As shown in Figure 9, the framework indicates Siemens has the absolute ability to build a complete standard in the manufactory, which outputs a comprehensive solution for the later companies who want transformation successfully.

It is evident that Siemens has a complete industrial chain from production to termination, which is more reliable from customers' perspective.

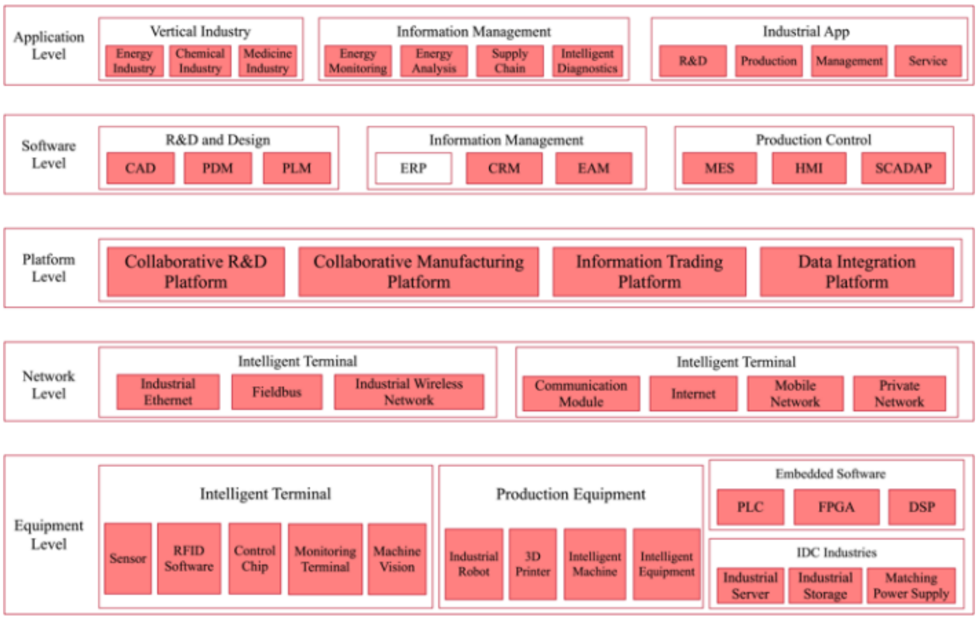

Figure 9. The Framework of Industrial Internet Industry Chain

As shown in Figure 10, Simatic, Sirius, NX, Teamcenter etc., drive the proceed of industrial chain pertaining to digital transformation. These software also prompt the rapid development of Siemens among numerous competitors.

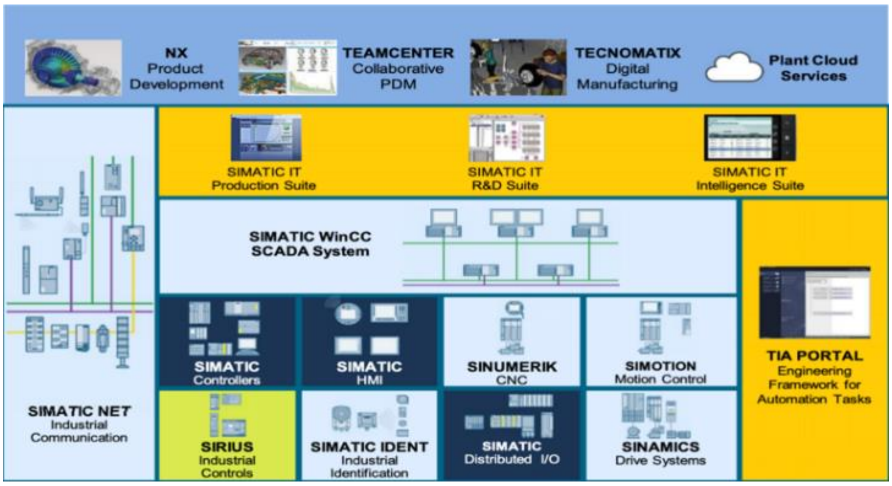

Figure 10. The Framework of Industry Chain for Siemens [14]

4.3 Two examples of the most advanced factories

Siemens built lots of smart factories, which offers a comprehensive product portfolio and system solutions for automation used in discrete and process industries; these offerings include automation systems and software for factories, numerical control systems, motors, drives and inverters and integrated automation systems for machine tools and production machines.

The most famous one is the electronics factory in Amberg, Germany, where the engineers simulate and optimize production processes including the control of entire factories and adapt them to current conditions when developing new products and while production is already underway. Almost every 1.26 employees could produce 1 product per second and the quality level is above 99.9989%. In the plant, more than 75% are automation devices, more than 1,000 software are SIMATIC applications. There are only 5,000 employees in Amberg, whereas 34,324 employees in 1907. The reason is that in 1907 Siemens produced products in assembly lines, so more employees were required to work in workshops as a population-intensive company. Along with digital transformation, human is replaced by smart machines gradually, and fewer supervisors and workers are needed in the factory. Limited jobs allow employees tend to be multi-skilled.

In this context, as Siemens had developed steadily and a solid foundation in Germany, it started to export its technique and software to other countries. Siemens built one digital factory in China in 2013 which is located in Chengdu. It is the second digital factory in the world. The Siemens Chengdu plant has more than fifty R&D personnel, so that it can meet the needs of local customers more quickly and achieve a seamless connection between R&D and production. In the Siemens Chengdu plant, the primary product data is in the PLM system. Once the component data is updated, the purchase price of the material and the raw material information in the manufacturing process will be updated through the MES system. There are changes in the production process corresponding to some raw materials, and they will also be automatically updated through seamless integration between the systems.

These are two typical plants in Siemens that demonstrate that how advanced the equipment, process and strategies are. Siemens experienced the process of digitalization which brought not only attractive high-tech products, but also a great profit for enterprises, and the intense competitiveness of the company as well. Siemens has attained a massive achievement in Industry 4.0. Especially for the complete industrial chain, Siemens cana output its system and standard. Since to date, Siemens has become a giant in manufacturing without a doubt.

5 FUTURE EXPECTATION

Assuming the impact of the COVID-19 pandemic will decrease in the future, Siemens expect the book-to-bill ratio will be over 1, and the comparable revenue will grow 11%-12%. The net income is 6.1-6.4 billion with the company’s anticipation. Compared with the previous year, either revenue or income both will rise. To be more specific, the revenue of Digital Industries is expected to increase 10%-12% compared to 9%-11% previously. The gain of Smart Infrastructure would rise 8%-9% which was 5%-7% before. The growth of EBITA of Digital Industries and Smart Infrastructure would be faster than that of revenue. Siemens had an excellent outcome in Industry 4.0 so far, no matter for the internal or external company. However, there are still some vital points which have a tremendous influence on the destiny of Siemens. For example, increasing the profit margin is one thing Siemens need to consider. Three aspects that need to improve will be analyzed here.

The first one is about the profit margin. Siemens is a profit-oriented enterprise, so profit rate is a core index. There are 293000 employees in Siemens in 2020 and attained 4200 million profit. The profit per employee for Siemens is 0.0143 million. Compared with SAP, which is a German multinational software corporation as well, SAP's profit per employee is 0.0704 million that is nearly five times more than that of Siemens. It reflects the low efficiency of employees in Siemens. The profit will rise if Siemens improve employees' efficiency and productivity and increase the appliance of smart devices.

The next one is the development of digital industries. Due to the launch of the SIMATIC IOT2050 gateway, Siemens further will expand its portfolio and partnerships for industrialized additive manufacturing, and automate and digitalize more facilities particularly in Germany, China and the Czech Republic. Smart Infrastructure is expanding its digital offerings in its existing businesses while integrating recent acquisitions in such critical areas as power control systems, power electronics and building Industrial Internet of Things (IIoT).

The last one is more ambitious about Industry 5.0 which was proposed by European Commission in 2020. The goal for manufacturing companies was put forward, which is to construct a sustainable, human-centric and resilient European industry [15]. As a result, Siemens should follow the objectives positively, transforming to a more environmentally friendly company, such as supporting technologies that make the use of natural resources more efficiently. Furthermore, Siemens will improve its resilience against disruptive external disaster, like Covid-19.

6 CONCLUSION

With the advent of industry 4.0, digital transformation has become a necessary topic for almost every manufactory company. Analyzing the transformation of Siemens has great significance due to its universality. As Fama-French five factor model shown, manufacturing has many opportunities to earn an excess profit, and have a bright future by digital transformation, especially for the aggressive investment style like Siemens. The study highlighted the results, process and future vision of Siemens regarding digital transformation. Profit, merger and acquisition including two smart factories, and three perspectives about profit rate, digital industries and Industry 5.0 need to be improved were analyzed. The profit margin increased since the digitalization transformation started, and Siemens had begun to spill or dispose of some unprofitable sectors like Communication, and acquire software companies to pave the way for the development of digital transformation since 2001. After years of preparation, these processes facilitated the success of transformation for Siemens. Until now, Siemens has a complete industrial chain to guarantee its leadership in manufacturing. Furthermore, two advanced template factories symbolize the success of this transformation, such as machine intensive instead of labor intensive. With the research, the strategies and history of development for Siemens were discussed. It is crucial for other traditional manufacturing companies who want the transformation to provide a standard to imitate and study, especially for those large manufacturing companies in the developing countries such as Baoshan Iron & Steel Co., Ltd. in China. They will understand the information of digital transformation clearly. Siemens will put more effort into sustainability and environmental protection of its products and equipment in the future to respond to the call of Industry 5.0. Improving profit margin by raising profit per employee and developing IIoT are also accessible goals to reach. The sustainability and resilience for Siemens, and the efficient way to develop IIoT were recommended to further research with the context of Industry 5.0, because these are the most critical aspects Siemens will focus on in the future.

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