<center>Chapter 5</center>

Manufacturing of Computer Servers

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5.1. Company Background

The company represented in this case study is a leading global manufacturer of servers based in Chinese Taipei. It has grown over the years into a conglomerate, and has been listed on the Chinese Taipei Stock Exchange and has worldwide operations. The firm has manufacturing plants, research and development (R&D) centers, logistics and distribution centers, and after-sales service centers on different continents. The company has built a competitive edge in server production. The case study will focus on the server global value chain of this company.

5.2. The Server Industry

Technically, a server is a computer or device on a network that manages network resources. It performs tasks on behalf of clients and facilitates the sharing of data, information, and hardware and software resources. In multiple operating systems, a server could refer to the program that is managing resources rather than the entire computer (Webopedia). Servers can be classified into different categories. Depending on the functionality, there are communication servers, database servers, media servers, web servers, application servers etc. Depending on their size and sophistication, there are rack servers, tower servers, miniature servers, blade servers, ultra-dense servers, super servers, etc.

From a configuration point of view, a server is quite similar to a computer, because both have components such as a bare board, a processor, memory, hard drives, network connections, power supply etc. Yet, a server is different from a desktop or laptop computer in three major ways:

- First, a server is designed to carry out heavy-duty back-end tasks, which support desktop or laptop applications. For example, a server can be dedicated to host databases, while a computer only runs the interface of the databases and retrieves data.
- Second, the most important component for both a server and a computer is the central processing unit (CPU), which has a small cache to store frequently used data. A desktop or laptop may have one or two sets of CPU, but the size of cache is quite limited; while a server has larger and more varied caches, which increases the processing power substantially.
- Third, a desktop or laptop often has only one hard drive, while a server has several hard drives configured into a single disk, called Redundant Array of Inexpensive Disks (RAIDs). In this case, failure of one hard drive does not mean the failure of a server, as other hard drives back up the system.

The server emerged on the global IT stage in 1981, when IBM made the LISTSERV, the first email server, to enable group email collaboration. From then on, web servers, rack-mountable servers, open search servers, and blade servers gradually established their presence with the advance in technology. More recently, cloud computing has become widely popular. Virtualization has led to more web-based applications and requires the establishment of mega data centers, which created enormous demand for cloud servers. (Iweb Technologies, 2012)

As businesses become more reliant on advanced connectivity, and new uses of digital technology emerge, demand grows for data processing capacity. Intensified internet traffic and the growing need for real-time analytics in turn drive the development of information technology (IT).

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The global server market has been expanding steadily since early 2000s thanks to increasing infrastructure investments (3rd platform infrastructure[2]) and the setup of hyper-scale datacenters, especially in the Asia and Pacific region. The server market is dominated by big brand vendors, such as IBM, HP, Dell, Oracle, Cisco, Lenovo, Fujitsu, etc. Data obtained from Statista on the market share of major server vendors from 2009 to 2014 indicated that IBM, HP and Dell accounted for an overwhelming portion of server market, although their combined share has been declining. IBM led the market at the very beginning, in the1980s. In the last two years, however, it has been overtaken by HP. In 2014, IBM experienced a sharp decline in market share, because it partially sold its server business to Lenovo. This also explained the quick catch up of Lenovo in 2014. In addition, the market share of original design manufacturing (ODM) direct[3] has been growing fast, reflecting intense competition in the market place.

Like in many manufacturing industries, in the server sector of the IT industry, vendors are not necessarily the manufacturers of the product; they are only the brand owners. Server manufacturing is outsourced to first tier suppliers, usually the contract manufacturers who supply several brand owners simultaneously. To understand what components make a server and how a server is manufactured, it is essential to examine the server global value chain.

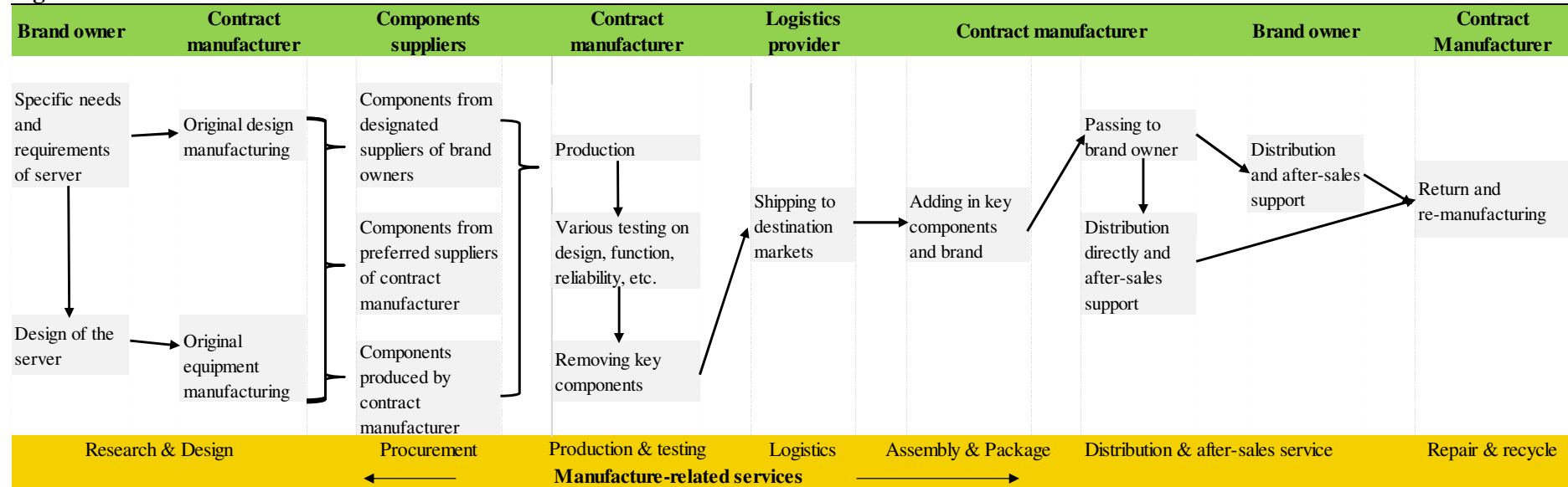## 5.3. Description of the Value Chain

Server global value chains are long and sophisticated, involving many participants. Two key participants are the brand owner (vendor) and the contract manufacturer. Brand owners pass the order to the contract manufacturers with requirements and specifications for the servers. Contract manufacturers usually manage the server global value chain, and their capacity determines the structure of the chain. Notably, many server contract manufacturers are based in Chinese Taipei – an economy that has developed a reputation for the competitiveness of its IT sector over the years (The Economist, 2013).

Figure 5.1 presents the server global value chain of the interviewed company. There are seven major stages of the chain, namely research and design, procurement, production and testing, logistics, assembly and package, distribution and after-sales service, and repair and recycling. These stages also reflect the major services involved. The path of physical components and products is depicted in the middle part of the Figure, which shows the complexity of server production. Key players are specified on the top segment of the Figure, where the coordinating role of contract manufacturer as the value chain manager clearly stands out.

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[2] The 3rd platform is a computing platform of technologies that emerged after 2010. According to IDC, the 3rd platform is built on mobile devices, cloud services, social technologies, and big data (IDC, 2013).
3 ODM direct refer to the sales of servers by the server manufacturer, not the brand owners.

Figure 5.1. A Server Global Value Chain

Brand owner	Contract manufacturer	Components suppliers	Contract manufacturer	Logistics provider	Contract manufacturer	Brand owner	Contract Manufacturer

Specific needs and requirements of server → Original design manufacturing

Design of the server → Original equipment manufacturing

Components from designated suppliers of brand owners

Components from preferred suppliers of contract manufacturer

Components produced by contract manufacturer

Production → Various testing on design, function, reliability, etc. → Removing key components

Shipping to destination markets → Adding in key components and brand

Passing to brand owner → Distribution directly and after-sales support

Distribution and after-sales support

Return and re-manufacturing

Research & Design	Procurement	Production & testing	Logistics	Assembly & Package	Distribution & after-sales service	Repair & recycle

Manufacture-related services

Note: Participants in a server global value chain are depicted in the upper range of the Figure. They are brand owner, contract manufacturer, component suppliers, and logistics providers. The middle range shows the value creation process along a server global value chain, from conception to return and re-manufacturing. The lower range shows the key services involved in a server global value chain at each stage, and manufacture-related services cover several stages.

Source: Author based on interview of Chinese Taipei-based server manufacturer

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Research and design

A server global value chain starts with the specific needs and requirements for a server on the part of the brand owner. The brand owner can either design the server in-house or work with the contractor manufacturer to design it. Depending on the level of engagement of contract manufacturers, there are two different ways that a server is designed:
- Original Equipment Manufacturing (OEM) refers to the brand owner designing the server and passing it to the contract manufacturer to build it.
- Original Design Manufacturing (ODM) refers to the brand owner asking the contract manufacturer to design and produce the server.

Once a server is designed, the contract manufacturer will carry out three important testing.
a. Engineering verification test, EVT. It assesses whether the design is free from any engineering bugs and all product functions conform to the needs of brand owner.
b. Design verification test, DVT. Once the product passed EVT tests, a pilot run will build several units with parts out of hard tooling. These units are subjected to various reliability and compatibility tests to ensure products can meet brand owner's requirements in compatibility and reliability.
c. Production process verification test, PVT. In PVT, higher volume are subjected to pilot run process is fined tune until yield rate meet customer requests.
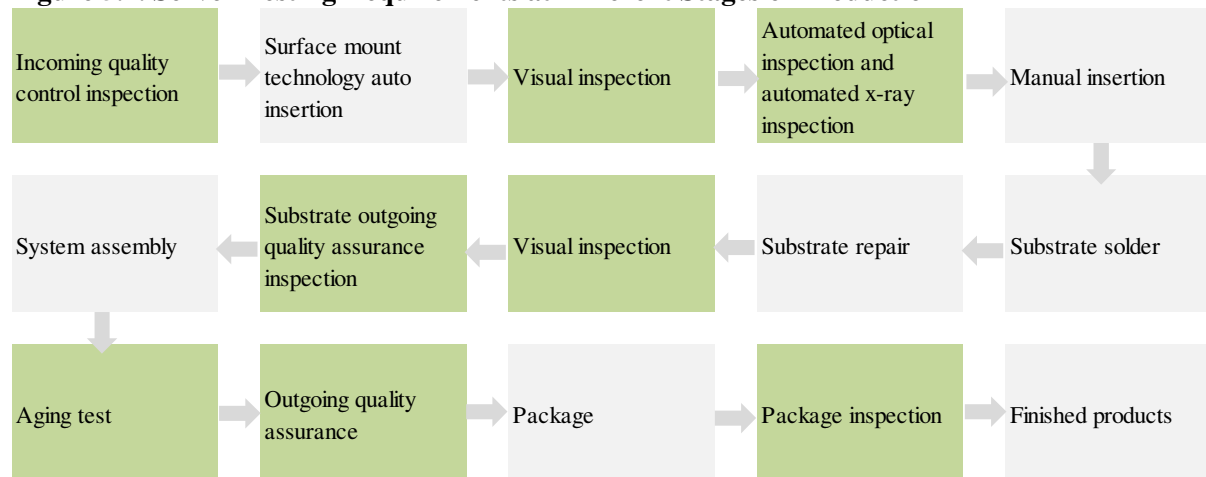
Procurement

The next stage of a server global value chain is procurement. The contract manufacturer will purchase components to mass build servers following the prototype. There are three sources of components:
- Certain components are sourced from designated suppliers of the brand owners.
- If brand owners do not have designated suppliers for certain components, the contract manufacturer can source components from its own preferred suppliers.
- Contract manufacturers could also produce certain components that meet the design requirements of a server.

In general, 70 percent of the server components are sourced from external suppliers, which account for a substantial part of the value generated in the chain. For server production, key components are controlled by Intel, Samsung, and Seagate. As an industry practice, if the purchasing volume is high, the contract manufacturer will purchase directly from components suppliers; however, if the purchasing volume is low, the contract manufacturer could turn to an agent, who will collect and combine the orders from many contract manufacturers and purchase in bulk.

Production and testing

After procurement, the contract manufacturer will conduct an incoming quality control inspection to ensure that the components meet the requirements of server design and functionality. Various testing procedures are required for quality assurance. Servers need to meet industry standards and/or the standards of brand owners, which are usually more stringent than industry standards. Figure 5.2 sketches the production process and the various testing procedures involved. From sourced components to finished products, there are eight testing and inspection steps to ensure quality and functionality.

Figure 5.2. Server Testing Requirements at Different Stages of Production

Incoming quality control inspection	→	Surface mount technology auto insertion	→	Visual inspection	→	Automated optical inspection and automated x-ray inspection	→	Manual insertion

System assembly	←	Substrate outgoing quality assurance inspection	←	Visual inspection	←	Substrate repair	←	Substrate solder

Aging test	→	Outgoing quality assurance	→	Package	→	Package inspection	→	Finished products

Note: Dark color highlights various testing in the production process.
Source: 2013 annual report of the interviewed server manufacturer

Towards the end of production, a final testing on overall functionality and the quality of the product is carried out. However, this testing is not done in the destination markets, it is performed in Chinese Taipei. Once the server has passed the final testing process, it is considered finished and ready for shipping to destination markets. But the contract manufacturer will not ship the finished products as a whole. It will remove the key components from the finished products, leaving only the barebones, which represents only around 30 percent of the value of a server.

The key components of a server are the CPU, the hard disk drive and the memory unit. All these components contain elements whose prices can fluctuate considerably. The price trend, however, tends to be in a downwards direction because of rapid technological change in this industry.

Logistics

The barebones are then shipped to destination markets, in this case the Americas, by logistics providers. Depending on the destination, shipping requires a significant amount of time, especially if the contract manufacturer is located in Asia and major markets are in North America or Europe, which would require over a month. To avoid the risk of losing too much value on the key components due to a drop in price, contract manufacturers choose to ship the barebones and then source the key components right before the barebones arrive.

Assembly and package

In the destination markets, the barebones and newly-purchased key components are assembled together. At this stage, the servers are ready to use. The next step is packaging, for example the United States, the contract manufacturer will put the brand of the brand owner or its own brand. After that, a server is finalized and readied for distribution.

Distribution and after-sales service

The brand owners sell the servers through their distribution channels and provide after-sales service directly. If the contract manufacturer has its own brand, it could also sell directly to customers, categorized as ODM direct. In this case, the contract manufacturer will be responsible for the after-sales service.

Repair and recycle

Once a server is put into use and runs toward the end of its life cycle, usually 5 years, it then will be returned and re-manufactured, which marks the end of this server global value chain. The repair and re-manufacturing can be done by the original contract manufacturer or companies that are specialized in repair and recycle.

5.4. Services along the Server Global Value Chain

A total of 54 main services categories have been identified in the server global value chain, which can be disaggregated into the 96 separate services recorded in Appendix A. Information is not available on the share of these services in overall value creation. Research and design are usually high value-added services. According to the company, the value of manufacture-related services is not as high as physical components[4]. This is due to the nature of the sector - key components and physical materials hold the predominant share of value in a server.

The 54 aggregated categories of services have been listed in Table 5.1 as horizontal services and value chain specific services. Under horizontal services, 25 items are included, covering management and operation-related services, which are required at all stages of the value chain. The value chain specific services, include 29 items, and can be categorized by stages in which services are prominently involved. In order to avoid duplication in Table 5.1, services that are required in the previous stage are not shown twice.

Table 5.1. Main Service Categories in a Server Global Value Chain

Horizontal services	Value chain specific services	
Company registration and licensing services	**Research & design**	Market research, customer needs assessment
Set up offices, computers		Conception of the product
Financial services (include IPO related services)		Design the product
	Procurement	Customs-related services (for import & export)
Service charges for listed companies		
Accounting, auditing and bookkeeping services		Procurement service
		Freight transportation services (raw materials)
Legal consulting		
Human resources		Storage of raw materials – general storage
Telecom services	**Production & testing**	Installation of production equipment
Information technology services		Utilities (electricity, water and gas)
Insurance service		Production administration/ management
Public relations services		Technical testing
Business hospitality		Manufacture
Social insurance for factory workers		Meeting international standards
		Maintenance and repair production equipment
Accommodation for workers and managers		

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[4] Though the value creation of services in the server global value chain is not high, it is understated. There are implicit services in production of the key components, as these require R&D, and specialized IT and engineering services, which are not counted separately in the server global value chain.

Canteen service			Sewage water treatment services
Training services (for workers)		**Logistics**	Product testing (for export market)
Security services			Freight transportation
Cleaning services			Freight insurance
Waste collection services		**Assembly & package**	Design of packages
Government inspections on work environment			Packaging services
Travel services		**Distribution & after-sales services**	Advertising
Visa and immigration services			Marketing (trade fairs and conventions)
Patent and trademark protection			Warehousing
Industry association membership			Retail trade services
Interaction with Trade Union			Market research/consulting services
			News and information service
			Maintenance and after sales services
		Repair & recycle	Recycling services
			Disposal services

Source: Author based on interview of Chinese Taipei-based server manufacturer.

Value added by Services

The 96 services categories are listed in the second column of Appendix A tables according to the Central Product Classification list (United Nations). The disaggregation underlines the sophistication of services in the chain, as well as the varied sources of value created by services.

The 25 horizontal services in Table 5.1 add up to 49 more detailed categories that appear in Appendix A. Financial services and insurance services involve a relatively large number of different services. Under financial services, eight different services included are investment banking services, mergers and acquisition services, corporate finance and venture capital services, deposit services, credit-granting services, financial consultancy services, foreign exchange services, and corporate tax consulting and preparation services. Included under insurance services are life insurance and pension services, accident and health insurance services, other property insurance services, and general liability insurance services. The company has to use various financial services, because it has operations worldwide and is listed on the stock exchange. Insurance services are required by law and regulations.

The 29 value chain specific services in Table 5.1 break out into 47 different services in Column 2 of Appendix A Table. In the 7 value chain stages listed in Table 5.1, the 8 broad categories in the production and testing stage contain a total of 15 distinct services. The next highest spread of different services is in the distribution and after-sales category, where the comparable numbers are 7 and twelve.

In-house Services and Outsourced Services

Among the 96 services listed in Column 2 of Appendix A, some are produced in-house and some are outsourced either to affiliates of the company or to a third party. In certain instances, one service can be supplied both internally and externally. Detailed listings on how services enter the value chain are provided in Appendix A. Table 5.2 indicates how services have entered the value chain.

Table 5.2. Number of Services by Source

Supplier of services	Horizontal services	Value chain specific services
Company only	5	0
Affiliates only	0	0
Third parties only	13	13

Company and affiliates	1	4
Company and third parties	13	4
Affiliates and third parties	0	0
Company, affiliates and third parties	17	26
Total number of services	**49**	**47**

Source: Author based on interview of Chinese Taipei-based server manufacturer.

As mentioned previously, 49 horizontal services are related to the company's management and operations. There are only five services sourced exclusively in-house, and 13 services are supplied exclusively by third parties. These are investment banking, corporate finance and venture capital, credit-granting, financial consultancy, internet access, insurance, waste collection, industry association membership services. The company and affiliates jointly provide one service, and the company and third parties jointly provide 13 services. Seventeen services are partly sourced in-house and partly outsourced to affiliates or third parties.

In-house services are essential services that lay the foundation for daily operations, such as financial services; accounting, auditing and bookkeeping, human resources, etc. When the firm sources services from its affiliates, it is mainly for resource sharing purposes so as to achieve economies of scale. Services are sourced from third parties for many reasons, such as to leverage the expertise lacking in-house, to conform to laws and regulations, to achieve economies of scale, to ensure access to the best services, and/or to build a stronger relationship with related stakeholders. In some cases, using services provided by third parties is simply due to a lack of feasibility to supply them in-house. There are also services provided by the government, for example company registration services, licensing, visas, environmental inspection etc.

As for value chain specific services, 47 services have been identified along the chain. Among these services, third parties exclusively provide 13 services, including freight transportation, water distribution, electricity and gas, technical testing for obtaining certificates for export markets, freight insurance, retail trade, recycling, and disposal services. The company jointly with its affiliates provide four services, and with third parties provide four services. Twenty-six services are simultaneously supplied by the company, affiliates and third parties.

The company controls the majority of value chain services because they involve proprietary technology or are necessary to ensure product quality. Outsourced services are considered mainly as non-core for the company's business and the company does not have the equipment, the expertise or the capacity to provide such services.

5.5. Policies Affecting the Value Chain

One objective of this case study is to analyze the impact of policies and public and private standards on the server global value chain, and based on that, to identify measures that government can adopt to facilitate growth and contribution of services sectors to manufacturing value chains. The firm was of the view that no significant policy-related barriers hindered the expansion of its value chain. The company has managed multinational operations for many years, and has gained valuable experiences and financial resources in adapting to different policy environments and regulations. This did not mean, however, that policies never added unnecessary costs across the value chain.

Trade policies

As the company needs to source components from overseas and ship barebones to destination markets, trade policies play a role at procurement and assembly and package stages of the value chain. Tariffs can be a potential hindrance to server import or export, but the tariff rates on IT products are already low. Many components, such as CPUs, enjoy a zero tariff rate in international trade. Therefore, the company does not view tariffs as a big barrier to its business.

Globally, trade in many IT products are governed by Information Technology Agreement (ITA) signed in 1997. Today, some of the goods covered by the original ITA are obsolete, such as word-processing machines, accounting machines, magnetic tapes, and so on. There are other products that are being phasing out, such as electronic calculators, analogue or hybrid computers, input or output units, etc. By contrast, many new products developed since the mid-1990s are not part of the agreement, such as digital video discs (DVDs), media player 4 (MP4), liquid-crystal displays (LCDs), etc. (APEC PSU, 2013). Signatories to the ITA are currently negotiating an expansion of the ITA to cover newly-emerged products. A modernized ITA could make a valuable contribution to growing the server market.

Public and private standards

In the IT industry, a company has to meet numerous standards to be a qualified supplier, manufacturer, or distributor. There are both public and private standards, though private standards are more dominant in this industry. Public standards, under rules and regulations, mainly concern public health, environment, consumer safety and safety at work place. The difficulty in complying with public standards lies in cross-border trade, when different economies have different public standards that companies are required to follow. Substantial resources are needed to ensure compliance with these public standards.

Private standards are more diverse, detailed, and specific, and mainly cover three areas:
1) Operation and product-specific standards: these are standards set up by industry associations, private companies who have an influential position in the industry, or the brand owners who have their own standards for a product. TL9000, for example, is an international standard on quality management systems to meet the supply chain quality requirements of the global information and communication technologies industry.
2) Brand specific standards: these standards are implicit rather than explicit, in the sense that the quality characteristics of the product are signaled by the branding. They reflect the market position of the component suppliers or the identity of the brand owner. For example, in the server sector, Intel and AMD are two leading manufacturers of CPU, and the barebones of a server have to be designed for a CPU from one of the two. During production, contract manufacturers need to meet specific standards of the brand owner, who uses these standards to differentiate its brands from others.
3) Private standards with a public nature: these are standards established by international alliances or entities to meet social objectives, such as a safe and healthy work environment, environmental sustainability etc. Examples are ISO 14001 Environment Management System, OHSAS18001 Occupational Health and Safety Management[5], Electronic Industry Code of Conduct, and Design for Environment.

The company devotes considerable resources to meeting these standards, such as using special equipment, assigning dedicated personnel, putting in place specific procedures, and so on. Often, the company has to pay third parties who established these standards to certify its products or operations. The incremental costs from all the certifications add up to a significant amount.

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5 OHSAS is a British Standard designed to work alongside UK health and safety legislation. It has been tweaked to confirm to ISO standards and hence it is a higher standard.

Labor supply and mobility

Although the company has not experienced any issue in accessing labor supply, retaining staff or labor mobility, it is an area where potential difficulties may arise. The company's main production sites are in China, where labor supply is in abundance. But recently, the wages of Chinese workers have been rising, which increases production costs. In the meantime, prices of servers are declining, squeezing the profit margin of server manufacturers.

The company runs R&D centers in Chinese Taipei. An emerging trend is for more and more well-trained researchers and engineers of Chinese Taipei-based companies to be headhunted by Chinese companies, who offer better compensation packages.

Due to its multinational nature, the company needs to send personnel to various plants to oversee or supervise operations. So far, the company has not faced any problem in sending staff to its affiliates in China, Europe or the United States. But the company is aware that if it expands operations in other locations in the future, labor mobility may arise as an issue.

Intellectual property protection

In general, as a multinational IT firm, the company has taken effective measures to protect its intellectual property. But as mentioned in the last section, it is a growing concern that researchers and engineers leave companies based in Chinese Taipei to join Chinese companies, because researchers and engineers carry the product and process knowledge with them and it is highly possible that the Chinese companies they join are competitors.

5.6. Conclusions and Policy Recommendations

This case study presents the background of server market and production, examines the server global value chain, identifies the services along the chain, and studies the policies affecting the development of the value chain. The server global value chain is complex and sophisticated. A contract manufacturer needs to have multinational capacity to organize and manage it. Various policies and standards shape the development of the chain, and impact the competitiveness of the server manufacturer.

Looking ahead, a successful expansion of the ITA would add momentum to the development of the global IT industry. Although tariffs on many IT products are quite low, there is still scope to reduce them further or to eliminate them in some markets. The IT industry is the backbone of modern economies, and it is critical to ensure open trade in IT products. An extended coverage of quality IT infrastructure is essential to develop a knowledge-based economy.

Public and private standards are necessary to ensure public wellbeing and product quality. But too many standards complicate production and operations, and incur significant costs for the company. Mutual recognition agreements can help reduce the burden on firms.

Labor shortage is a looming issue, and could be solved partially through smart manufacturing, which integrates information along value chains, optimizes manufacturing intelligence, operates industrial plants though innovation, and reduces production costs. Smart manufacturing improves operational efficiency and labor productivity, and helps to ease the constraint of labor shortage. Labor mobility is another area which can help the smooth functioning of businesses. Visa facilitation and more open labor markets are critical for the survival and growth many companies in the region.

Protection of intellectual property through stricter implementation is also another key area for public policy. Where researchers and engineers possess patented knowledge and join competitor companies, more stringent rules in the contract may be required on maintaining trade secrets. In such cases, governments could provide guidance on reasonable ways to protect trade secrets through the design of employment contracts in the private sector.

Last but not least, facilitating the development of services catering to global value chains involves multiple government agencies. Proper coordinating mechanisms to ensure corresponding measures are carried out across different agencies to promote value chain development should be put in place.

Abbreviations

AMD	Advanced Micro Devices Inc.
Cisco	Cisco Systems, Inc
CPC	United Nations Central Product Classification
CPU	Central processing unit
Dell	Dell Incorporated
DVT	Design verification test
Fujitsu	Fujitsu Ltd.
HP	Hewlett-Packard
IBM	International Business Machines Corporation
Intel	Intel Corp.
IoT	Internet of Things
IPO	Initial public offering
IT	Information technology
ITA	Information Technology Agreement
Lenovo	Lenovo Corp.
ODM	Original design manufacturing
OEM	Original equipment manufacturing
Oracle	Oracle Corporation
PVT	Product verification test
RAIDs	Redundant Array of Inexpensive Disks
R&D	Research and development
Samsung	Samsung Group
Seagate	Seagate Technology

Appendix A
Services in Server Global Value Chain

Services	Corresponding CPC Rev. 2 code	In-house	If outsourced		Bundled
			To affiliates; reasons	To third parties; reasons	
Value Chain Specific Services Stage1: research and design					
1. **Market research, customer needs assessment**	837 Market research and public opinion polling services	X	X: resource sharing	X: certain industry trend, new application, etc.	
2. **Conception of the product**	8112 Research and experimental development services in engineering and technology	X	X: resource sharing	X: leverage the expertise	
3. **Design the product**	8314 Information technology design and development services	X	X: resource sharing	X: leverage the expertise	
	8391 Speciality design services	X	X: resource sharing	X: leverage the expertise	
	8392 Design originals	X	X: resource sharing	X: leverage the expertise	
Stage 2: procurement					
4. **Customs-related services (for import)**	85999 Other support services n.e.c.	X	X: resource sharing	X: brokers for clearance, etc	
5. **Procurement service**	85999 Other support services n.e.c.	X	X	X: brokers/vendor	
6. **Freight transportation services (of raw materials) by road, rail, sea or air**	Division: 65 - Freight transport services			X: not feasible to supply in house	
7. **Storage of raw materials – general storage**	67290 - Other storage and warehousing services	X	X: resource sharing	X: transition	
Stage 3: production and testing					
8. **Installation of production equipment**	87320 Installation services of industrial, manufacturing and service industry machinery and equipment	X	X: resource sharing	X: certain type of equipment	
		X	X: resource sharing	X: certain type of equipment	

	87360Installation services of electrical machinery and apparatus n.e.c.				
9. **Utilities (electricity, water and gas)**	691 Electricity and gas distribution (on own account) 692 Water distribution (on own account) 863 Support services to electricity, gas, and water distribution	X	X: resource sharing	X:lack of expertise X:lack of expertise X:required by law and regulations	
10. **Production administration - Production management**	83115 Operations management consulting services 83116 Supply chain and other management consulting services 83117 Business process management services 83118 Head office services	X X X X	X: resource sharing X: resource sharing X: resource sharing X: resource sharing	X: for better management X: for better management	
11. **Technical testing (IQC inspection, visual inspection, AOI/AXI test, substrate OQA inspection, package inspection)**	8344 Technical testing and analysis services	X	X: resource sharing		
12. **Manufacture**	8874 Computer, electronic and optical product manufacturing services 8875 Electrical equipment manufacturing services	X X	X: resource sharing X: resource sharing	X: economic scale X: economic scale	
13. **Meeting international standards**	990 Services provided by extraterritorial organizations and bodies	X	X: resource sharing	X: strong relationship with the related stakeholder	
14. **Maintenance and repair of production equipment**	87156 Maintenance and repair services of commercial and industrial machinery	X	X: resource sharing	X:lack of expertise and for better service	

15. **Sewage water treatment services**	94110 - Sewerage and sewage treatment services	X		X: required by law and regulations	
Stage 4: logistics					
16. **Product testing (for obtaining certification at the export market)**	8344 Technical testing and analysis services			X: strong relationship with the related stakeholder	
17. **Freight transportation (domestic and cross-border)**	651 Land transport services of freight			X: not the core business	
	652 Water transport services of freight			X: not the core business	
	653 Air and space transport services of freight			X: not the core business	
	67910 Freight transport agency services and other freight transport services			X: not the core business	
18. **Freight insurance**	71333 Freight insurance services			X: not the core business	
Stage 5: assembly and package					
19. **Design of packages**	83919 - Other specialty design services	X		X: leverage the expertise	
20. **Packaging services**	85400 Packaging services	X	X: resource sharing	X: economic scale	
Stage 6: distribution and after-sales service					
21. **Advertising**	8361 Advertising services	X	X: resource sharing	X: leverage the expertise	
	83611 Full service advertising	X	X: resource sharing	X: leverage the expertise	
	83612 Direct marketing and direct mail services	X		X: overseas partner	
	83619 Other advertising services				
22. **Marketing (attending trade fairs and conventions)**	8596 Convention and trade show assistance and organization services	X	X: resource sharing	X: leverage the expertise	
	83114 Marketing management consulting services	X	X: resource sharing	X: leverage the expertise	
23. **Warehousing**	672 Storage and warehousing services	X	X: resource sharing	X: EU/US partner	

24. Retail trade services	624 other non-store retail trade services			X: better coverage	
25. Market research/consulting services	8370 Market research and public opinion polling services 8311 Management consulting and management services	X		X: leverage the expertise X: better service coverage	
26. News and information service (PRNewswire/ Thomson Reuters)	84410 News agency services to newspapers and periodicals	X	X: resource sharing	X: strong relationship with the related stakeholder	
27. Maintenance and after sales services	8713 Maintenance and repair services of computers and peripheral equipment	X	X: resource sharing	X: certain maintenances and service agreement	
	8715 Maintenance and repair services of other machinery and equipment (including electrical machinery and apparatus, telecommunication equipment and apparatus, commercial and industrial machinery, etc.)	X	X: resource sharing	X: certain maintenances	
Stage 7: repair and recycle					
28. Recycling services	894 Material recovery (recycling) services, on a fee or contract basis			X: required by laws and regulations	
29. Disposal services	943 Waste treatment and disposal services			X: required by laws and regulations	
Horizontal services					
30. Company registration and licensing services	91138 - Public administrative services related to general economic, commercial and labour affairs	X	X: resource sharing	X: government service	
31. Set up offices, computers	8733 Installation services of office and accounting machinery and computers	X	X: resource sharing	X: government service	

32. Financial services (including IPO related services)	7120 Investment banking services			X: leverage the expertise	
	71511 Mergers and acquisition services	X		X: leverage the expertise	
	71512 Corporate finance and venture capital services	X			
	7112 Deposit services			X: not the core business	
	7113 Credit-granting services	X		X: required by laws and regulations	
	71591 Financial consultancy services			X: leverage the expertise	
	71592 Foreign exchange services			X: required by laws and regulations	
	8231 Corporate tax consulting and preparation services	X			
33. Service charges for listed companies in the securities market	71552 Financial market regulatory services	X			
34. Accounting, auditing and bookkeeping services	8221 Financial auditing services	X	X: resource sharing	X: required by laws and regulations	
	8222 Accounting and bookkeeping services	X	X: resource sharing	X: required by laws and regulations	
35. Legal consulting, including legal compliance, dispute settlement and arbitration	8212 Legal advisory and representation services concerning other fields of law	X	X: resource sharing	X: required by laws and regulations	
	8213 Legal documentation and certification services	X	X: resource sharing	X: required by laws and regulations	
	82191 Arbitration and conciliation services	X	X: resource sharing	X: required by laws and regulations	
36. Human resources	8512 Labour supply services	X		X: better coverage	
	8511 Personnel search and referral services	X		X: better coverage	
	83113 Human resources management consulting services	X			
37. Telecom services	841 Telephony and other telecommunications services	X		X: better coverage	

	8422 Internet access services			X: better coverage	
38. Information technology services	83132 IT support services	X	X: resource sharing	X: better coverage	
	83151 Website hosting services	X		X: better service	
	8422 Internet access services			X: better service	
39. Insurance service (commercial life and accident/health insurance, property insurance for the factory compound, product quality insurance, management liability insurance)	7131 Life insurance and pension services			X: required by laws and regulations	
	7132 Accident and health insurance services			X: required by laws and regulations	
	71334 Other property insurance services			X: required by laws and regulations	
	71335 General liability insurance services			X: required by laws and regulations	
40. Public relations services	83121 Public relations services	X		X: leverage the expertise	
41. Business hospitality	63 Accommodation, food and beverage services	X		X: better coverage	
42. Social insurance for factory workers	91320 Administrative services related to government employee pension schemes; old-age disability or survivors' benefit schemes, other than for government employees	X		X: required by laws and regulations	
	91330 Administrative services related to unemployment compensation benefit schemes	X			
43. Accommodation for workers and managers	63220 Room or unit accommodation services for workers in workers hostels or camps	X	X: resource sharing		
	72111 Rental or leasing services involving own or leased residential property	X	X: resource sharing	X: required by law and regulations	
44. Canteen service	63393 - Other contract food services	X	X: resource sharing	X: economics scale	
45. Training services (for workers)	9291 Other education and training services	X	X: resource sharing	X: certain professional training	
46. Security services	8523 Security systems services	X		X: for better service	

	8525 Guard services	X		X: for better service	
47. Cleaning services	85330 General cleaning services	X	X: resource sharing	X: economic scale	
48. Waste collection services	942 Waste collection services			X: required by law and regulations	
49. Government inspections on fire prevention, health hazards, environmental protection and other aspects	91133 - Public administrative services related to mining and mineral resources, manufacturing and construction	X	X: resource sharing	X: required by law and regulations	
	91290 - Public administrative services related to other public order and safety affairs	X	X: resource sharing	X: required by law and regulations	
50. Travel services	642 Long-distance transport services of passengers	X		X: better coverage	
	641 Local transport and sightseeing transportation services of passengers	X	X: resource sharing	X: better coverage	
51. Visa and immigration services for foreign investors/employees (travel between headquarter and offices in different economies)	91290 - Public administrative services related to other public order and safety affairs	X	X: resource sharing	X: required by laws and regulations	
52. Patent and trademark protection	8396 Trademark and franchises	X	X: resource sharing	X: required by laws and regulations	
53. Industry association membership	9511 Services furnished by business and employers organizations			X: strong relationship	
	9512 Services furnished by professional organizations			X: strong relationship	
54. Interaction with Trade Union	9520 Services furnished by trade unions	X		X: strong relationship	

References

Majority information to draft this case study is collected from a face-to-face interview with the server manufacturer and the annual reports of the company. Besides that, the following sources are also referred to:

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