Chapter 2

Manufacturing of Aircraft Control Systems in the Philippines

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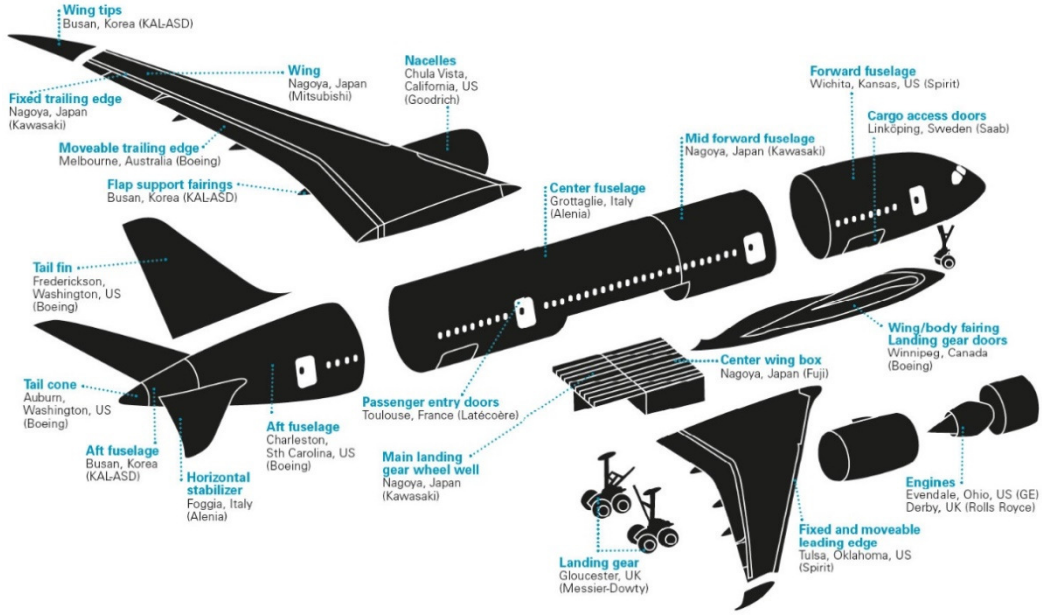
2.1. Industry Overview

The manufacturing process of an airplane is a complex undertaking involving myriad global partners. It is a real example of a global value chain (GVC) in action. The Boeing B787 illustrated in Figure 2.1 below shows how many different parts and components originating from different economies make up the aircraft. For instance, the wings are manufactured in Japan, the movable trailing edges are produced in Australia, while the passenger entry doors are from France, and so forth. These tier 1 suppliers, in turn, have their own global value chains to be able to produce the wings or the door or the landing gear. It is no surprise, therefore, that Boeing has relationships with more than 5,000 supplier factories and sub-tier suppliers around the globe[2]. One such company, not depicted in Figure 2.1, is the case study firm - a supplier of components that are crucial for how planes fly.

Figure 2.1. Simplified supply chain of a Boeing B787



Source: Courtesy of Boeing

2.2. Background Information on the Firm[3]

The firm is a designer, manufacturer and integrator of high performance precision motion control products and systems. From an original application for aircraft, it has since expanded its products and applications to satellites and space vehicles, launch vehicles, missiles, industrial machinery, wind energy, marine applications, and medical equipment. Its business segments are grouped into five,

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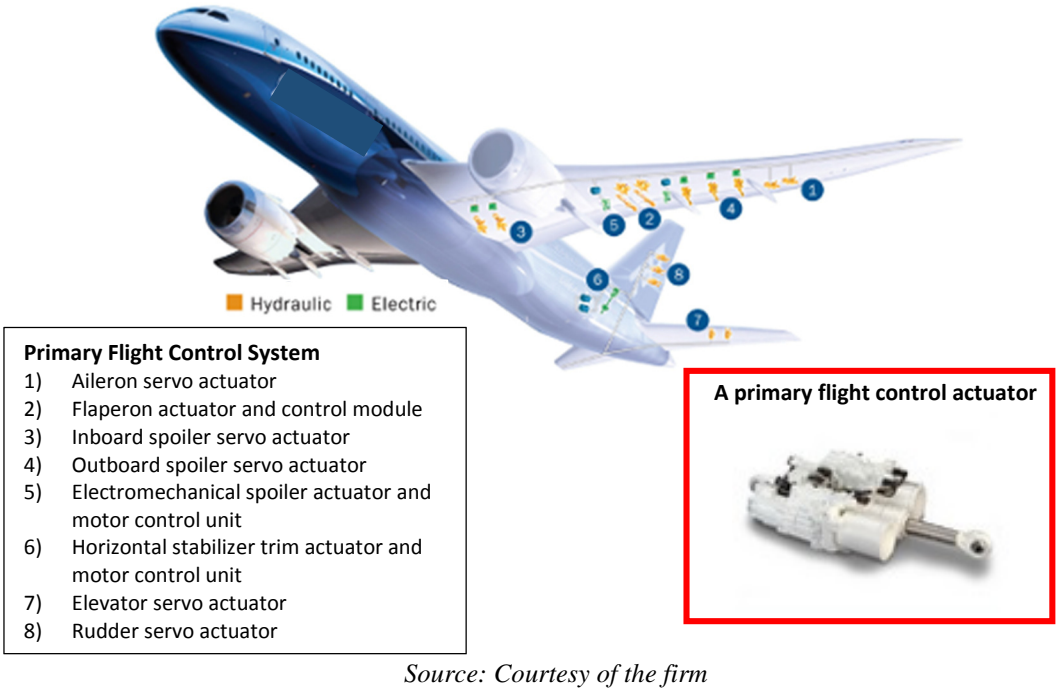
[2] http://www.boeingblogs.com/randy/archives/2013/02/supply_chain.html
[3] All information about the firm in this case study is from its corporate website as well as from the interview.

namely aircraft controls, space and defence controls, industrial controls, components, surveillance camera systems, and medical devices. The firm is headquartered in the United States and has international operations (wholly-owned foreign subsidiaries) that are predominantly located in Europe and Asia Pacific.

Among the products that the firm manufactures and for which the firm was founded are primary and secondary flight controls systems and components for commercial aircraft such as servo valves and servo actuators. This is what the Philippines operation does. A servo valve is a device which controls hydraulic pressure for fine control of actuators. A servo actuator is a mechanism to induce or control motion in mechanical systems. They are devices that transform an input signal (usually electrical) into motion. Today, these products have various applications but initially, they were supplied to the airplane manufacturers such as Gulfstream, Airbus and Boeing, which install them in various models such as Gulfstream G280, Airbus A350 and Boeing B787 (see Figure 2.2). From the perspective of these airplane manufacturers, the firm is a first-tier supplier.

The firm has expanded the range of products that it manufactures over the years. It started with the manufacture of servo valves which went into another company's servo actuators. It then moved to the manufacture of its own servo actuators, followed by a family of servo valves and servo actuators. Before long, it started supplying fully integrated flight control systems. The firm is involved in the development and production of flight control systems of almost all major airplane models and is typically part of the early stage team of any major airplane model development because servo valves, servo actuators and flight control systems are critical parts of airplanes.

Figure 2.2. The location of servo actuators in a Boeing B787



Source: Courtesy of the firm

In addition to selling manufactured products, the firm has a segment focusing on the provision of after-sales services. Its 5 customer support centres spread across the world have been certified by leading civil aviation authorities such as the US Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA) and the Civil Aviation Administration of China (CAAC) to provide services such as maintenance, repair and overhaul (MRO) services of servo valves and servo actuators as well as inspection, modification and testing of components for auto flight, flight controls, hydraulic power and landing gear systems. Sometimes the company group partners up with existing plane maintenance

and repair services providers for the servicing of their own servo valves and actuators. It is reckoned that its after-sales business could provide revenue for the firm for 20-30 years, providing a strong anchor for revenues in a highly cyclical aircraft manufacturing industry.

2.3. Description of the Value Chain

This case study will focus on the firm's Philippine subsidiary, which is the largest manufacturing site of the firm for aircraft controls. The product of focus for this study is a set of servo actuators for Boeing B787. For a single Boeing 787, it supplies over 200 separate Line Replaceable Units (LRUs) classified into two groups. Primary actuators are typically hydraulic or electrohydraulic actuators while secondary actuators usually include hi-lift and gear-type actuators. They come in various sizes and the largest one can weigh up to 200 pounds.

For the purpose of this case study, the value chain begins when the design is provided to the case study firm by its UK- or US-based design centres/subsidiaries within the company. The chain then moves on to the importation of raw materials from its suppliers up to the provision of after-sales services to the customer (see Figure 2.3).

Figure 2.3. Dimension of the value chain covered by the case study

Note: Optional activities in the value chain are indicated by green boxes. *Source: APEC Policy Support Unit based on firm interview*

Pre-manufacturing: design, materials sourcing, and logistics

The case study firm's job starts with the sourcing and importation of raw materials into the Philippines. However, before describing this part of the value chain in greater detail, it may be worthwhile to take a few steps back to better understand the complex processes that occur prior to this stage.

The actual starting point for any airplane model is when the airplane manufacturer provides the detailed specifications and asks its first-tier suppliers to produce parts and components to meet these specifications. Once chosen by the plane manufacturer, the company group's design centres are typically part of the early stages of the design and development process of the plane.

Everything from design, initial development and prototype production of parts and components for the Boeing B787 is carried out by one of the company group's 4 design centres. Before then, to even qualify to become suppliers, the process is highly involved requiring myriad certifications for the firm. Once the design is approved and finalized, it moves to large-scale manufacturing which is where the case study firm comes in.

Significantly, though not formally part of the design process, the case study firm contributes important inputs into the finalization of the design of servo valves or servo actuators. Because of its experience in actual manufacturing, the firm can have a say on the manufacturability of the designed product and provides such feedback to the design group. During the transition from the design centres to the large-scale manufacturing facility, engineers from both sites work closely together to ensure a smooth handover.

Moving on to the sourcing and importation of material inputs, the firm's local supply chain staff handle the operational and tactical aspects of procurement, such as issuing purchase orders, and maintaining and managing supplier relationships. The company group has its own supply chain management team that vets the qualification of its global suppliers. Once selected, this group[4] works with selected suppliers and regularly visits them to ensure that the quality of material inputs is always up to the standard, tracking them to their source to ensure compliance with international and domestic laws. The main reason for centralized supply chain management is direct and indirect cost savings made possible by resource sharing, but centralization also facilitates compliance with aviation standards for safety and security. The traceability requirement, for example, means that all parts or materials meet standards and that they should have been sourced from approved suppliers. At times, change in suppliers (and hence the source of material inputs) may, depending on its nature, have to be treated as modifications to the existing process, and therefore may require re-qualification and re-certification. Many changes, however, do not require re-qualification and re-certification.

The logistics of importation, including offloading and storage in the firm's stockroom, is mostly outsourced to third-party logistics providers. Once the materials reach the Philippines, these providers will facilitate the customs clearance process through their local agents. The raw materials are then trucked to the firm's facility where they are offloaded, inventoried, and sent for storage in the stockroom. The outsourced supplier of logistics may also be engaged within the factory, delivering materials from the stockroom to the fabrication, assembly and testing areas.

Manufacturing process

Products are manufactured in-house although certain non-proprietary steps such as basic machining may be outsourced to third-parties for cost reasons. These outsourced activities, however, are very few. Being at the low technological end of the spectrum when it comes to aircraft manufacture, they are an almost insignificant source of value. The outsourced suppliers will typically be part of the local metal

[4] Or sometimes also the local supply chain staff.

fabrication industry[5]. The firm prides itself on its engineering expertise, where each product and each part is built to stringent tolerances and precision, inspected and controlled for quality at every step of the manufacturing process.

The in-house staffs are organized around product line/business units, each with its own organization chart. Each unit's management team oversees the segment of manufacturing or manufacturing-related activity that has been assigned to it such as materials planning, fabrication, assembly and testing of specific servo actuators. Each unit also has staff that oversees shops, planning, engineering and quality matters.

Once the manufacturing process is completed, the products are inspected before being transferred to the logistics provider for post-manufacturing handling. Concurrently, the sales/marketing team is notified of the completion of the manufacturing process so they can inform the customers.

Post-manufacturing

In this case study, post-manufacturing refers to certification, packaging, handling and transport/logistics services to customers. This is mostly handled by the third party logistics provider which has an office on-site at the firm's manufacturing facilities. Its agreement with the logistics firm is for both internal and external logistics, which means that it includes the movement materials on-site. The logistics company designs or procures the packaging materials and readies all the products for loading onto the truck, and thereafter for transport to the destination. Because the case study firm's Philippine manufacturing facility has certifications from a wide range of international regulations and standards, it undertakes certifications in-house, making the products ready for shipment direct to the end-user.

Because of the highly regulated natured of its business, the firm's logistics provider also has to follow closely the firm's processes which have been certified by US Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA).

After-sales services

From the company group's perspective, after-sales services are among the core segments of its business. The firm can potentially extend the revenue stream from a single aircraft model by 20-30 years. The services offered include maintenance, repair and overhaul (MRO), as well as parts supply. The case study firm's servo actuators are 'built to last' but there may be a need for maintenance to fix damaged parts due to corrosion and use. The Mean Time Between Failures (MTBFs) of actuators range between 50,000 hours (for primary actuators) to millions of hours of flying time (for hi-lift actuators).

The customers for the firm's after-sales activities are airline companies, not the aircraft makers who are the clients for the firm's manufactured output. The service offered is therefore different and undertaken by a different business entity within the firm's structure. Certification by civil aviation authorities is a pre-requisite for providing after-sales services to airlines. In this market, response cycles are usually timed in days rather than months.

[5] These third-party firms are usually members of Metalworking Industries Association of the Philippines, Inc. (MIAP). The Metalworking Industries Association of the Philippines, Inc. is a trade association whose members comprise firms engaged in metalworking and related activities. Among its activities are the establishment of product standards with accredited technical/professional societies and appropriate government agencies as well as provision of training to industry staff in collaboration with government agencies such as the Technical Education and Skills Development Authority (TESDA). More information about MIAP can be obtained at: http://hdm.miapnational.com/

The way the firm provides after-sales services has changed over time in order to maintain competitiveness. While airline companies used to purchase spare parts upfront and store them in their own warehouses to ensure the supply of critical parts, many are beginning to choose a different arrangement. Airline companies are buying access to a pool of spare parts within a guaranteed period instead of buying them upfront, essentially outsourcing the stock management to the parts supplier.

2.4. Services along the Value Chain

Services identification and value contribution

A total of 53 services, which have been further disaggregated into at least 92 separate services (see Figure 2.4) are identified in this value chain and they are categorized according to the various stages within the chain: i) pre-manufacturing services, ii) services during manufacturing, iii) post-manufacturing services, iv) after-sales services, and v) back-office services.

Although information on which are the most important services inputs in terms of added value is not available, it may be inferred that engineering services are perhaps the most critical services input. With the exception of post-manufacturing, engineering services feature in all stages covered in this case study and in fact, play a very central role even when an airplane model is still in its conception stage. Indeed, the firm considers itself first and foremost an engineering entity. The large number of services that enter the manufacturing value chain of servo actuators conforms to a pattern of pervasive reliance on services observed across all productive sectors subject to value chain case studies in this project.

Figure 2.4. Breakdown of services by stage and examples of key services

Back-office:

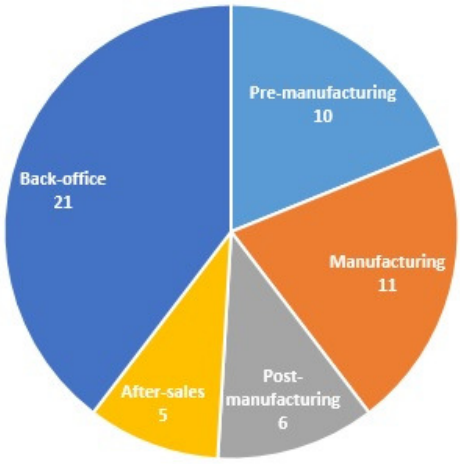
- Headquarter services
- Financial services
- Legal services

After-sales:

- Government after-sales certification services
- Maintenance, repair and overhaul (MRO) services

Post-manufacturing:

- Packaging services
- Transport/logistics services
- Certification services



Pre-manufacturing:

- Engineering services
- Design services
- Procurement services
- Transport/logistics services

Manufacturing:

- Engineering services
- Production management services
- Maintenance and repair of equipment
- QA/QC services

Source: Compiled by APEC Policy Support Unit

The importance of services can also be observed in the share of employees devoted to service activities. The case study firm employs approximately 1,500 people[6] on-site, of which 400 are contractual (i.e. non-permanent) workers. Of the 1,100 full-time employees, 750 are manufacturing-specific staff such as machinists, while the remaining 350 are involved in the provision of services such as management

[6] Globally, the firm employs around 10,000 employees.

and other support services, planning, supply chain services, facilities maintenance, security, etc. Service-related employees are therefore approximately one-third of the firm's full-time workforce. This segment of employees is likely to account for more than one-third of added value since it includes most of the company's executives. Moreover, some of the personnel categorized as manufacturing personnel are also supplying services such as testing, inspection, and other quality control services.

The share of services in the firm's value chain is expected to remain significant because the firm believes that in addition to price competitiveness, the principal determinants of success in the industry are factors such as product quality and reliability, design and engineering capabilities, product development, conformity to customer specifications, timeliness of delivery, effectiveness of the distribution organization, and the quality of after-sales support. Many of these are essentially services in character, or at least heavily reliant on services.

Outsourcing, bundling and other aspects of services supply

Of the 92 services identified in the value chain, 23 services are supplied in-house, 13 are partially outsourced while 56 are fully outsourced (see Appendix A)[7].

Services provided entirely in-house are generally those that can be considered core services activities such as engineering services, production management, technical testing services as well as maintenance, repair and overhaul (MRO) services[8]. These services are conducted in-house because they are necessary to ensure the quality and/or involve proprietary technology.

The firm outsources about 20-30 percent of its fabrication activities to global and regional suppliers as well as local firms. However, it is noted that the share captured by local firms is relatively low because of the certification hurdles. Besides, the main activity of the case study firm is 'precision machining' which requires skilled labor as well as very specific and specialized equipment. The local fabrication industry (includes many SMEs), does not possess the skills nor the resources to purchase the necessary technology that would open the way to participating in large segments of the firm's supply chain.

In addition, the firm makes use of outsourced bundled services. For example, the logistics provider not only supplies transportation services but also customs clearance and even loading and unloading of raw materials, as well as inventory services. In fact, as mentioned above, the agreement between the firm and the third-party provider also covers movement and handling of materials/products within firm's premises. In addition, the same logistics provider designs and procures custom-made packaging for the firm's products.

2.5. Policies Affecting the Value Chain

An essential part of this study is the analysis of how policies, both government and private, influence the value chain (see Appendix B). The firm identified a number of policy issues in the areas of trade

[7] Some of the reasons for firm to outsource services include: i) government services, such as certification for provision of after-sales services, visa and immigration services and inspections pertaining to environmental, health and safety (EHS); ii) required by laws and regulations, such as external auditing services by third party providers; iii) lack of expertise or specialization in-house to provide certain services, such as consulting services, medical services and legal services; iv) need access to the best services, such as waste collection and recycling services and training services; v) lack of feasibility to supply service in-house, such as freight insurance and utilities services; vi) economies of scale, such as transport/logistics services; vii) need for strong relationships with government agencies, such as customs clearance services; and viii) network economies, such as recruitment services.

[8] Although firm has also began to form partnership with third-party service providers in the aviation industry to provide MRO services.

and labour which will be further elaborated upon below. However, it must be noted that the firm generally faces few challenges. One probable reason is that the firm has the necessary preparedness and resources to address problems as they arise. As a large multinational firm that makes a significant contribution to output and employment in a high technology, high profile sector with high profile international customers, the firm has the ear of government when problems arise. The firm receives benefits from being located in a government-designated special economic zone. The firm is also recognised for its contribution to the local economy, including the provision of technical training of the local workforce.

Multiple certifications and need for mutual recognition

Provision of after-sales services is one of the businesses the firm wants to grow in Asia. Globally, aftermarket sales accounted for 16 percent of its total sales in 2014, and specifically for the aircraft controls segment, these activities represented about one-third of sales in the last three years (i.e. 2012-2014)[9]. In order to serve this market, the firm requires certification from the regulatory authorities of each individual economy before its repair station in the Philippines is allowed to provide after-sales services to the carriers or airlines established in a specific economy. For example, in order to provide services to carriers established in Singapore and Malaysia, the firm has to be certified by the Civil Aviation Authority of Singapore (CAAS) and the Department of Civil Aviation of Malaysia (DCA Malaysia) respectively. Complying with these requirements means that the firm has to be audited by approximately 6 to 7 different regulatory agencies annually.

These audits are necessary to ensure that the services provided are of the highest standards. Nevertheless, the certification process is a cost to the firm because time and effort are needed to ensure that every audit proceeds smoothly. In addition to the on-site visit which usually takes between 2 to 3 days, a typical audit also takes days or weeks to prepare. The challenge is to keep up with the high number of audits and to minimize the potential disruptions that such audits may cause in its operations.

One possibility is to reduce the frequency of each audit. The firm indicated that its repair station has to be re-certified at any time between one and five years, although the most common re-certification takes place every two years. If the regulatory authorities were able to issue certificates with a longer time validity, the cost to firm could be significantly reduced.

Another alternative is to reduce the number of regulatory authorities conducting the audit by mutually recognizing each other's certifications. This has in fact been practised in different economies. For example, the firm noted that DCA Malaysia and Civil Aviation Authority of Singapore (CAAS) do not need to audit the firm's repair station in the United States because: 1) the repair station has certifications from the Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA) and the Civil Aviation Administration of China (CAAC); and 2) Malaysia and Singapore each has a bilateral agreement with the US for recognition of these certifications. In the case of its repair station in the Philippines, the firm also has certifications from FAA, EASA and CAAC but there is no mutual recognition agreement between the Philippines, Malaysia and Singapore. This is certainly an issue that could be resolved considering that the repair station has been named one of the best in the world by the FAA and EASA. The issue in this case is not so much of capacity nor of standards, but more of perception and regulatory bureaucracy which can be minimized.

[9] The firm defines aftermarket sales for the aircraft controls segment as consisting of maintenance, repair, overhaul and parts supply to both military and commercial aircraft. Although this case study focuses on commercial aircraft, data specific to that operation are not publicly available.

Security-related export restrictions

On the manufacturing side, some of firm's imported equipment are highly advanced and can also be used for missile production - so-called dual-use equipment. Importation of such equipment into the Philippines is complicated by many security-related export restrictions in source economies, especially because the Philippines is not a signatory to the Missile Technology Control Regime (MTCR)[10].

The MTCR is an association of economies which seeks to coordinate national export licensing policies so as to prevent the proliferation of unmanned delivery systems capable of carrying weapons of mass destruction[11]. Its 38 partner economies, which exclude the Philippines, adhere to common export policy guidelines applied to controlled items listed in the MTCR Equipment, Software and Technology Annex. Export transactions are considered on a case by case basis. The list includes a broad range of military and dual-use equipment and technology relevant to missile development, production, and operation[12].

To address security concerns, the equipment manufacturer is required to install a mechanism in the equipment for it to automatically shut down if the company ever changes or increases measurements beyond a certain threshold. More recently though, the source economy has relaxed some export restrictions on condition that the firm informs them if the equipment is moved to another location or has its function changed. The equipment also has to be shipped back to the source economy if it is no longer needed for industrial production.

The same problem is faced by the firm in the importation of some materials. Export restrictions to the Philippines are in place in several source economies for materials such as steel beyond a certain threshold quality because they can be used to make missiles.

Related to the above issues is the need for firm to also trace the origin of raw materials to ensure that it does not source materials from economies that are under sanctions. However, once the system is in place, these policies are not considered burdensome by the firm because it benefits from the company group's supply chain management system.

Availability of skilled labour

Skilled and semi-skilled labour is very important for the firm because these employees are the backbone of the production process. Being close to the educational centre in the northern part of the Philippines, the firm does not encounter any significant problem with a potentially highly skilled supply of labour. However, the firm still needs to send its employees, many of them with a minimum 3 years of engineering education, for six months of vocational training at Technical Education and Skills Development Authority (TESDA) schools to become machinists. The firm's wage structure is competitive but from time to time some staff move to other firms in the Philippines or abroad. To minimize the disruption from employment attrition, the firm provides inputs in TESDA's vocational training program so that TESDA graduates, especially those that have been selected for paid internships with the firm, become a reserve pool of labour. Once hired at an entry-level position, it still takes 3-5 years of learning-by-doing to reach an expert level for machinists. The firm provides possibilities for promotion and career growth in order to keep good workers, especially because it takes years to build the necessary expertise in their workforce.

[10] Philippines is a signatory of the UN Treaty on the Non-Proliferation of Nuclear Weapons (http://disarmament.un.org/treaties/t/npt) and Comprehensive Test-Ban Treaty (http://ctbto.org/map/#status).
[11] More information about the Missile Technology Control Regime (MTCR) can be obtained at: http://www.mtcr.info/english/index.html.
[12] The MTCR Equipment, Software and Technology Annex can be accessed at: http://www.mtcr.info/english/annex.html.

Environmental, health and safety (EHS) and labour compliance inspections

A requirement for operating manufacturing facilities in many economies is certification and licensing by government agencies in areas such as environmental, health and safety (EHS) standards and also labour standards. In the Philippines, environmental issues are overseen by the Department of Environment and Natural Resources (DENR)[13], while labour issues (including the health and safety of workers) are overseen by the Department of Labor and Employment (DOLE)[14]. In addition to inspections conducted by these two departments, the firm is also inspected by its estate manager, the Philippine Economic Zone Authority (PEZA). The firm has no major issues with regard to these regulations because it follows the high environmental and labor standards of its parent company. Nevertheless, in the case of environmental policies, for example, it noted shortcomings in government regulation whereby companies observe strict environmental standards even as 'jeepneys'[15] ply the road belching pollution seemingly without sanction.

Electricity supply and cost

Constant electricity supply is indispensable for the firm's manufacturing operations but the firm has had 3 outages in the last 7 months and had to rely on its standby generator during the period. While the firm does not consider the cost of electricity a core issue, greater reliability and lower costs would be helpful. Electricity costs in the Philippines are among the highest in ASEAN.

Limited capacity of SMEs

Private standards are rarely an issue for established industries, especially for multinational companies which in fact participate in crafting industry standards. But for the aviation industry, regulations abound. For example, for some aerospace customers, firms in its value chain must adhere to the many standards and requirements set by the National Aerospace and Defense Contractors Accreditation Program (Nadcap) at different stages of the manufacturing process. Nadcap is a private-led approach to establish requirements for accreditation, accredit suppliers and define operational program requirements. It provides independent audits for various activities which it has grouped into 17 categories, among which is conventional machining and welding[16].

Except for the time and resources spent on preparing for and attending to regular and multiple standards- or accreditation-related audits, the firm does not encounter any significant issues in meeting the requirements of the certification programs. However, this is not the case for its suppliers, in particular small and medium enterprises (SMEs), which also need to be certified if they want to be part of the firm's manufacturing value chain. The scope covered by each of the 17 categories of Nadcap standards is broad and requires the audited firm to demonstrate compliance with different category-specific checklists. Indeed, several of the firm's suppliers have found the process too complex and costly and have withdrawn, or not ventured to attempt to supply the value chain in the first place.

The firm's product requirements likewise sometimes call on suppliers to acquire special kinds of very costly equipment. Considering the relatively small market in the Philippines for products that need the same equipment, local metal fabricators cannot justify such big capital expenditures. In short, local companies have a hard time inserting themselves into this value chain because of the costs involved.

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[13] Details of laws and policies overseen by the Department of Environment and Natural Resources (DENR) can be obtained at: http://www.denr.gov.ph/laws-and-policies.html.
[14] More details about the Labor Codes of the Philippines overseen by the Department of Labor and Employment (DOLE) can be obtained at: http://www.dole.gov.ph/labor_codes.
[15] Typical public transportation vehicle in the Philippines.
[16] Complete list of auditable activities by Nadcap can be obtained at: http://p-r-i.org/nadcap/accreditation/.

The way forward

This case study has endeavoured to present an aviation component manufacturing firm's perspectives on the importance of services in its operations. Policies clearly impact the firm's access to and use of services, as well as its ability to provide them. Policymakers can therefore play a significant role in supporting businesses by providing the right enabling environment.

A case in point, which can serve as a model, is the firm's positive experience in its dealings with the government, including the economic zone management authorities. The firm has open communication channels with the relevant government agencies, including the Department of Trade and Industry (DTI), the Board of Investments (BOI), the Philippine Economic Zone Authority (PEZA) and the Technical Education and Skills Development Authority (TESDA), ensuring that issues brought to their attention are generally resolved. The problem-solving mechanisms in place to address the case study firm's concerns should be the norm for the productive sector as a whole, regardless of firm size.

However, there are also areas where the policy environment could be improved. Concerns over security issues, for example, lead to export restrictions for equipment and raw materials with dual functions. Though not completely insurmountable, restrictions nevertheless add to costs and cause delays in companies' operations. By being part of international agreements, host economies can facilitate the importation of security-related products and equipment needed for manufacturing.

Likewise, the noodle soup of certification requirements and regulatory bureaucracy sometimes results in deadweight losses for the firm and the economy, particularly if these are repeated several times for different accrediting institutions and for different economies. Mutual recognition of many of these accreditations could minimize such costs. Host government participation in international agreements, whether multilateral, bilateral, or among a few economies, lessen the need for numerous international audits and help improve the business environment, for both foreign and domestic companies.

If MNCs find some certification processes burdensome, the situation can only be worse for SMEs with far less resource capacity to meet the costs of repeated audits. More importantly, to be certified and participate in global value chains often requires that SMEs upgrade their capacity and purchase costly equipment or technologies. Lack of capital and access to finance remain major hurdles for their insertion in GVCs.

Appendix A

Table A.1. Pre-manufacturing stage including sourcing and importation of raw materials

Service		Corresponding CPC Ver. 2 Code	Supplied in-house	Outsourced to affiliated companies and reasons	Outsourced to third-party suppliers/ government and reasons	Bundled
1	Product research and development to facilitate transition of production from design centres to manufacturing facility	81129 – Research and experimental development services in other engineering and technology	Yes	No	No	n/a
		81400 – Research and development originals	Yes	No	No	n/a
2	Product design services during transition from design centres to manufacturing facility	83920 – Design originals	Yes	No	No	n/a
		83912 – Industrial design services	Yes	No	No	n/a
3	Engineering services during transition from design centres to manufacturing facility	83310 – Engineering advisory services	Yes	No	No	n/a
		8332 – Engineering services for specific projects	Yes	No	No	n/a
4	Procurement services	83116 – Supply chain and other management consulting services	Yes	No	No	n/a
5	Customs clearance services and logistics of raw materials	67110 – Container handling services	No	No	Yes, efficiency; strong relationship with government agencies; government services	Bundled as part of the logistics agreement
		85999 – Other support services n.e.c.	No	No	Yes, efficiency; strong relationship with government agencies; government services	Bundled as part of the logistics agreement
6	Technical testing of raw materials	83441 – Composition and purity testing and analysis services	Yes	No	No	n/a

7	Transport services of raw materials	651 – Land transport services of freight	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
		652 – Water transport services of freight	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
		6531 – Air transport services of freight	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
		67910 – Freight transport agency services and other freight transport services	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
8	Freight insurance of raw materials	71333 – Freight insurance services	No	No	Yes, not possible to supply in-house	n/a
9	Storage and warehousing services of raw materials	67220 –Bulk liquid or gas storage services	No	No	Yes, efficiency	Bundled as part of the logistics agreement
		67290 – Other storage and warehousing services	Yes	No	Yes, efficiency	Bundled as part of the logistics agreement
10	Training services for staffs	92919 – Other education and training services, n.e.c.	Yes, learning by doing	No	Yes, in collaboration with Technical Education and Skills Development Authority (TESDA)	n/a

Source: Authors' own understanding of firm's value chain

Table A.2. Manufacturing stage

Service		Corresponding CPC Ver. 2 Code	Supplied in-house	Outsourced to affiliated companies and reasons	Outsourced to third-party suppliers/ government and reasons	Bundled
11	Production administration – Production management	83115 – Operations management consulting services	Yes	No	No	n/a
12	Maintenance and repair of factory equipment	87156 – Maintenance and repair services of commercial and industrial machinery	Yes	No	Yes to equipment suppliers	n/a
13	Utilities (electricity, gas and water supply)	691 – Electricity and gas distribution (on own account)	No	No	Yes, not possible to supply in-house	n/a
		692 – Water distribution (on own account)	No	No	Yes, not possible to supply in-house	n/a
14	Manufacturing services provided in-house and by suppliers of activities such as basic machining	886 – Basic metal manufacturing services	Yes	No	Yes, cost consideration	n/a
		887 – Fabricated metal product, machinery and equipment manufacturing services	Yes	No	Yes, cost consideration	n/a
15	Engineering services during manufacturing	83310 – Engineering advisory services	Yes	No	No	n/a
		8332 – Engineering services for specific projects	Yes	No	No	n/a
16	Warehousing services for intermediate goods	67220 – Bulk liquid or gas storage services	No	No	Yes, efficiency	n/a
		67290 – Other storage and warehousing services	Yes	No	Yes, efficiency	n/a
17	Quality control and assurance as well as compliance with ISO	8344 – Technical testing and analysis services	Yes	No	No	n/a
18	Product testing to obtain certification at export market	8344 – Technical testing and analysis services	No	No	Yes, required by laws and regulations	n/a

19	Sewage water treatment services	94110 – Sewerage and sewage treatment services	No	No	Yes, efficiency; not possible to supply in-house	n/a
20	Specialized cleaning services for machines and equipment	85340 – Specialized cleaning services	Yes	No	No	n/a
21	Waste collection and recycling services	942 – Waste collection services	No	No	Yes, efficiency; not possible to supply in-house	n/a

Source: Authors' own understanding of firm's value chain

Table A.3. Post-manufacturing stage

Service		Corresponding CPC Ver. 2 Code	Supplied in-house	Outsourced to affiliated companies and reasons	Outsourced to third-party suppliers/ government and reasons	Bundled
22	Certification and commissioning services of equipment	8344 – Technical testing and analysis services	Yes	No	No	n/a
23	Packaging services	83919 – Other specialty design services	No	No	Yes, efficiency	Bundled as part of the logistics agreement
		85400 – Packaging services	No	No	Yes, efficiency	Bundled as part of the logistics agreement
24	Warehousing services for products	67220 – Bulk liquid or gas storage services	No	No	Yes, efficiency	Bundled as part of the logistics agreement
		67290 – Other storage and warehousing services	Yes	No	Yes, efficiency	Bundled as part of the logistics agreement
25	Customs clearance services and logistics of products	67110 – Container handling services	No	No	Yes, efficiency; strong relationship with government agencies; government services	Bundled as part of the logistics agreement
		85999 – Other support services n.e.c.	No	No	Yes, efficiency; strong relationship with government	Bundled as part of the logistics agreement

					agencies; government services	
26	Transport services of products	651 – Land transport services of freight	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
		652 – Water transport services of freight	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
		6531 – Air transport services of freight	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
		67910 – Freight transport agency services and other freight transport services	No	No	Yes, efficiency; economies of scale	Bundled as part of the logistics agreement
27	Freight insurance of products	71333 – Freight insurance services	No	No	Yes, not possible to supply in-house	Bundled as part of the logistics agreement

Source: Authors' own understanding of firm's value chain

Table A.4. After-sales services

Service		Corresponding CPC Ver. 2 Code	Supplied in-house	Outsourced to affiliated companies and reasons	Outsourced to third-party suppliers/ government and reasons	Bundled
28	Government certification and licensing to provide after-sales services	91134 – Public administrative services related to transport and communications	No	No	Yes, government services	n/a
29	Telephone-based technical support services	85931 – Telephone call centre services	Yes	No	Yes, efficiency	n/a
30	Warranty, maintenance, repair and overhaul services	8714 – Maintenance and repair of transport machinery and equipment	Yes	No	Yes, partnership with service providers for aviation industry	n/a
		Options contract for parts supply	Yes	No	No	n/a
31	Travel services for engineers and other staffs pertaining to after-sales services	8551 – Reservation services for transportation	No	No	Yes, efficiency	n/a
		85521 – Reservation services for accommodation	No	No	Yes, efficiency	n/a
32	Visa and immigration services for staffs	91290 – Public administrative services related to other public order and safety affairs	No	No	Yes, government services	n/a

Source: Authors' own understanding of firm's value chain

Table A.5. Business processes (Back-office support)

Service		Corresponding CPC Ver. 2 Code	Supplied in-house	Outsourced to affiliated companies and reasons	Outsourced to third-party suppliers and reasons	Bundled
33	Company registration and licensing services (obtaining permit to operate)	91138 – Public administrative services related to general economic, commercial and labour affairs	No	No	Yes, government services	n/a
34	Government licensing and inspections on fire prevention, health hazards, environmental protection and other aspects	91133 – Public administrative services related to mining and mineral resources, manufacturing and construction	No	No	Yes, government services	n/a
		91290 – Public administrative services related to other public order and safety affairs	No	No	Yes, government services	n/a
35	Headquarter services	83118 – Head office services	No	Yes, economies of scale	No	n/a
36	Management services	83111 – Strategic management consulting services	Yes	Yes, economies of scale	No	n/a
37	Accounting, auditing and bookkeeping services	82210 – Financial auditing services	No	No	Yes, required by laws and regulations	n/a
		8222 – Accounting and bookkeeping services	Yes	No	No	n/a
38	Financial services	71121 – Deposit services to corporate and institutional depositors	No	No	Yes, not possible to supply in-house	n/a
		71313 – Group pension services	No	No	Yes, not possible to supply in-house	n/a
39	Legal services	82120 – Legal advisory and representation services concerning other fields of law	No	No	Yes, lack of expertise	n/a
		82130 – Legal documentation and certification services	No	No	Yes, lack of expertise	n/a
40	Insurance services (commercial life and	7131 – Life insurance and pension services	No	No	Yes, not possible to supply in-house	n/a

	accident/health insurance, property insurance for the factory compound, product quality insurance, management liability insurance)	7132 – Accident and health insurance services	No	No	Yes, not possible to supply in-house	n/a
		71334 – Other property insurance services	No	No	Yes, not possible to supply in-house	n/a
		71335 – General liability insurance services	No	No	Yes, not possible to supply in-house	n/a
41	Human resources services	91320 – Administrative services related to government employee pension schemes; old-age disability or survivors' benefit schemes, other than for government employees	Yes	No	Yes, government services	n/a
		91330 – Administrative services related to unemployment compensation benefit schemes	Yes	No	Yes, government services	n/a
		8511 – Personnel search and referral services	Yes	No	No	n/a
		8512 – Labour supply services	No	No	Yes, network economies	n/a
		83113 – Human resources management consulting services	Yes	No	Yes, lack of expertise	n/a
42	Business and management consultancy services	8311 – Management consulting and management services	No	No	Yes, lack of expertise	n/a
43	Corporate communications and public relationship	83114 – Marketing management consulting services	No	No	Yes, economies of scale	n/a
		83121 – Public relations services	Yes	No	No	n/a
44	Courier, postal and local delivery services	681 – Postal and courier services	No	No	Yes, not possible to supply in-house	n/a
45	Information technology services	8313 – Information technology (IT) consulting and support services	Yes	No	No	n/a
		8314 – Information technology (IT) design and development services	Yes	No	No	n/a
		83151 – Website hosting services	No	No	Yes, lack of expertise	n/a

		8316 – IT infrastructure and network management services	Yes	No	No	n/a
46	Telecommunication services	841 – Telephony and other telecommunications services	No	No	Yes, not possible to supply in-house	n/a
		84210 – Internet backbone services	No	No	Yes, not possible to supply in-house	n/a
		8422 – Internet access services	No	No	Yes, not possible to supply in-house	n/a
47	Uniform design, alteration and laundry	83919 – Other specialty design services	No	No	Yes, efficiency	n/a
		97130 – Other textile cleaning services	No	No	Yes, efficiency	n/a
48	Transport services for staffs	641 – Local transport and sightseeing transportation services of passengers	No	No	Yes, efficiency; not possible to supply in-house	n/a
49	Property management services	72212 – Non-residential property management services on a fee or contract basis	No	No	Yes, efficiency; lack of expertise	n/a
50	Medical services	93121 – General medical services	No	No	Yes, lack of expertise	n/a
51	Catering services	63393 – Other contract food services	No	No	Yes, lack of expertise	n/a
52	Security services	85230 – Security systems services	Yes	No	Yes, lack of expertise	n/a
		85250 – Guard services	No	No	Yes, lack of expertise	n/a
53	Cleaning services	853 – Cleaning services	No	No	Yes, lack of expertise	n/a

Source: Authors' own understanding of firm's value chain

Appendix B

Policies affecting services in the value chain

Government and private policies/services	Authority(ies) in charge	Details	How the policy affects services in the value chain
Certification by regulatory agencies of individual economies for provision of after-sales services	Various jurisdictions	Different certification is needed to provide after-market services to carriers/airlines based in different jurisdictions and most need regular re-certification which ranges between 1 to 5 years.	The policy restricts the coverage and extent of after-sales services that the firm can provide to its customers.
Export restrictions for equipment and raw materials with dual function in source economy	Signatories of Missile Technology Control Regime (MTCR)	Export restrictions are applied by the 34 partner economies on controlled items listed in the MTCR Equipment, Software and Technology Annex. Partner economies consider each transfer on a case by case basis and may require additional steps to be taken by the importer before granting the transfer.	Where the policy is not streamlined to the extent possible, it may unnecessarily restrict the firm's access to critical equipment and raw materials for its operations. It may also need to explore alternative options to access these items, hence increasing costs to the firm.
Provision of labour training	Philippines Technical Education and Skills Development Authority (TESDA)	Firm collaborates with TESDA to select potential candidates and sends them to centres run by TESDA for 6-months vocational training.	Best practice examples of how collaboration helps to minimize labour issues faced by the firm such as insufficient experience of new hires and replacement of ex-staff.
Environmental, health and safety (EHS) and labour compliance inspections	Philippines Department of Environment and Natural Resources (DENR) Philippines Department of Labor	Regular inspections are carried out by the different authorities on areas affecting environment, health as well as safety of the workers.	Although the firm benefits from these inspections, it also incurs cost from having to prepare for the inspections. In addition, regulations are sometimes non-transparent and the firm is found not to have adhered to them although it intends to follow strictly all regulations.

	and Employment (DOLE) Philippines Economic Zone Authority (PEZA)		
Electricity supply and cost	Philippines Department of Energy (DOE)	Firm has had 3 run-outs in the last 7 months and had to rely on its standby generator during the period. Electricity cost is competitive but does not adjust in response to firm's needs.	Firm's manufacturing operations are affected by the run-outs and may have to adjust its delivery time if run-outs happen regularly.
Audits for different categories of manufacturing activities are required	National Aerospace and Defense Contractors Accreditation Program (Nadcap)	The highly-regulated nature of the aviation industry makes it necessary that the industry players and their suppliers be audited for various activities that they undertake during the manufacturing process.	The audit is a challenge for firm's suppliers, particularly SMEs, who may opt not to do business with the firm. This affects firm's outsourcing strategy and limit the pool of suppliers that firm has access to. Perhaps ways could be found of assisting SMEs to develop the necessary capacity.

Source: Authors' own understanding of firm's value chain

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