Servicification of Manufacturing in Global Value Chains: Upgrading of Local Suppliers of Embedded Services in the South African Market for Wind Turbines

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Abstract

While services are an essential element in the global production, trade and consumption of manufactured goods, limited research has been conducted on the role of services in studies of global value chains (GVCs). Recently, however, an emerging literature on the 'servicification' of manufacturing in GVCs has evolved, most of which involves aggregate-level analyses of countries and sectors based on trade statistics. Previous studies have thus failed to explore whether and how local firms in developing countries may capture value and upgrade through their insertion into GVCs as service suppliers. In this paper, we contribute to the literature by analysing the development of an industry supplying wind-turbine services in South Africa. We draw on in-depth fieldwork, including fifty-two interviews and five case studies of firms operating as suppliers of various types of 'embedded' services to wind-power projects constructed in South Africa. We show the significant economic value in terms of the employment thereby created and the upgrading pathways of five local service-suppliers in knowledge-intensive and high value-added service activities. Our findings point to the benefit of devoting attention to the role of services in relation to upgrading in GVCs.

Keywords: Global value chain; Upgrading; Services; South Africa; Wind power

1. Introduction

The literature on global value chains (GVC) provides a key analytical perspective for understanding the development and competitiveness of firms and industries in developing countries (Ponte, Gereffi, & Raj-Reichert, 2019). Of particular importance in the GVC literature has been the insertion of suppliers from the Global South into value chains as manufacturers and suppliers of intermediate goods and components to lead firms in the Global North (Gereffi, Humphrey, & Sturgeon, 2005). 'Learning-by-exporting' through their interaction with lead firms has been conceptualised as a main driver for local suppliers to upgrade to higher value-added activities in value chains (Humphrey & Schmitz, 2002). The GVC perspective has been widely adopted in development policy both nationally and in the large development organisations, such as the World Bank. This has resulted in the widespread

adoption of industrial policies aimed at stimulating the development of export-oriented manufacturing industries in developing countries (Gereffi, 2014).

In Africa, however, the development of local manufacturing industries has made only limited progress: manufacturing only accounts for 10 per cent of GDP in Sub-Saharan Africa and has been declining since 2000 (Black & McLennan, 2015; Sampath, 2016). Indeed, as evidenced in previous GVC research, export-led manufacturing in Asia is not playing a major role in the structural transformation of Africa's economies. One of the reasons for the limited amount of industrial manufacturing in Africa is the increasing automation of manufacturing processes and, more importantly, the growing importance of service sectors to GDP, including tourism, ICT business services and logistics. Recent research has pointed to the growing importance of these 'industries without smokestacks' as an alternative path for industrial development in Africa (Newman et al., 2017). Potentially, the development of service sectors could absorb African workers leaving agriculture and moving to cities, a role that industrial manufacturing has previously played in industrialisation (Atolia, Loungani, Marquis, & Papageorgiou, 2020). Cramer, Sender, and Oqubay (2020, p. 108) have also argued that 'manufacturing has become increasingly imbricated with other activities traditionally labelled as services' and argued that industrial policies must therefore attend to the services that are essential to manufacturing. It is uncertain, however, whether and how the development of service sectors can function as an alternative path to achieving economic growth in Africa. Indeed, some commentators have talked of a 'services illusion', questioning whether a services-led growth model in Africa is a viable avenue for development policy (Monga, 2020; UNECA, 2016).

While the role of services in the GVC literature is usually neglected, services contribute to GVCs in broader and deeper ways, for example, by providing critical support functions along the entire value chain (Fessehaie, 2017). The GVC literature has tended to treat services as a separate economic sector, as reflected in studies of the insertion of developing countries in 'global value chains in services' (e.g. Marín-Odio, 2014). Previous GVC research has focused on the trade in services and the outsourcing of specific service functions, such as back-office and data-processing services (e.g. Lanz & Maurer, 2015; Thangavelu, Wang, & Oum, 2018). Increasing analytical attention has been paid to the 'servicification' of manufacturing in GVCs, which involves the increasing use, production and selling of services in manufacturing sectors (Atolia et al., 2020; Lodefalk, 2017). The term 'servicification' covers a wide range of services used and supplied by manufacturing firms, including financial, transport and environmental services, as well as research and development (R&D) (Miroudot & Cadestin, 2017). Most of this research is based on cross-national and industry-level studies at an aggregate level of analysis and has typically been based on large databases and trade statistics. Accordingly, as argued by Lodefalk (2017), studies that make use of detailed micro-level data to explore this phenomenon at the firm level are currently lacking (see also Stare & Jaklič, 2020). We posit that a micro-level perspective of this sort is needed to further unpack whether and how service suppliers in developing countries may benefit from their insertion into GVCs.

In this paper, we contribute to the literature on the servicification of manufacturing in GVCs by analysing the development of a service sector in South Africa pertaining to the construction of wind-power projects under the so-called Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The REIPPPP involved a competitive tendering scheme for the public procurement of large-scale renewable energy, including wind power, which was implemented across four rounds of bidding held from 2011 to 2015 (Leigland & Eberhard, 2018). During this period, a total of 3,366 MW of wind-power was procured, involving a total investment of five billion USD. By March 2020, 22 independent power producers (IPPs) had

started commercial operation of 1,980 MW of wind capacity (IPP office, 2020). A few globally leading wind-turbine manufacturers were supplying turbines to wind-power projects commissioned under REIPPPP. Most of the service activities related to the installation, operation and maintenance of wind-turbine projects are knowledge-intensive and high value-added activities, such as advanced business services (e.g. legal consulting), engineering, construction, project management and logistics (Matsuo & Schmidt, 2019). At the same time, in contrast to wind-turbine component manufacturing, the barriers to entry for local firms in a range of service activities in the wind-turbine industry are relatively low (MacKinnon et al., 2019). Accordingly, insertion into the wind-turbine GVC as a service supplier offers a window of opportunity for local firms in developing countries to capture a share of the value added in this market. This empirical setting thus presents an interesting opportunity to study the possible value capture and upgrading of local firms in a rapidly growing market with a wide range of service activities of relevance to local firms (see also Rohe, 2020). To explore this issue further, in this paper we analyse the opportunities and challenges for upgrading in GVC-related services through a number of case studies of firms. The paper is guided by the following research question of: *whether and how local firms in developing countries may capture value and upgrade from their involvement in service activities in GVCs*?

The remainder of the paper is structured as follows. Section 2 describes its conceptual framework, Section 3 its research methodology. Section 4 provides a description of the development of the service-supplier industry in South Africa, while Section 5 presents the findings on the five case-study firms. In Section 6, the empirical results are discussed. Finally, the main conclusions of the paper are provided in Section 7.

2. Conceptual framework

2.1. Upgrading in global value chains

In this paper, we draw on the literature on global value chains (GVCs), which has long provided a key perspective for analysing how the competitiveness of developing-country firms and industries can be improved through their insertion into GVCs (Ponte et al., 2019). The GVC literature focuses on the role of the dominant actors within a given industry, the so-called 'lead firms', whose decisions and activities have repercussions throughout the entire value chain. Due to their central position in the value chain, lead firms are powerful actors that control flows of both information and resources, as well as the functional division of labour in the value chain (Dallas, Ponte, & Sturgeon, 2019). Lead firms set the terms of chain membership, such as compliance with standards, the related incorporation or exclusion of other actors and the re-allocation of value-adding activities (Nygaard & Bolwig, 2018).

The key concept of upgrading has been developed to describe how firms may gradually move to more rewarding functional positions in a value chain or to making products that have more value-added invested in them. A classical terminology suggested by Humphrey and Schmitz (2002) envisages upgrading as occurring by improving the quality of products (product upgrading), improving production efficiency (process upgrading), moving into high value-added activities such as R&D (functional upgrading) or applying previously acquired capabilities from one chain in a different sector (inter-sectoral upgrading). More recent research has broadened the scope of the upgrading concept to include the many possible ways in which local firms inserted into GVCs may 'reach a better deal' and improve the balance between rewards and risks (Gibbon, 2008). As pointed out by Ponte and Ewert (2009), the possible development pathways that local firms may follow in order to improve the competitiveness and

viability of their businesses do not necessarily proceed along a predefined upgrading trajectory (see also Hansen, Fold, & Hansen, 2016). Rather, a multitude of possible upgrading routes may be economically advantageous for local firms, including 'functional downgrading' into lower quality products targeted at volume sales (Gibbon, 2008). Moving upwards to higher value-added and more knowledge-intensive activities (with high entry barriers) may therefore be only one of the many possible trajectories of upgrading. As argued by Staritz and Whitfield (2019;389) '*Upgrading paths are complex and may involve important deepening and downgrading aspects as well as diversifying and moving up in the same or different value chains*'. In this paper, we adopt the broad definition of upgrading suggested by Ponte and Ewert (2009, p. 1637), which involves '*any trajectory or strategy that is likely to yield a positive impact on developing country firms*'. According to this understanding, upgrading is essentially a question of whether and how local firms are able to achieve a better deal by improving the rewards and reducing the risks associated with their insertion into a given value chain.

2.2. Services in global value chains

The emergence of GVCs as the predominant form of organising global production and trade in manufactured goods has been enabled fundamentally by developments in a number of essential support services, such as transport and means of communication. Technological advances and cost reductions in such critical service functions have made it possible for multinational companies, the 'engines' of economic globalisation, to relocate production activities to distant countries (Fessehaie, 2017). While services continue to be critical to the functioning of GVCs, the literature has only belatedly begun to focus on their importance to GVCs. To the extent that services have been included in GVC analyses, they have been subject to different interpretations. One interpretation understands services broadly as '*the glue that holds supply chains together and ensures that they function in a fluid manner*' (Low, 2013, p. 63). Here services are understood as 'enablers' of GVCs (Marín-Odio, 2014), i.e. as the vast range of services that go into the activities of producing and selling goods along the entire value chain, from the initial input suppliers to the final stage of consumption and disposal (see Figure 1 and Table 1).

Table 1. Examples of service activities along the entire value chain

R&D and Product Development	Marketing and Distribution	Professional Services	Infrastructural Services	After-market Services
-Offshored R&D centres -Laboratory experimentation -Basis science -Business process outsourcing (BPO)	-Marketing -Branding -Advertising -Distribution -Retail	-Legal -Accounting -Auditing -Bookkeeping -Engineering -HR -Environmental impact assessments	-Transport -Logistics -Financing -ICT -Construction services	-Repair -Operation -Maintenance -Technical testing -Troubleshooting -Monitoring

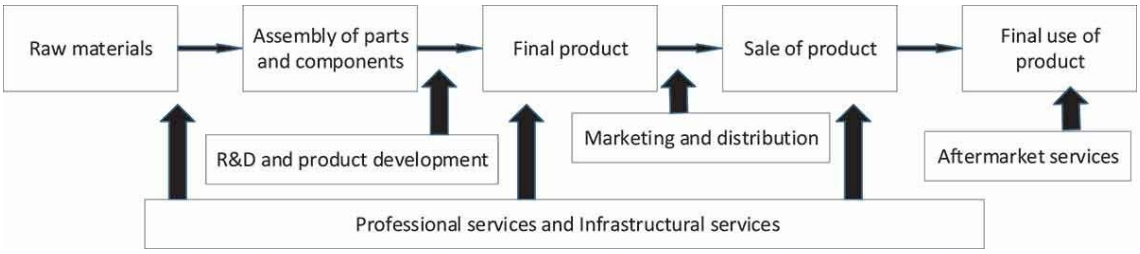

Figure 1. Services as enablers of the functioning of GVCs.

Source: Adapted from Fessehaie (2017).

Another perspective understands services as the inputs used in the production of goods at the upstream end of the value chain (Thangavelu et al., 2018). Service inputs can, for example, be measured as the cost share of input services in the total cost of producing a given product based on a detailed breakdown of inventories (Lodefalk, 2017). Such an understanding is referred to as services 'embodied' in manufactured goods and may involve a broad range of input services used by manufacturing companies, including energy, transport, communications, insurance, accountancy, design, software and other technical expertise (Drake-Brockman & Stephenson, 2012). An important element of this is related to the increasing share of employment within manufacturing firms themselves in service-support functions, such as R&D, design, logistics, marketing and sales (Miroudot & Cadestin, 2017). In the GVC literature, a focus on embodied services translates into a perspective involving research based on trade statistics examining the service content of exported goods, typically at an aggregate level of sectors or countries (Lanz & Maurer, 2015; Lodefalk, 2017). Others understand services as a sector in their own right and therefore focus on the global trade in specific services, such as back-office services, logistics centres, data-processing services (such as call centres), business process management and software programming (Heuser & Mattoo, 2017). GVC research on the trade in such services focuses on the outsourcing (or offshoring) of service functions from advanced countries to developing countries (Lanz & Maurer, 2015; Lema, 2014; Marín-Odio, 2014). A final interpretation of services focuses on the circumstance that manufacturing firms are increasingly selling services in packages as total solutions bundled up with the sale of products in order to increase value (Miroudot, 2019). This includes the sale of various kinds of services to customers, such as training, maintenance, operation, repairs and other after-sales services, alongside actual products.

In this paper, we draw on the framework provided by Miroudot and Cadestin (2017) conceptualising the notion of the 'servicification' of manufacturing in GVCs, which draws together the different interpretations of services in GVCs discussed above. As can be seen in Figure 2, the first dimension refers to the increasing use of service inputs in manufacturing, while the second dimension involves the shift to service activities within manufacturing firms. The third dimension, which is of particular interest to this paper, refers to the increasing selling of services by manufacturing firms (see also Lodefalk, 2017). In this paper, we focus on the service activities related to the downstream end of the value chain at the final destination of the manufactured products. Such services are referred to as 'embedded' services, which can be undertaken by lead firms as bundled goods and services or by local service-suppliers operating in the end-markets (Drake-Brockman & Stephenson, 2012; Lodefalk, 2017). Following Fessehaie (2017), we focus on two modalities of servicification related to the end-markets of

products: (i) embedded services provided by the local subsidiaries of lead firms (i.e. in-house), and (ii) embedded services outsourced by lead firms to local service-suppliers.

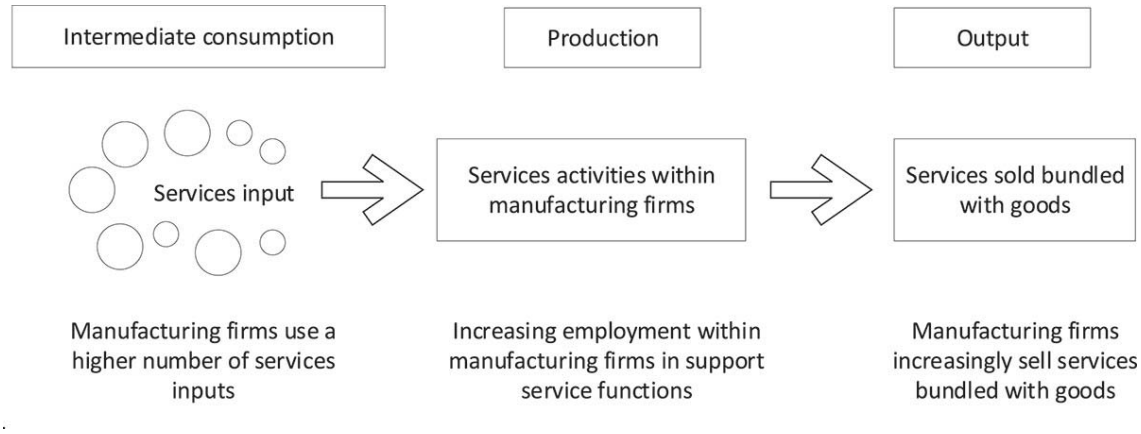

Figure 2. Three dimensions of the 'servicification' of manufacturing in GVCs.

Source: Adapted from Miroudot and Cadestin (2017).

In the next section, we will focus on the wind-power GVC and further operationalise the understanding of services along the value chain described in Table 1 with a specific focus on the embedded services described above.

2.3. The global wind-turbine value chain

Wind power is playing a major role in achieving the transition away from fossil fuel-based energy systems to renewable energy that is currently taking place on a global scale. The total installed capacity of wind power globally increased from 148 GW to 540 GW between 2009 and 2018 (IRENA, 2019). In Africa, wind-power capacity increased from 739 to 5,500 MW in the same period, mainly driven by South Africa and to a lesser extent Morocco and Egypt (IRENA, 2019). The market for wind power is among the fastest growing markets globally, with a total estimated value of USD 93 billion in 2019[1]. The global wind-turbine value chain resembles a so-called producer-driven chain (Gereffi, 2001) in which lead firms coordinate the production networks of component suppliers, and where competition is mainly based on technological progress through continued R&D. The industry continues to be dominated by a few large lead firms: in 2018, only five wind-turbine manufacturers (Vestas, Siemens, General Electric, Goldwind and Envision) accounted for 66 per cent of the global market for onshore wind (GlobalData, 2019).

Following Lema, Berger, Schmitz, and Song (2011), the wind turbine value chain can be seen as two-pronged, being divided into a manufacturing chain and a deployment chain (see Figure 3). The manufacturing chain involves the production and assembly of wind turbines by lead firms, including the sourcing of up to eight thousand components, such as gearboxes, bearings and blades, from a range of sub-suppliers globally.[2] The deployment chain involves all the activities related to the installation and operation of wind turbines, including services such as engineering, site assessments, planning, project management, site construction and maintenance.

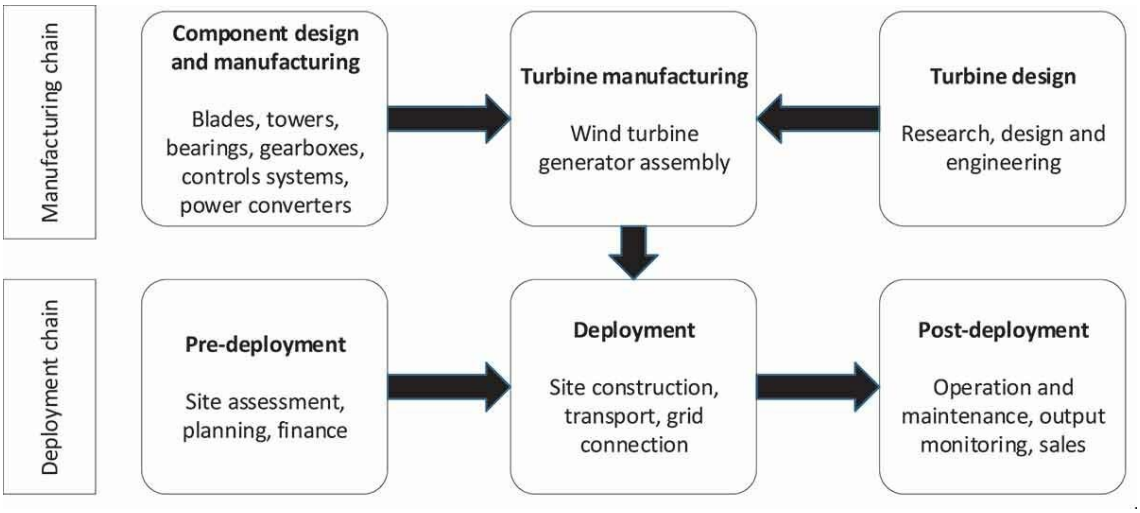

Figure 3. Manufacturing and deployment chains of wind turbines.

Source: Lema et al. (2011).

Most previous research on the upgrading of developing-country firms in the global wind-turbine industry is concerned with the manufacturing chain, for example, studies of the emergence of Chinese lead firms (see e.g. Binz, Gosens, Hansen, & Hansen, 2017). However, increasing attention has also been paid to the deployment chain – involving, for example, logistics, engineering and consulting (Matsuo & Schmidt, 2019; Rohe, 2020) – which has provided more nuances in understanding the services pertaining to the deployment chain. In this paper we build on these recent contributions to focus our attention on the involvement of local firms in service activities in South Africa. Figure 4 presents the paper's focus on the specific types of embedded services at the final stage of the project cycle.

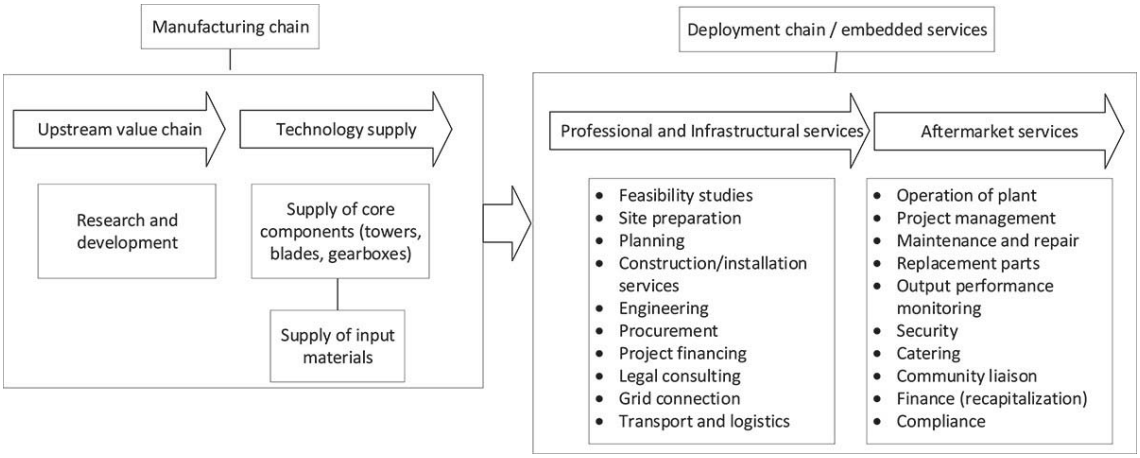

Figure 4. Embedded services provided to wind power deployment chain.

Source: Modified from Rohe (2020), Lema et al. (2018).

3. Research Methodology

3.1. Firm case studies

A case-study approach was considered the most suitable research design for this paper, as it involves exploratory research on a contemporary phenomenon that has not been previously explored in detail, one in which the context is difficult to separate from the study object (Yin, 2009). A major advantage of case-study research lies in its ability to produce findings with a high level of internal validity arising from a prolonged period of extensive empirical fieldwork involving different forms of triangulation (Adcock & Collier, 2001; Meijer, Verloop, & Beijaard, 2002). Furthermore, empirical findings from case-study research can contribute to theory development by generating new conceptual propositions of theoretical relevance through a process of analytical generalisation (Eisenhardt & Graebner, 2007). To this end, the paper relies on multiple case studies of firms, which were selected through several iterative rounds of data collection based on two main considerations. Firstly, we identified firms in the three specific types of embedded services in the wind-power deployment chain of interest to this paper (i.e. professional services, infrastructure services and after-market services) (see Figure 4). For this purpose, we used the list of members of the South African Wind Energy Association (SAWEA)[3] as a starting point, while additional firms within each category were identified during fieldwork. Secondly, we selected a number of firms as case studies from within each category based on their ability to generate illuminating aspects of theoretical relevance. Specifically, we purposely selected firms that had managed to compete and thrive in their respective market segments as a basis for studying their individual development and upgrading trajectories. This approach draws inspiration from a long line of studies in the GVC literature that focus on analysing successful firms in various sectors and the main factors enabling their growth (see e.g. Dantas, 2006; Dutrénit, 1998; Hobday, 1995; Kim, 1998; Kwak, Kim, & Kim, 2018). However, it should be emphasised that the exclusion of unsuccessful firms from our analysis restricts us in being able to determine decisively the key factors that have an impact on the growth of firms across the entire population of firms. The case-study firms are thus not representative in a statistical sense of the firms within the category, but may according to Flyvbjerg (2006) be considered 'critical cases' identified through intensity sampling (Miles & Huberman, 1994; Patton, 2001) based on their ability to generate detailed insights into the complexity, processes and mechanisms of upgrading in services in GVCs. As such, our paper provides a first, exploratory attempt to meet the call by Lodefalk (2017) for firm-level research aimed at capturing how and why upgrading in services in GVCs may occur. In Appendix A, we provide further information about the selection of the case study firms included in the paper. Due to confidentially concerns, the case-study firms have been anonymised.

3.2. Data collection

This paper draws on fieldwork conducted in the wind-power sector in South Africa during 2018 and 2019. The fieldwork consisted of a total of fifty-two semi-structured interviews conducted with representatives of a range of companies and stakeholders, including lead-firm turbine-suppliers, local service-providers, investors, project-developers, consultancy companies, government agencies, ministries and industry associations (see Appendix B for a complete list of interviewees).[4] The interviews with firm representatives were aimed at obtaining a comprehensive understanding of the development of specific firms involved as service providers in specific wind-power projects in South Africa. Interviews with other industry stakeholders focused on obtaining a broader understanding of the development of a domestic

wind-power service-supplier industry in this country. Two sets of interview guides were therefore prepared to accommodate these different research interests.

Using a similar research protocol, the researchers involved participated in different constellations during the interviews in order to ensure that a common direction was being pursued. As far as possible, the interviews were recorded digitally to allow for subsequent transcription and analysis. In all cases, the interviews were accompanied by notetaking by at least one of the researchers involved, which were subsequently written into a condensed format and shared among all researchers. As more information was gathered from the interviews, the interview guides were revised in order to formulate more targeted questions for specific interviewees and to fill in missing information. During the fieldwork period, bimonthly meetings were held in the research group to discuss the emerging findings. In order to triangulate the information obtained from individual representatives of firms, we sought to obtain insights from additional representatives within the firm and from representatives of other firms. As a further effort to enhance the reliability of the findings, we triangulated the information obtained from interviews with documentary sources, including firm brochures, websites and archival records gathered on company visits. We also collected relevant industry reports published on the subject. Ultimately, however, in this paper we only present findings that could be verified from at least two sources of data.

3.3. Data analysis

The collected data were combined and analysed with the objective of preparing a number of narrated 'firm biographies' (Miller, 2017) describing each firm's development trajectory. The analytical efforts were thus focused on preparing a coherent narrative of the individual firms following a chronological order and focusing on the main events and milestones in its development trajectory. To portray the possible upgrading of the firm, the emphasis was placed on depicting its changing competitiveness over time and the key events underlying such changes (Ponte & Ewert, 2009). Here, we used information obtained on firm growth in, for example, numbers of employees, market share, profits, regional coverage and numbers of projects or contracts. To describe the key events underlying changes in competitiveness, we focused on the main events occurring over time to explain whether and how the firm managed to improve its competitiveness (in terms of market share, for example). Key events may include a change of leadership or ownership, landmark deals and projects, changes to business strategies, marketing approach, business models, pursuit of new markets, investing in new employment (e.g. strategic recruitment), and learning and skills development.

4. Development of a wind-turbine services industry in South Africa

In the following, we provide a brief description of the development of the wind-turbine services industry in South Africa, which emerged from 2011 following the start of the REIPPP programme. REIPPPP involved a competitive bidding programme for large-scale renewable energy, including wind power. Typically, wind-power projects implemented under REIPPPP were owned by a project company in the form of a special purpose vehicle (SPV) in charge of all aspects related to project development and operation (Baker & Wlokas, 2015). These companies, which were owned by national or international development companies, including European utilities, submitted their bids in competition with other project developers. During bid preparation the SPV would typically contract an engineering, procurement and construction (EPC) company to be in charge of preparing the bid and subcontract a lead firm (OEM) as the supplier of the wind turbine (including its main components, such as the gearbox, blades and

towers). The EPC would also typically be in charge of project management and subcontract services such as transport, logistics and construction. Once the project was commissioned, a range of operational activities would be subcontracted by the SPV, including maintenance, performance management, security and compliance (see Figure 5).

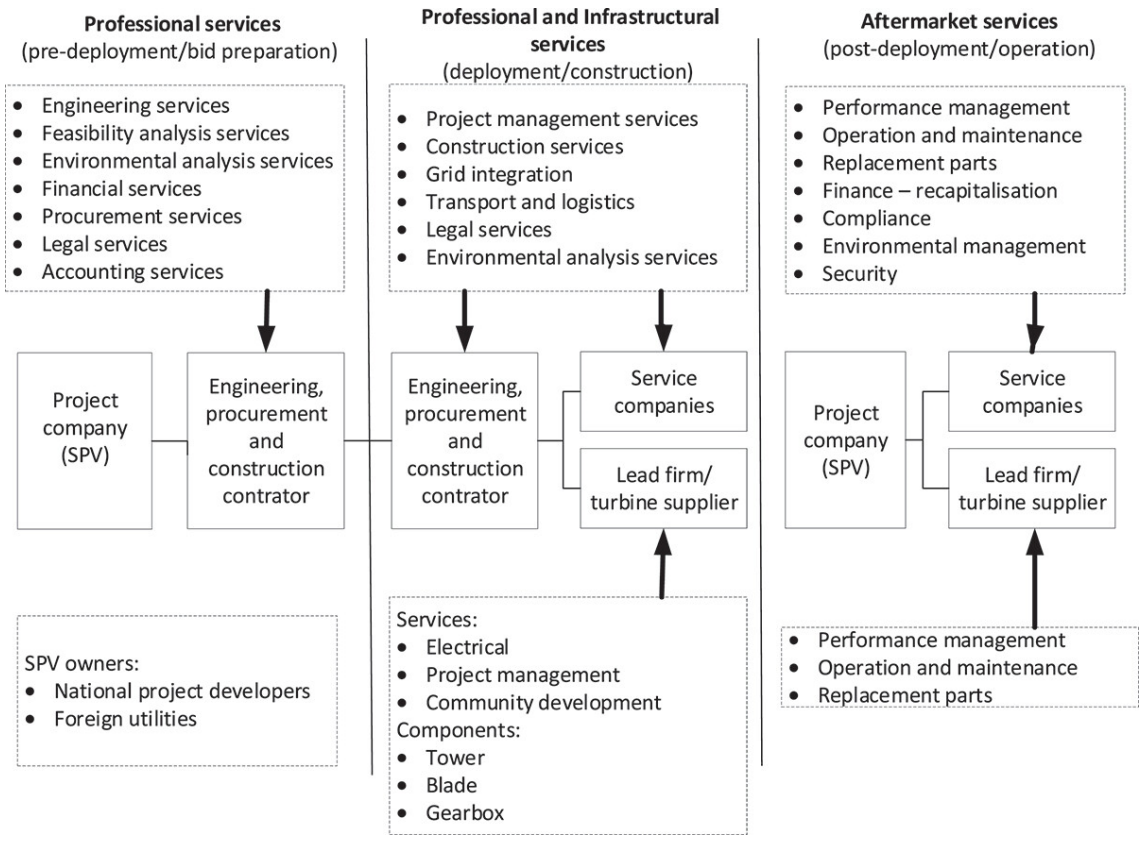

Figure 5. Typical roles and responsibilities in wind power projects under REIPPPP.

Source: Modified from Lema et al. (2018), Wlokas and Baker (2015), Matsuo and Schmidt (2019), Morris et al. (2020).

Prior to REIPPPP, only a limited number of small-scale wind-power projects had been constructed in South Africa, which meant that an industry for large-scale wind turbines simply did not existent in the country before 2011 (Larsen & Hansen, 2020). Over the course of the four bidding rounds of REIPPPP from 2011 to 2015, a total of 3,366 MW of wind-power was procured, and by 2020, the total installed capacity of wind power put into operation amounted to 1,980 MW. In parallel with the implementation of an increasing number of wind-power projects under REIPPPP, a market for related services started to emerge. The demand for such services opened up market opportunities for South African-based firms with relevant competences. Specifically, with reference to Figure 5, activities related to professional services, infrastructural services and aftermarket services provided key entry points for the insertion of South African companies into the value chain for wind-power projects in South Africa. The involvement of locally owned firms was also encouraged politically through a range of socio-economic development criteria included in the REIPPPP. Indeed, bidders in the REIPPPP were evaluated against the cost of electricity (70 per cent) and a number of economic development

(ED) criteria (30 per cent). As shown in Table 2, these ED criteria mainly focus on local job-creation through various sub-criteria. Direct local job-creation constitutes 25 per cent, local content requirement,[5] which also favours local job-creation, another 25 per cent. These two criteria therefore make up half of the total ED criteria. However, preferential procurement (10 per cent), local ownership (15 per cent), enterprise development (5 per cent) and even a criterion such as 'black people in top management' (5 per cent) also contribute to local job-creation. That is, up to 85 per cent of the ED criteria provide incentives for the creation of local jobs in the wind-turbine industry.

Table 2. Economic development criteria in the REIPPP programme

Element (weighting)	Description	Threshold	Target
Job creation (25 per cent)	RSA-based employees who are citizens	50 per cent	80 per cent
	RSA-based employees who are Black people	30 per cent	50 per cent
	Skilled employees who are Black people	18 per cent	30 per cent
	RSA-based employees who are citizens and from local communities	12 per cent	20 per cent
	RSA-based citizens employees per MW of contracted capacity	N/A	N/A
Local content (25 per cent)	Value of local content spending	40 per cent-45 per cent	65 per cent
Ownership (15 per cent)	Shareholding by Black people in the seller	12 per cent	30 per cent
	Shareholding by local communities in the seller	2.5 per cent	5 per cent
	Shareholding by Black people in the construction contractor	8 per cent	20 per cent
	Shareholding by Black people in the operations contractor	8 per cent	20 per cent
Management control (5 per cent)	Black people in top management	-	40 per cent
Preferential procurement (10 per cent)	BBEEE procurement	-	60 per cent
	QSE and SME procurement	-	10 per cent
	Woman-owned vendor procurement	-	5 per cent
Enterprise development (5 per cent)	Enterprise development contributions	-	0.6 per cent
	Adjusted enterprise development contributions	-	0.6 per cent
Socio-economic development (15 per cent)	Socio-economic development contributions	1 per cent	1.5 per cent
	Adjusted socio-economic development contributions	1 per cent	1.5 per cent

Source: Eberhard and Naude (2017).

It is evident that these criteria played an important role in stimulating the development of a wind-turbine service sector in South Africa, as is clearly discernible from the number of jobs created. Estimates of employment creation in renewable-energy projects implemented under the REIPPPP typically distinguish between construction jobs and operation jobs (Eberhard & Naude, 2017). Unfortunately, these categories do not correspond directly to the category of service jobs, which is of special interest to this paper. As illustrated above, there is a range of professional services and infrastructure services in the pre-deployment and deployment phases that the REIPPP programme characterises as construction jobs, while at the same time not all jobs categorised as operation jobs in the post-deployment phase are service jobs. Local job-creation stipulated on the basis of the bids in the four rounds are provided in Table 3, showing that 76 per cent of all jobs (measured in person years) are jobs during operations. Assuming that 20 per cent of construction jobs and 95 per cent of operation jobs are service jobs, then around 77 per cent of all jobs in REIPPPP are service jobs, underlining the importance of focusing on upgrading in service industries.

Table 3. Construction jobs and operation jobs (person years) stipulated in bids

	BW 1	BW 2	BW 3	BW 3.5	BW 4	Total
Local construction jobs	1810	1,787	2,612	NA	5,146	11,355
Local operations jobs	2,461	2,238	8,506		18,836	32,041

Source: Eberhard and Naude (2017). Note: 'BW' = bidding window.

5. Case studies of the upgrading of local companies in embedded services

In this section, we present the main findings on the five case-study firms selected and analysed for this paper. Following Fessehaie (2017), these case studies represent embedded services related to wind-power projects in three main areas: (i) professional services, (ii) infrastructural services and (iii) after-market services (see Table 4). The specific types of service activities within these three overarching categories, such as engineering, project management, specialised logistics and after-sales services, may, according to the concept of the GVC 'smiling curve', be considered high value-added activities (Mudambi, 2008; Stöllinger, 2021).

Table 4. The case-study companies studied in this paper

Professional services	Infrastructural services	Aftermarket services
-Alpha (engineering) -Beta (project management)	-Gamma (transport and logistics)	-Delta (O&M on balance of plant components) -Lead-firm subsidiaries (O&M on own turbines)

Source: Authors' own elaboration

The findings are presented in the form of five brief biographies of the individual firms depicting key elements of their development and upgrading pathways. When presenting the case-study results, we devote attention to addressing (i) *whether* upgrading has occurred (using indicators such as the number of employees, the skills levels of employees, the complexity and value added of the activities undertaken, market share and degree of internationalisation); and (ii) if so, *how* it occurred, focusing on enabling factors, such as previous experience, firm structure, strategy and economic incentives. This approach is aligned with the broadening of the scope of the concept of upgrading (see Section 2), which involves a broad range of possible pathways for local firms to improve their competitiveness and 'reach a better deal' (Ponte & Ewert, 2009; Staritz & Whitfield, 2019). Accordingly, our approach involves a multitude of indicators of relevance to the individual firms, which have been included based on the degree to which they were considered important by the interviewees. Finally, it should be mentioned that the use of direct quotes is intended to provide illustrative examples that exemplify the main insights obtained from the interviews.

5.1. Professional services

5.1.1. Case-study company*: Alpha*

Alpha is a global engineering company with a total staff worldwide of around seven thousand employees. The company is registered in South Africa and has owners in both South Africa and abroad. According to a representative of the company, it is currently the largest consultancy company in South Africa and the second largest in Sub-Saharan Africa, with around 25 per cent of work undertaken outside South Africa. Alpha specialises in engineering related to

infrastructure projects, including civil works, roads, ports and harbours, water, hydropower, energy and transport.

Renewable energy is a relatively new business area for Alpha. According to a representative of the company, the REIPPP programme was the direct reason for it becoming involved in engineering related to renewable-energy projects. The company has been involved in around 70 per cent of all the renewable-energy projects (mainly solar and wind) constructed in South Africa. In these projects, Alpha typically deals with all of the engineering activities along the project cycle, from the initial pre-feasibility studies, including wind-energy modelling and due diligence, via site preparation and balance of plant (BoP) system design to the final O&M stage. Our interviews suggest that, of the handful of similar engineering companies operating in South Africa that are involved in renewable-energy projects under the REIPPPP, Alpha's market share is currently around 30–40 per cent. In 2009 only one person in the company was working specifically on renewable-energy projects in South Africa, but in 2019 a total of ten employees were working exclusively in this area of the company's activities.

Alpha was involved in the first renewable-energy project in 2011 to undertake a feasibility study. Subsequently, according to a firm representative, the company has undergone a period of '*organic growth*' in which clients have contracted it to perform increasingly complex engineering tasks in the project cycle. This learning process has included the acquisition of knowledge through involvement in successive projects over time, resulting in the development of a highly skilled group of engineers in South Africa. These engineers are now responsible for the engineering activities related to Alpha's renewable-energy projects globally, including projects in Australia, Malaysia and Kenya.

5.1.2. Case-study company*: Beta*

Beta is a South African company, founded in 2013. Its development is mainly based on the experiences of individuals who had worked in engineering and project management previously, with some exposure to the early wind-power projects constructed in 2011 under the REIPPP programme. The company has grown from an operation employing a handful of staff to having a team of around fifty core staff, but at peak periods with many project contracts it has had in excess of three hundred staff. It specialises in the management and installation of wind-power projects, including the management of port logistics, the transportation of components, the delivery of cranes and the erection of turbines on site. In addition to the project management of wind-turbine installations, Beta has increasingly undertaken services to maintain blades (including repairs) and other O&M services. A management representative noted that involvement in such post-construction services reflected a strategic decision to try to benefit from foreseen business opportunities as the market for wind-power projects in South Africa matured.

Beta's expertise is based on the recruitment of skilled staff from the South African labour market and then on providing in-house training and training with certified global entities to enable teams to work on specialised wind-power projects. Apart from individuals with degrees and years of experience in different industries, Beta also works with technicians with specialised training in the logistics and transportation of wind-turbine components, the erection of towers and turbines, and related O&M services. A representative of Beta stated that the company, and other South African companies, were able to respond rapidly to the increasing demand for skills and services due to the REIPPPP, as there was a substantial basis of relevant expertise in the domestic labour market.

Since it was founded, Beta has become a global company with operations in countries outside South Africa, including neighbouring countries, Southeast Asia and Europe. Involvement in projects implemented by lead firms in South Africa enabled Beta to be contracted by the lead firms in new projects the latter were implementing globally. The stalling of the REIPPP programme was a key factor in Beta seeking business opportunities outside South Africa. According to a representative of the company, its relationship and cooperation with the lead firms enabled knowledge exchange, which was a crucial element in Beta's learning and capability building process. The market for O&M services in South Africa was highly competitive, as both lead firms and international service-providers were competing for contracts. However, according to a representative from Beta, the company was in a favourable position to win such contracts because of its qualifications, short response times and competitive costs, themselves partly due to its South African origins.

5.2. Infrastructural services

5.2.1. Case-study company*: Gamma*

Gamma is a South African company that started operations in 2009 as a specialised supplier of heavy-duty equipment and transporter of machinery mainly for the mining industry. Currently, however, it focuses on the provision of specialised transport, rigging and mobile crane services for wind-power projects in South Africa. When the REIPPPP began, Gamma's management saw an opportunity to provide specialised rigs to transport towers for wind-power projects through support to transporting a concrete tower for another contractor. Subsequently the company gradually expanded its operations by investing in additional trucks and trailers, thus providing it with the capacity and flexibility to cater for different types of loads. In 2013, Gamma employed a total staff of 60 and owned 15 trucks and 10 trailers. In 2016, these numbers had increased to a staff count of 150, 40 trucks and 35 trailers, and by late 2019, the company had 180 employees, 50 trucks, 50 support vehicles, 50 trailers and 6 mobile cranes. Initially the company had the capacity to handle 40-tonne loads, but this grew into an ability to handle 200-tonne loads. As a further reflection of the company's rapid and significant growth, Gamma won the transport and logistics contracts for nearly all the wind-power projects procured or implemented towards the end of the REIPPPP's last bidding round. It had thus become the preferred choice for the lead firms in terms of transport and logistical services, thus outcompeting the international firms that dominated in the initial phase of the REIPPPP.

According to a representative of Gamma, a key feature of the learning process enabling the growth of the company was the ability to draw on previous experience in related services. However, its employees' skills had to become more specialised over time in order to handle services specifically related the transport and installation of wind towers, blades and turbines. The company therefore invested in training the largely untrained workers in undertaking these highly specialised tasks in areas such as vessel discharge and port-handling through training and certification programs.

5.3. After-market services

5.3.1. Case-study company*: Delta*

Delta was founded in 2012 as part of a larger corporation that was active as an EPC turnkey provider of complete substations (including power lines) for wind- and solar-power projects in South Africa. Delta specialises in providing operation and maintenance (O&M) services to

wind- and solar-power projects and currently employs a total staff of 76, most of whom are technicians (including one engineer), while the remainder are hired locally in relation to specific projects. According to our interviews, the company started as a direct result of the foreseen business opportunities in South Africa associated with the REIPPP programme.

The company's specific O&M activities include all aspects of site operations, from the basic tasks of scheduled maintenance to the more advanced troubleshooting of inverters, control systems and SCADA. Specifically, the day-to-day operations of substations, including fault-finding and malfunctions, checks on silica gel and the infrared scanning of bolts to identify possible areas of tension, are key elements of its O&M activities. Accordingly, the company's activities are related to preventative measures according to pre-set specifications (e.g. requirements for checking frequencies). O&M activities are only related to the substations and other electrical BoP components of the wind-power plants. As a representative of the company explained: '*O&M on the turbines is done by the* [*lead firms*] *themselves*'.

Until now, the company has been contracted to undertake O&M on substations in wind-power projects for some of the wind-turbine lead firms in South Africa. However, the company has been more successful in the market for solar PV than in that for wind and has been contracted to undertake full maintenance of four solar PV projects in South Africa of around 60 MW each. A representative of the company explained that a main reason for this is the lower level of complexity in a PV plant compared to a wind-power plant because there are no rotating parts and because the company's expertise is in electrical rather than mechanical components.

Delta has started to submit bids for O&M contracts on wind turbines after the guarantee period (typically five years) has started to expire. So far, the company has not been successful in winning such contracts, mainly due, according to a representative of the company, to the high level of competition in this service market. However, the company's management expects it to be successful, since it can offer lower prices compared to the lead firms.

Delta has been able to draw on the existing competencies of the parent company by consulting colleagues on a needs basis. However, the company has also developed skills and capabilities continuously based on involvement in successive projects. Whereas most of this knowledge has been acquired through practical work and hands-on learning-by-doing on specific projects, the company has begun to formalise knowledge in the form of internal project databases.

5.3.2. Case-study company: *subsidiaries of lead firms*

The following is based on data collected on two foreign lead firm wind-turbine suppliers that are active in the market for wind power in South Africa. Our interviews with representatives of these firms indicate that for a long period their core businesses were focused on the development, manufacture and supply of wind turbines. Specialised companies, so-called independent service providers (ISPs), are typically contracted by project developers to undertake after-sales services on turbines, including maintenance and repair, as well as operations. However, along with the rapid and significant increase in the number of wind turbines installed over time, the global demand for such services has become a lucrative and attractive market for the lead firms. In parallel, it appears that the increasing competition between lead firms has reduced the profit margins on the production and sale of wind turbines. According to our interviews, this has meant that the lead firms have started to compete with the ISPs for contracts in this service market. The increasing competition for service contracts has involved a number of strategic acquisitions of ISPs by lead firms and vertical integration

downstream in the value chain as a further continuation of an ongoing trend towards consolidation and market concentration in the wind-power industry.[6] The lead firms also aspire to retain control of the operational performance data of their plants, including the functioning and maintenance of critical components, such as gearboxes, blades, electrical equipment and control systems.

In South Africa, the lead firms established local subsidiaries focusing exclusively on conducting O&M services on their own turbines, including the repair of critical components such as gearboxes. The local subsidiaries further outsourced services on balance of plant components (including sub-stations) to local third-party suppliers and contracted local suppliers to undertake relatively simple scheduled maintenance of turbines, such as lubricating components, checking oil and tightening bolts. The local subsidiaries were established around the end of the REIPPPP's second bidding round in 2012 and currently employ fifty and eighty full-time staff respectively. The employees of the local subsidiaries were all recruited in South Africa.

Over time, the lead firms have devoted significant resources to developing the skills levels of their employees in South Africa mainly through training and supervision, including longer-term stays at the headquarters of their parent lead firms in Europe. Eventually, these employees became increasingly capable of conducting O&M services with a higher level of complexity independently, such as troubleshooting, endoscopy of gearboxes, condition-monitoring, evaluation tasks and special repairs, all of which require specialised skills. According to our interviews, the lead firms clearly had an incentive to localise such service activities. As a representative of a local subsidiary of a lead firm stated: '*it does not make sense to send in an engineer from Europe to South Africa whenever there is a problem which goes beyond simple repairs*'. Some South African employees with the ability to perform such tasks have subsequently been involved in projects implemented by the lead firms in other countries in Africa, such as Kenya. The lead firms were also directly involved in the training and upgrading of some of their third-party service-providers, including Beta and Gamma, extending to training and overseas visits to Europe.

6. Discussion

6.1. Discussion of empirical findings

In Table 5, we provide a summary of the main insights from the case-study firms presented above, which we discuss in the following.

Table 5. Summary of insights from firm case studies

	Alpha	Beta	Gamma	Delta	Lead-firm subsidiaries
Year of establishment	2009	2013	2009	2012	2012
Firm structure and strategy	New business opportunity in existing engineering company	Start-up established for this market	Transport company moving into adjacent market	Subsidiary established for this market	Subsidiary of lead firms established for this market
Current no. of employees in South Africa	10 (in renewable energy department)	50	180	76	50 and 80 respectively
Types of wind-power services	Engineering	Project management	Transport and logistics	O&M on balance of plant components	O&M on own turbines
Previous experience in related areas	Engineering (energy sector)	Engineering, project management	Transport of heavy-duty equipment in mining sector	Construction and operation of power substations	Lead firms experienced in after-sales services
Main sources of learning in upgrading	-Incremental, inter-project learning	-Incremental, inter-project learning -Knowledge transfer from lead firm	-Incremental, inter-project learning -Knowledge transfer from lead firm -Training and certification programmes	-Incremental, inter-project learning	Knowledge transfer from lead firm parent company
Expanding into international markets (incl. neighbouring countries)	Yes	Yes	Yes	N/A	Yes

Source: Authors' own elaboration.

It is evident from the above that the local case-study firms were able to capture value and upgrade in the market to provide embedded services to wind-power projects in South Africa as reflected in the increasing numbers of employees, projects and market shares within their respective market segments. Furthermore, the skills levels of the employees in the case-study firms were significantly enhanced, and they became specialised within their areas of expertise over a short period of time. Eventually, some of the local firms were able to deploy the accumulated competences of their staff internationally as preferred service-providers for lead firms in regional markets and abroad. Similarly, the local subsidiaries of the lead firms came to function as a regional hub of expertise in wind-turbine services, which they applied in projects in the region. Hence, the acquired capabilities become tradeable services as a valuable and 'exportable' activity (Matsuo & Schmidt, 2019). Evidently, the stalling of the REIPPP programme played a key role in motivating the case-study firms to seek business opportunities outside South Africa. These findings suggest that over time the case-study firms have undergone a process of functional upgrading by moving into more value-added and more complex service activities (see also Davy, Hansen, & Nygaard, 2021). Similar findings have been identified in the literature on extractives, where the outsourcing of activities by foreign lead firms to local firms may in some cases lead to the development of an export-oriented service supplier industry (Morris, Kaplinsky, & Kaplan, 2012). The growth of the market for

wind power in South Africa may therefore have given rise to the emergence of southern lead firm suppliers of services in this sector (Horner & Nadvi, 2018). From an economic development perspective, this is certainly interesting in light of the expected growth of markets in renewable energy across various developing economies.

Our empirical findings provide insights into the factors that have enabled local firms to thrive and become competitive in this market. A main factor is the previous experience of individual employees and the organisation of the parent company in related areas of work. It is evident that such prior experience enabled local firms to adapt quickly and efficiently to meet a new market demand, for example, by diversifying into a new business area. The swift learning and skills development of employees observed in the case-study firms also seem to have been enabled by the existence of related experiences. The strategic choices and management decisions by firms, for example, to pursue a competitive strategy based on specialisation and the specific sources of learning also appear to have been instrumental for firm growth. Furthermore, we point to the importance of the incentive for lead firms to meet local content requirements and other economic development criteria, which contributed to stimulating the localisation of service activities. Relatedly, embedded services in the wind-power industry may be 'naturally localised' simply due to the economic incentive for lead firms to reduce costs and the need for a range of on-site service activities (Morris, Robbins, Hansen, & Nygaard, 2020). Due to the exploratory nature of the case-study research design, however, it should be noted that we are not able to determine definitely the most important enabling or disenabling factors across all of the firms in each category of services.

6.2. Theoretical implications

The findings of this paper encourage theoretical reflections regarding how upgrading and the role of lead firms should be conceptualised. The concept of upgrading normally involves activities related to *upstream* manufacturing activities in value chains (process and product upgrading) and product development (functional upgrading). Our paper provides a starting point for research aimed at obtaining a greater understanding of upgrading in the context of (embedded) service activities *downstream* in the value chain. As such, we point to a need in GVC research on services to clarify which types of services it is relevant to consider in specific industries in relation to value-chain insertion and upgrading.

Often, the strategic interests of lead firms are generally seen as determining local firms' options to upgrade (see e.g. Pietrobelli & Rabellotti, 2011). Accordingly, the GVC literature understands agency mainly as a question of how lead firms govern the value chain, which determines the prospects for the upgrading of local firms. This prevailing understanding led Kadarusman and Nadvi (2013, p. 1008) to argue that '*the GVC framework provides limited insight into the "agency" of local firms to engage with upgrading processes*'. In this paper, we contribute to advancing understanding of the agency of local firms in GVCs by pointing to the importance of devoting analytical attention to the business strategies adopted by local firms in their pursuit of upgrading (see also Armando, Azevedo, Fischman, & Pereira, 2016; Holtke, 2015; Sako & Zylberberg, 2019). Specifically, we suggest that the analysis of upgrading should include deliberate investments and strategic choices made by local firms aimed at improving their competitiveness (see also Whitfield, Staritz, Melese, & Azizi, 2020). While local firms may be restricted in their agency due to the influence of powerful lead firms, they may still be regarded as agents that are potentially capable of shaping their own development paths.

Compared to traditional South-North value chains with end-markets in the Global North, it has been argued that Southern value chains with end-markets in the Global South are generally less tightly controlled by lead firms (Tessmann, 2017). The 'room for manoeuvre' and the prospects for the upgrading of local firms may thus be higher in Southern value chains. The ability of the local firms studied in this paper to capture value and upgrade in embedded services seem to confirm this proposition. However, asymmetric power relations between local firms and lead firms seem to have remained intact when the limitations on upgrading into some of the core service functions in the value chain, such as the repair of critical wind-turbine components (including gearboxes, blades and control systems), are taken into account. Lead firms may therefore try to prevent local firms from taking over the former's core competences in areas the latter consider to be of strategic importance (see also Navas-Alemán, 2010). The prospects for new entrants to enter the chain in such core service functions are thus low compared to other types of project-related services, such as maintenance of balance of plant components, transport, logistics, project management and plant engineering. An essential strategic choice for local firms thus involves identifying the most promising opportunities for insertion into value chains. However, the prospects for the entry of local service providers depends fundamentally on the decisions of lead firms to outsource different project-related tasks, as opposed to retaining the responsibility for such activities in-house (Lanz & Maurer, 2015). Research in this field should therefore address the strategic considerations of lead firms regarding outsourcing to local suppliers, for example, by studying the marginal threshold costs.

It could be argued that a local supplier industry would automatically materialise simply due to the scale of the market, the local content requirements and the economic incentives for lead firms to localise a range of service functions. However, our findings point to the importance of a strong knowledge base in related fields of expertise as a key precondition for local forms to capture value and upgrade in this market. This is not least due the knowledge- and skills-intensive nature of service activities that require an advanced level of capabilities on the part of suppliers. Furthermore, the global market to provide services to wind-power projects is highly competitive, with a range of specialised independent service providers operating globally. Accordingly, insufficient skills development in related areas of expertise in other countries could constitute an important barrier to the development of a competitive domestic service-supplier industry. Analytically, this points to the importance of factoring in the strength of the existing industrial supply base in related services.

Finally, our findings provide several interesting insights into firm-level learning and capability development in relation to upgrading in GVCs. As stressed earlier, the GVC literature generally ascribes importance to the role of lead firms in the upgrading of local firms through knowledge transfer. This knowledge transfer was important for the local subsidiaries studied in this paper, as they depended heavily on the resources their parent companies devoted to developing the skills of locally recruited employees. Furthermore, some local firms, i.e. Beta and Gamma, also benefitted from the direct involvement of lead firms in their upgrading in providing training and supervision. However, a range of additional sources of learning escaped the influence of the lead firms. While local firms initially relied on knowledge transfers from their parent companies, our findings stress the importance of firm-internal learning occurring gradually over time as local firms accumulated more knowledge during their involvement in successive projects. It appears that such incremental forms of learning may be a characteristic feature of the project-based nature of the wind-power industry, which in this regard is comparable to other project-based renewable-energy industries (Hansen & Ockwell, 2014). These insights contribute to advancing the emerging literature on the development of technological capability as part of upgrading (Staritz & Whitfield, 2019).

7. Conclusion

While previous research on the role of services in the GVC literature is generally lacking, an emerging literature on the servicification of manufacturing in GVCs has started to address this issue. Most previous research has focused on aggregate levels of countries and industries based mainly on trade statistics on the outsourcing of service functions to developing countries and the global trade in services. In this paper, we have responded to the call by Lodfolk (2017)for more research aimed at providing insights into the micro-level aspects of the servicification of manufacturing in GVCs (see also Atolia et al., 2020). Specifically, we present an analysis of the development and upgrading of a number of case-study firms involved as suppliers of embedded services to wind-power projects constructed in South Africa.

Our empirical findings stress the opportunities for local firms to capture value and upgrade from their insertion as suppliers of high value-added and knowledge-intensive services in (home) markets for infrastructure projects dominated by foreign lead firms. The GVC literature highlights the insertion of local developing-country firms as suppliers of manufactured goods (as intermediary inputs) as the preferred mode of entry into value chains. However, given the high entry barriers, the prospects for the entry of local manufacturers of wind-turbine components in the global wind-turbine GVC are low except for producers of peripheral components, such as towers (Schmidt & Huenteler, 2016; Surana, Doblinger, Anadon, & Hultman, 2020). The findings presented in this paper thus show that service provision may be a more favourable entry point into GVCs for local firms in the context of the growing markets for renewable energy in African countries and possibly elsewhere.

Theoretically, our findings point to the importance of attributing more agency to individual firms in research on upgrading in GVCs. While lead firms still play an important role, at least in Southern value chains, their room for manoeuvre and prospects for upgrading may be higher than in conventional South-North value chains. Furthermore, a range of learning mechanisms were shown to have been important in the capability building of the local firms, going beyond the influence of the lead firms. Learning in project-based value chains seem to involve a specific form of tacit knowledge, which firms can accumulate gradually over time from their involvement in successive projects (Binz et al., 2017).

The empirical context for this paper involved a large-scale renewable-energy procurement programme in South Africa, which included a political focus on the development of a domestic manufacturing industry mainly through the use of local content requirements (Leigland & Eberhard, 2018). The results of these requirements on the development of the local wind-turbine component-manufacturing industry have reportedly been limited (Larsen & Hansen, 2020). This stands in sharp contrast to the development of a viable and flourishing wind-power service-supplier industry as described above. The development of such a service-supplier industry could be seen as an unintentional consequence of the programme. We therefore argue that services deserve greater attention in policy circles not only in South Africa, but also in the many developing countries that are currently in the process of designing and implementing large-scale procurement schemes for renewable energy, such as Turkey and Brazil (Hansen, Nygaard, Morris, & Robbins, 2020). Government-funded support instruments, such as training programmes, could thus be considered in order to help local service firms capture a greater share of the value in this market.

Finally, our findings provide relevant insights into the discussion about the feasibility of a manufacturing-led versus a services-led growth model for Africa. Generally, we argue that

there are significant opportunities for African countries to focus on a range of services in a particular sector. This should not be interpreted as a rejection of similar opportunities for manufacturing in the same sector. Rather, in the context of renewable energy, we argue in favour of a policy approach where focuses on supporting the development of both domestic manufacturing and service industries go hand in hand.

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Notes

1. See: https://www.gminsights.com/industry-analysis/wind-energy-market

2. While turbines may be considered as goods inputs to wind-power projects, we consider the production and assembly of wind turbines as part of the manufacturing chain (Lema et al., 2011).

3. See: https://sawea.org.za/. It should be mentioned that, while the list provided by SAWEA is not exhaustive, it does cover a significant number of firms involved in wind energy projects in South Africa.

4. Some of the interviewees were interviewed on several occasions during the fieldwork and data collection undertaken for this paper.

5. It should be noted that the minimum threshold for locally produced content increased across the four bidding rounds from 2011 to 2015: 25 per cent in 2011, 35 per cent in 2012, 40 per cent in 2013 and 40 per cent in 2015 (Eberhard & Naude, 2017).

6. See https://www.greentechmedia.com/articles/read/how-wind-oems-are-struggling-to-hold-onto-service-dollars

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