



MANAGEMENT AND CONTROL OF COMPLEXITY IN CLUSTERING FOR VALUE CREATION IN SUSTAINABLE SOCIETIES

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ABSTRACT

The global production challenges we face need to be addressed in the multifaceted context of sustainability. Startup enterprises need to be both creative and innovative in order to survive and realize growth. Production clusters are usually formed as a result of common geographical location and/or similar economic activity. Clustering can support distributed manufacturing incubators to overcome social, economic and technological challenges through sharing resources. As these clusters must contribute socio-economically to its community, without compromising the ability of future generations to meet their own needs, complex systems exist. The aim of this paper is to encourage ourselves to direct our research towards concepts which reduce production complexity and support simplicity. This research evaluates several production clusters toward sustainable value creation in developing communities. Key elements of a clustered based growth framework are identified to support manufacturing incubators in South Africa.

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1 INTRODUCTION

Manufacturing of products and goods is probably the most important economic activity in the world that exists to create value. As it becomes more difficult to understand and control values of products and services, the concept of “sustainable value” has emerged to target not only ecological sustainability, but also social and economic values [1].

Having a strong manufacturing base is important to any society or community, because it stimulates all the other sectors of the economy [2] to be productive. South Africa is facing severe poverty levels especially in underdeveloped regions. Manufacturing is seen as the sector which could create work, but it requires innovative development concepts.

Since the industrial revolution in the eighteenth century manufacturing has been considered to be the main engine of economic growth and development. It contributes to the quality of life of individuals, to growth of wealth in a nation as well as power and position of a state. Therefore, manufacturing deserves strong and continuous endeavor of all actors in a modern society to ensure prosperity, better life and sustainable development [3].

Complexity is a term to describe a characteristic which is not yet possible to quantify precisely. Yet the complexity of production systems is the critical cause of many management problems [4]. Figure 1 illustrates the drivers and enablers for complexity that should be managed in any production system to stay competitive [5].

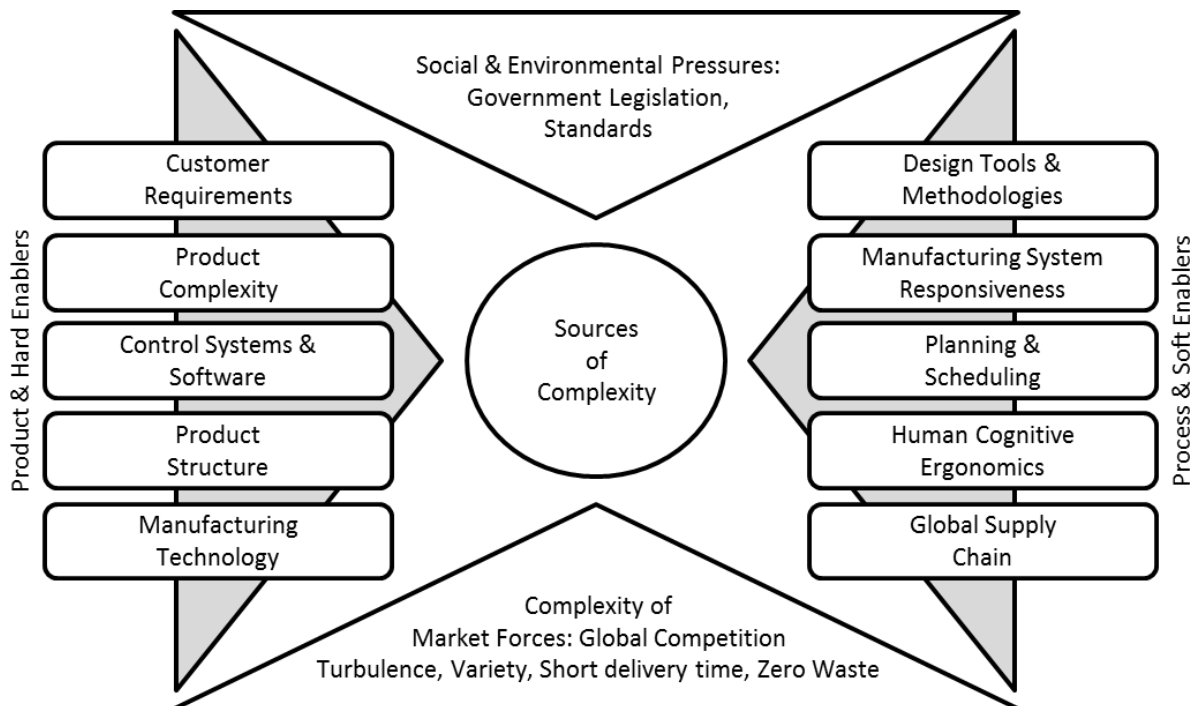


Figure 1: Drivers of manufacturing complexity (Adapted from [5])

Business incubators have proven to be an effective way of fostering sustainable business growth and stimulating entrepreneurship. However, establishing a business incubator is a challenging task. The United States National Business Incubation Association (NBIA) [6] defines the business incubator as a dynamic process of business enterprise development. Its main task is to support development of supported small and medium-sized enterprises (SME's), by providing management services and financial resources. The wider task of the incubator concept would be to support macro-economic related (e.g. employment) and micro-economic related (e.g. implementation of technology) objectives.

In the 1950's a very large industry in New York (US) closed down, leaving vacant a complex of multistory buildings with a total area of almost 80 000 m². The building was then successfully divided into smaller units to house new entrepreneurs. One of the first tenants

was a chicken processing company, thus the origin of the name “incubator” with this successful model of promoting SME development [7]. The United Nations Industrial Development Organization (UNIDO) also adopted this incubator model in order to create a support environment for entrepreneurship to expand SME’s in developing countries [8]. The universal idea is that a company located within a business cluster, experiences better chances of survival and stronger growth than a company located in isolation. It should be considered as a mutual support network for manufacturing.

The concept [3] of Open Collaborative Manufacturing (OCM) incubators include infrastructure in community centres designed to support the development of visionary entrepreneurs, using an array of support systems. These are developed and orchestrated by management and offered both in the incubator and through its network of open design contacts [3]. The core part of an OCM incubator is its ICT infrastructure, which facilitates the creation, operation, and eventual disintegration of the virtual organisations it contains. The OCM incubation concept can also be integrated into the country’s national innovation system as proposed by [9]. A consortium approach with a stage-gate management model is proposed as illustrated in Figure 2 [3]. Thereby, a clustered-based support system can manage progress of specific tasks, where the decision is based on the information available at the time. Clusters and innovation networks are promising and powerful instruments in promoting research and development, which in turn supports productivity and can create work opportunities.

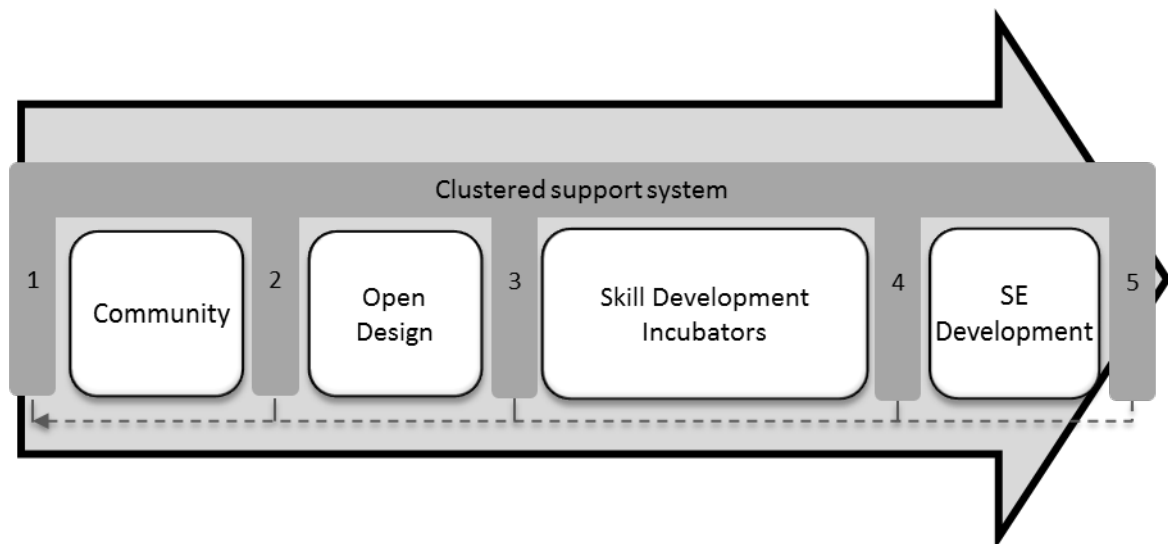


Figure 2: Building blocks for OCM incubators with the proposed clustered based support system managing the stage-gates elements (Adapted from [3])

In this favourable ecosystem, innovative enterprises can flourish by interacting with different innovation actors and across sectorial boundaries [10]. In order to meet customer demand, production organisations develop rapidly more products, which lead to an increase in the number of variants of assemblies and parts [4]. Thus, the coordination of activities can increase significantly.

Clustered support systems offer the benefit that production engineers can have physical access to the manufacturing floor to keep track of progress, while entrepreneurs are able to meet like-minded individuals to explore new ideas. The type and degree of regional specialisation and thus the potential for regional development depends on path-dependent processes influenced by regional characteristics of factors such as available resources, level of education and existing industrial structures. Collaboration in a cluster needs to be facilitated in order to tap the cluster’s full potential [10].

Current success stories in the US include the Silicon Valley and Massachusetts’s *Brainpower Triangle* clusters. Both are in close proximity to well established technology institutes. The collaboration of small and medium enterprises (SME’s) with each other and the research



sector can be seen as an opportunity to renew the economy and the society [10]. Business clusters refers to an area that is home to many companies or organizations working within the same industry to gain an edge by concentrating their resources in one area [11]. This support model gains competitive strength because of its better access to trained and experienced employees, suppliers, specialized information and public goods, as well as from the motivating forces of local competition and customer demand [12].

In Europe, the clustering policies towards cluster development are generally issued by national governments, with the co-operation of regional or local governments. National authorities focus on designing and coordinating cluster policies to create the general framework conditions and developing research and development programs [13]. Still, clusters are geographic concentrations of interconnected companies and institutions in a particular field that compete and collaborate at the same time [11]. These clusters also reflect the specialisations of regions in activities, within which companies can gain higher productivity through accessing external economies of scale or other comparative advantages.

In Sub-Saharan Africa (SSA) the South African Petrochemical cluster around Sasol near Witbank, is one of the most successful clusters [14]. This cluster supports various industries and downstream linkages were created. Around East London and Uitenhage (Eastern Cape in South Africa), the motor vehicle industry cluster that exists produced around 40% of the country's vehicle output [14].

The establishment of international cluster policy collaboration bodies and benchmarking of cluster organisations and programmes helped to develop these policies significantly [10]. Although scientific methods (e.g. agent theory, neural network, genetic algorithms, fuzzy logic [15, 16]) for managing complexity exist, the management and control of complexity in clustering remains a challenge. Key phases for implementation of a clustered based framework and a better understanding of the complex change management are also still needed. This research evaluates several production clusters in developing communities to identify key elements for a clustered based growth framework that can support manufacturing incubators in South Africa.

2 CASE STUDIES ON CLUSTERED BASED PRODUCTION

The methodology used in this research was a case study review. This involved reviewing several cases from different parts of the world. Thereafter, it was decided to specifically focus on developing countries where complexity has been managed. The value creation processes in these success stories were also studied. Although Africa is still seen as a developing continent, it holds pockets of vital economic activity of which many are clusters scattered across the continent's countries and industries.

2.1 The Suame manufacturing cluster in Ghana

The Suame cluster site was created in the 1950's when its entrepreneurs were relocated by the Kumasi City Council. A key turning point in the cluster's history occurred in the mid-1970s, when the government placed tight restrictions on the importation of new vehicles and parts [17]. This crippled large enterprises, which were capital-intensive and relied on imports. Small enterprises filled the gap by producing the spare parts that had been previously imported. Though the importation of spare parts and even whole vehicles resumed under the Economic Recovery Program in the 1980s, large enterprises did not regain their previous dominance [18].

According to research [19] the adoption of basic technologies and relatively complex machinery such as tool-making machines has raised the engineering capability of companies. The assistance rendered by the Suame Intermediate Technology Transfer Unit (ITTU) of the Technology Consultancy Centre (TCC) increased the number of machine tools. The ITTU was established by the government of Ghana to raise the technical competence of the cluster by



providing technology advisory services and machinery upgrades. There is a development from recent studies that the trade in engineering materials and spare parts was more profitable than manufacture and repair work [19].

The market of the Suame cluster currently includes the government, private companies and individuals. The products of its enterprises are also popular in other West African countries such as Burkina Faso, Cote d'Ivoire, Mali, and Togo. The market for vehicle repair benefits from the cluster's location on the main road as it is linking two capital cities, Accra (Ghana) and Abidjan (Cote d'Ivoire) [19]. The government of Ghana has also come up with policy incentives to support the growth of the cluster. The products and services of the Suame cluster are shown in Table 1.

Table 1: Products and services of the Suame Cluster [19]

Major Sectors	Products and Services
Manufacturing	Food-processing equipment and farm implements; cooking stoves and utensils; foundry products. Metal fabrication and plant construction; angle irons, channel iron bars.
Sales	Sheet metal, bars, iron rods, steel sections, hand tools, fasteners, electric motors, pumps. Second-hand engines and parts; car-decorating materials. Foods and beverages of all kinds.
Maintenance	Engine overhauling; auto electric works; vehicle interior upholstery; auto body work (straightening and painting).
Communication & business centres	Telephone and fax services, photocopying, computer typesetting; internet and e-mail services, mobile phone cards, barbering and sales of soft drinks.

The Suame cluster is one of the biggest in Africa, with a long history of craftsmanship and entrepreneurship. It has been the object of a sustained attempt to provide public support for small business development. The role of formal and informal associations has been important to the sustainability of the cluster [19].

In the early 1980s, the government launched a major national initiative to repair all state-owned vehicles, particularly those being used for transporting commodities such as cocoa and other food crops from the hinterland to urban areas. A new crop of young workers joined the cluster's labour force. The artisans of Suame and similar clusters were contracted to carry out the initiative using unsalvageable vehicles to repair others. This particular state policy led to the formation of the Ghana National Association of Garages, as a unified association of artisans. With its permanent national secretariat in the Suame cluster in Kumasi, the association later opened offices in Accra and other regional capitals to pursue its aims. The aspirations and needs of motor vehicle repairers have dominated the activities of both the Ghana National Association of Garages and the Magazine Mechanical Association in almost all clusters. By contrast, little has been done for manufacturing enterprises, or for enterprises that have upgraded their activities to manufacturing. To refocus the direction of metalwork manufacturers in the cluster, the clients of the Suame ITTU assembled in the late 1990s to form the Association of Micro and Small Metal industries. The aim of the association was to address the constraints and challenges faced by the metalwork manufacturers [19]. Considering the available literature [17, 18, 19] and data, influential governmental support to the Suame cluster are shown in Table 2.

**Table 2: Strategic governmental support to the Suame cluster [17, 18, 19]**

Commercialisation	Available Skilled Manpower	R & D	Intellectual Property Protection	IT Support	Venture Capital
	x	x	x		x

Since 2001 the challenges posed by globalization local economic hardship, and growing political awareness have diminished the effectiveness of the Ghana National Association of Garages and the Magazine Mechanical Association. It appears that the majority of enterprises began to favour regrouping into trades - foundry men, sprayers, auto electricians, engine reborers to promote their enterprises [19].

2.2 The Kamukunji metalwork cluster in Kenya

The Kamukunji cluster occupies about 10 hectares to the east of Nairobi's central district, known as the Eastlands. It has a population of 5,000 artisans. Kenya's colonial government designated the area as a business centre for native Africans, so it evolved under the colonial urban policy that segregated space on the basis of race [20]. Business activities carried out in the cluster were restricted to small and micro enterprises that catered to African consumption patterns. Trade licenses were issued to businesses engaged in the sale of indigenous foods, repairs and artisan manufacturing. The products produced included cooking pans and hand tools to meet local household demands. During this period, the cluster served as the economic centre for burgeoning settlements. It also served the needs of customers and traders from rural areas, as it was the bus station where busses arrived in Nairobi from the countryside [20]. Considering the available literature [20] and data, influential governmental support to the Kamukunji cluster are shown in Table 3.

Table 3: Strategic governmental support to the Kamukunji cluster [20]

Commercialisation	Available Skilled Manpower	R & D	Intellectual Property Protection	IT Support	Venture Capital
x	x				

This cluster still enjoys a location advantage and the role of the Kenyan government in this cluster has been minimal. However, the government has been actively involved in the agricultural sector [21].

2.3 The Nnewi automotive components cluster in Nigeria

The Nigerian automotive and component industry is publically known to be important to the national economy. Few industries allow for self-manufacturing, or use so many different raw materials, tools, machinery, and equipment. Consequently, the automotive industry serves as a stimulus for the development of other industries (e.g. machine tool production, iron and steel, and transportation). In 2002 there were 12 automotive vehicle assembly plants, 5 of which are partially state-owned (e.g. Peugeot Automobiles Ltd., Lagos; Anambra Motor Manufacturing Co. Ltd., Anambra; Volkswagen Nigeria Ltd., Lagos; National Trucks Manufacturing Ltd., Kano; and Steyr Nigeria Ltd., Bauchi), the rest being privately owned. The automotive industry in Nigeria has a capacity to produce 102,000 cars, 55,000 commercial vehicles, 500,000 motorcycles, and 650,000 bicycles annually [22]. Considering the available literature [22, 23] and data, influential governmental support to the Nnewi cluster are shown in Table 4.

**Table 4: Strategic governmental support to the Nnewi cluster [22, 23]**

Commercialisation	Available Skilled Manpower	R & D	Intellectual Property Protection	IT Support	Venture Capital
	x	x		x	x

The Nnewi automotive components cluster is made up of four villages - Otolo, Umudim, Uruagu, and Nnewichi. Each hosts a number of automotive spare parts manufacturing firms. Large and medium-size firms are generally located away from residential areas, while small enterprises are located in homes, apartment buildings, backyards, market stalls, and the federal government's Technology Incubation Centre. Colocation is evident [23]. According to reviewed literature all the firms in the cluster obtained their Intellectual property technology from Taiwan [23].

2.4 Handicraft and furniture clusters in Tanzania

Micro and small enterprises (MSEs) are dominant actors in the economies of many developing countries, and even more so of the least developed countries, such as Tanzania. These enterprises accommodate a workforce largely characterized by low levels of education and skill. Major challenges include low productivity, lack of capital accumulation, and labour-intensive (though capital-saving) production [18].

In a research [18] it was established that although the Tanzanian government had tried different economic development models since the country's independence (1961) it recently recognized the potential socioeconomic contribution of MSE's. This policy change was justified by studies that estimate that one-third of Tanzania's GDP originates from the informal sector, and particularly from MSE's. According to the Informal Sector Survey of 1991, there were 1.7 million businesses operating in the informal sector and employing about 3 million people (20%) of the Tanzanian workforce.

The informal sectors were long neglected and therefore systemic and institutional issues tend to define the sector's vision. This include the heavy costs of compliance with government regulations and taxation standards, inadequate working premises, limited access to finance, lack of entrepreneurship skills, lack of marketing expertise and business training, low technology levels, and lack of information. There are also weaknesses in the institutional structures that support the informal sector, such as business associations. These are for the most part weak, fragmented, and uncoordinated. The sector also lacks clear policy guidance from government authorities [18]. In spite of these challenges, MSEs have survived over time and at times have even produced relatively good-quality products despite intensified competition following import liberalization.

The furniture and handicraft sectors in Tanzania comprise a predominant number of small-scale enterprises and a few large firms utilizing simple technologies; the workforces of both have relatively low skill levels compared with internationally competitive enterprises.

2.5 The Lake Victoria fishing cluster in Uganda

Fish processing and exporting are important to the economy of Uganda [24]. In 1997, the European Union (EU) applied to Ugandan fish exports a set of sanitary and phytosanitary (SPS) standards that led to a conditional ban on one of the country's most important exports. When the country's fish processors and exporters were unable to meet the standards, the industry was plunged into a severe export crisis, as fish processors were locked out of their largest and most lucrative market for three long years. At the time, the country was still recovering from a troubled past and remained dependent on a few traditional agricultural exports, notably coffee.



The processed fish were still the most important non-traditional agricultural export and therefore swift and decisive action to induce the European Union to lift the ban was imperative. The industry had no choice but to become compliant with the EU standards. This case proved to be an interesting example of a technologically weak cluster in Africa that overcame a serious challenge through networking, linkages, learning, and upgrading [24].

These clusters in Uganda are not all clustered in a particular geographical city or sub-region, but are found in several cities surrounding Lake Victoria. Of the 17 plants in the country, 10 are located near two major cities, Kampala and Jinja, the latter being about 80 kilometres east of Kampala. There are important locational differences between the Jinja cluster and Kampala cluster. While the distances between plants in the Jinja cluster are very small, three of the five firms in the Kampala cluster are located in different suburbs or parts of the city, for a total cluster area of more than one square kilometre. The Kampala-Entebbe sub-region (3x plants), and the Masaka-Kyotera sub-regions (4x plants), may also be considered agglomerations.

Clustering is often associated [25] with four key advantages for members, namely: market access, labour-market pooling, intermediate input effects, and technological spill-overs. All fish-processing firms in Uganda have had to provide intensive training for their workers to create a pool of local skills in factory-based fish preparation. The establishment of that skill base has benefited both new and old firms in the clusters, both through labour mobility and through the diffusion of ideas often associated with the routine interaction of workers. However, the clusters are marked by an acute absence of workers highly skilled in the more sophisticated aspects of fish processing. Considering the available literature [18, 24, 25] and data, influential governmental support to the Lake Victoria Fishing cluster are shown in Table 5. For more complex tasks such as product development, some firms have obtained technical expertise from buyers and other experts outside Uganda, as such skills are unavailable locally [24].

Table 5: Strategic governmental support to the Lake Victoria fishing cluster [18, 24, 25]

Commercialisation	Available Skilled Manpower	R & D	Intellectual Property Protection	IT Support	Venture Capital
	x		x		

Formal technical and vocational institutes in Uganda have not provided adequate numbers of graduates qualified in industrial food processing. For their personnel needs, therefore, firms have relied on in-house training, usually of persons with only a few years of formal schooling. An additional benefit of clusters is that they often induce the emergence of suppliers who benefit from dealing with a group of customers located near one other. Suppliers sometimes even receive support from their customers. Both phenomena have been observed in Uganda's fish-processing clusters, but those benefits have been undermined by the failure to resolve the problem of reliance on a natural resource that cannot be harvested limitlessly. Research-industry linkages in fish processing are scarce even where research institutes can be found near the clusters [18].

2.6 The Textile and clothing sector in Mauritius

Over the last three decades Mauritius has recorded impressive economic achievements that have improved the living standards of its citizens, modernized the nation, and provided a window into the developed world. Mauritius is now categorized as an upper-middle-income economy. Within a very short period of time, outward-oriented strategies have transformed this small island with low agricultural productivity into a significant exporter with a manufacturing-based economy. The two sectors that have boosted the manufacturing



performance of the Mauritian economy are sugar milling and textiles and clothing. However, the textile sector is now at risk [26].

The textile and clothing sector appeared in the government's agenda as a solution to over-reliance on a sugar-based, mono-crop economy. Being labour intensive, it became a solution to unemployment as well. The clothing sector in Mauritius therefore plays an important role in the economy in terms of employment, foreign exchange earnings, and share of the GDP. In 2003 around 65,000 people - more than 60 percent of the manufacturing labour force were engaged in the manufacture of clothing. In 2002 the sector accounted for 22.4 percent of GDP. In 2001 apparel accounted for some 56 percent of Mauritius' total exports of goods, and some 82 percent of its total manufactured exports [26]. Although the bulk of activities in the textile and clothing sector of Mauritius are geared toward the manufacture of ready-made garments (94 percent of total textile and clothing exports in 2004), the importance, though minimal, of spinning and weaving firms in the local market should not be left out. In 2004, as in all years since the beginning of the 1990s, most Mauritian clothing exports were geared toward the United States, United Kingdom and France.

One of the strategic approaches to surviving in the apparel market is to move up-market into high-end, high-value-added products, where price competition is less severe. Lall and Wignaraja studied [27] the export competitiveness of the Mauritian economy, found Mauritius to be exceptionally vulnerable because of its heavy dependence on a few products, and because more than 80 percent of its manufactured exports come from one product group: clothing. They argued that once clothing exporters' wage-cost advantage was exhausted, export growth would depend on the ability to add value through backward integration (into textiles) and, within clothing, to upgrade quality and flexibility. To upgrade garment quality, investment is required not only in equipment, but also in organizational and labour skills, quality management, and design, marketing, and response capabilities. In 2002 firms had to cope with a limited pool of available skilled labour, but since then the textile and clothing sector had to lay off employees. A lack of investment incentives and government support may now be the main factor causing firms to think about relocating.

2.7 The Wine Cluster in South Africa

South Africa's wine producers can be divided into four segments, each with a different structure and focus. The four segments are the established producers, new producers, cooperative producers, and wholesalers (some of which produce wine, in addition to buying and selling it). Development in the different segments has been influenced by changes in the political and economic landscape of South Africa, as well as by changes in the industry. Wine estates and none state wine farms are mostly small producers of quality wines. Table 6 shows the changes in production volumes by industry segment in the wine producing cluster of South Africa.

Table 6: Change in volume of production by industry segment, 1998-2003 (Cases of Wine Produced) [28]

	% Increase (1998-2003)
Producing Wholesalers	400.0
New Producers	698.7
Co-operatives	1166.7
Established Producers	104.5
TOTAL	403.2



There is wide disparity in performance between the different industry segments and considerable diversity within each industry segment. South African producers have been effective at innovation in product and production, by introducing new varieties that are in demand, particularly in export markets, and in improving the quality of output [28]. An under resourced but relatively effective network of technical support and research closely aligned to industry needs has aided these processes. The network is most intensively used by less well-resourced producers, with better resourced producers more inclined to turn to the private sector for the required expertise, in the form of consulting viticulturists and winemakers [28]. Considering the available literature [28] and data, influential governmental support to the Wine cluster are shown in Table 7.

Table 7: Strategic governmental support to the wine cluster [28]

Commercialisation	Available Skilled Manpower	R & D	Intellectual Property Protection	IT Support	Venture Capital
x	x	x			

In comparison with other New World producers, growth in export value has been less impressive. South African producers have had limited success in exporting quality wines. The critical constraint on performance throughout the industry is not in the technical or research areas, not in production or in winemaking, but in marketing [28].

2.8 The Film Production and Distribution Industries in Nigeria

Nigeria is the third-largest film producer in the world after the United States and India. The sector is dominated by SMEs [29]. The diffusion of digital and communication technologies in the 1990s has accounted for its fast growth. Currently, around 300 producers release between 1,000 and 1,500 movies per year. Nigerian directors are known to adopt new technologies as soon as they become available at an affordable price [29]. Considering the available literature [29] and data, influential governmental support to the Film Production and Distribution cluster are shown in Table 8.

Table 8: Strategic governmental support to the Film Production and Distribution cluster [29]

Commercialisation	Available Skilled Manpower	R & D	Intellectual Property Protection	IT Support	Venture Capital
x	x	x			

According to the UN report, lack of funding, lack of organized industry and business associations, inadequate skills & lack of professionalism are some of the problems experienced. Some upcoming clusters also have challenges with infrastructure and a weak distribution system.

3 SUMMARY OF CLUSTERED BASED PRODUCTION

The reviewed case studies show a common set of challenges faced by clustered-based growth frameworks in developing economies. As the world moves towards complete globalisation and the promotion of free trade, existence of industrial clusters will continue to face stiff competition from cheaper imports as a result of improved production methods from other developing countries. As a result, simple and less complex production methods become a survival prescription for players in the developing countries. Sustainable growth is achieved through cost competitiveness and continual creation of value [1]. Key concepts,



models and tools for managing and controlling complexity in clusters are summarized in Table 9 [4, 15, 16]

Table 9: Controlling complexity in manufacturing clusters [4, 15, 16]

Models	Tools	Concepts
Object-oriented	Performance measurement	Open Design collaboration
Analytical	Monitoring diagnostics	Agile or Fractal factories
IDEF 0	Simulation	Value engineering
Funnel	Production planning and control	Ubiquitous Manufacturing Systems (UMS)
Petri-nets	Decision support	Distributed Manufacturing Systems (DMS)
		Group technology

Clustering supports enterprises to overcome capital, skills, technology, and markets constraints. Enterprise clusters help their constituents grow and compete by encouraging more effective knowledge and technology diffusion and product specialization, leveraging local comparative advantage, fostering production value chains, and achieving collective efficiency. In so doing, they contribute significantly to Africa's economic growth. They provide jobs for the continent's growing population, thus enabling families not only to survive, but also to educate their children and perhaps move out of poverty. But in today's increasingly knowledge-intensive and globalized economy, these clusters also face serious challenges in the areas of technology, natural resources, infrastructure, skill acquisition, and quality control. Evaluating these cluster case studies, the following elements were found to be common characteristics in most:

- Physical proximity of enterprises ensure concentration of resources
- Core competencies of enterprises are complementary
- Collaborating these enterprises have a collective growth potential
- Collaborating as an production system with long-standing coordinating mechanisms

In order to ensure sustainable development and value creation, these clustered ecosystems attempt to manage complexity by:

- Concentrating resources in an specific geographic area and streamlining supply chains by identifying gaps earlier
- Long-term collaboration among cluster enterprises helps to improve performance with trusted buyer-seller relationships
- Interdependence and the mutual believe in the speed of trust also strengthens commitment levels and reduces conflict through faster access to specialized information
- Shorter feedback loops helps to modify supply chains faster, which can also result in cost savings
- Flexibility can be increased, while reducing risk with partners of a supply chain are clustered

In order to manage the complexity and performance of clusters a standardised clustered based business process framework need to be established among stakeholders. This sometimes includes changes in the nature and mix of activities carried out at each link in the value chain. These changes cover process, product, functional and chain upgrading.



Product improvement includes the ability to produce components or retail innovative products developed by product leaders. Product quality is enforced through value chain relations, given that the final value-adding entity is held accountable for compliance.

Process upgrading aims to increase cluster productivity by increasing throughput, reducing inventory and lowering operating cost. It includes both processes within individual links in the chain (e.g. increased inventory turnover, lower scrap) and between the links in the chain (e.g. more frequent, smaller and on-time deliveries). Successful adoption of such standards is an important means of industrial upgrading, one that in part protects firms from lower-cost competitors who are not able to comply with these standards. Functional upgrading seeks to increase the value added by changing the mix of activities conducted within the firm (e.g. taking responsibility for outsourcing accounting, logistics and quality functions) or moving the locus of activities to different links in the value chain (e.g. from manufacturing to design). Chain upgrading creates opportunities for suppliers that have developed competencies and skills to move to a new value chain.

Trust and accountability need to be recognized as the cluster's foundation. Increased competitiveness can be realized through analysing the value chain and identifying opportunities to make it more efficient. Waste management and recycling activities are key elements to ensure sustainable production systems.

4 CONCLUSION

The aim of this paper was to encourage ourselves to direct our research towards concepts which reduce production complexity and support simplicity. This research evaluated several production clusters in developing communities. Key elements of a clustered based growth framework are identified to support manufacturing incubators in South Africa. Concepts for managing complexity in clustered ecosystems are discussed and various possible changes mentioned.

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