Servitization strategies in pharmochemistry firms of nutrition and animal health in Argentina

Lepratte, Leandro; Blanc, Rafael; Hegglin, Daniel; Rodriguez, María Alejandra

GIDIC (Grupo Investigación sobre Desarrollo, Innovación y Competitividad), Universidad Tecnológica Nacional, Ing. Pereira 676, Concepción del Uruguay, Argentina, E3260DAD, +5493442529236, llepratte@gmail.com

Abstract

The servitization in manufacturing firms has gained relevance in recent years. In the pharmochemistry industry of nutrition and animal health, these types of strategies have been little explored, particularly those that incorporate knowledge intensive business services in veterinary and agronomic activities. The aim is to analyze the services offered by firms and their relationship with innovation. The study focused on a survey of 40 firms in Argentina. Cluster analysis is used as a methodology. The most relevant findings are: that firms develop different servitization strategies and there are differences between them in terms of types of non-technological, service and organizational innovations, foundation years, productivity levels, specialized human capital, use of laboratories and profile of exports of goods and services. the type of companies is discussed making contributions to the literature on servitization and knowledge intensive business and services. The conclusions present challenges in terms of innovation policies and future researches.

Keywords: servitization; innovation; service dominant logic; veterinary services; knowledge intensive business services.

Introduction.

The servitization is growing great interest in scholars and practitioners of industrial organization, management and engineering, as well as policy makers (Baines et al., 2017; Lodefalk, 2017). This process of change in the strategies of firms, even in mature sectors, is an emerging one of a complex socio-technical dynamic (Cusumano, Kahl, & Suarez, 2015), based on organizational and technological innovations guided by product - service system models (Goedkoop, Van Halen, C. J., Te Riele, H. R., & Rommens, P. J., 1999) and service – oriented manufacturing (Fry, Steele, & Saladin, 1994). Currently, the servitization presents two broad fields of relevant studies, one aimed at analyzing servitization strategies at the level of firms, and the other, on the location and geographical proximity of servitization processes (Gomes, Cunha, & Vendrell-Herrero, 2018).

Here we focus on the study of certain firms with knowledge-intensive product-service strategies that redefine their business and management models as specialized suppliers, going from mere suppliers of manufactured inputs to transferring core competencies that customers demand to give solutions to their problems, which in turn stimulate interactive innovation processes based on user-supplier relationships (I. Miles, 2005; I. D. Miles, Belousova, & Chichkanov, 2018). A central issue appears in the growing literature that studies the specificity of these firms, which is the relationship between the product-service strategies of these firms (servitization strategies), the intellectual capital they use for being knowledge-intensive, their technological capabilities, cooperation modalities, types of innovations, their orientation towards internationalization, and size (J-Figueiredo, Neto, Quelhas, & Ferreira, 2017).

The present article is part of this challenging agenda since it studies a sector of specialized suppliers of nutrition and animal health, which manufacture and market pharmo-chemical products and supply veterinary and agronomic services related to the meat production industry in Argentina (2016-2017). The main question to answer here is what type of servitization strategies do these firms have developed in the analyzed period? Are there significant differences between them in terms of their results of innovation, human intellectual capital, technological capabilities, technological cooperation and other characteristics?

In this way, an original contribution is proposed when analyzing veterinary and agronomic services that are firms of advanced services with few previous studies and that are close to the characteristics of human health, although with specificities (I. D. Miles et al., 2018).

Theoretical framework.

This contribution is even more relevant given that we are facing a paradigm shift with a greater integration of services in the different industrial and primary sectors, where it has appeared, in recent times, the concept of servitization (Baines et al., 2017; J-Figueiredo et al., 2017; Kamp, 2016) to refer to the tendency of industries to use their goods as vehicles for the provision of services (Lightfoot, Baines, & Smart, 2013), based on strategies to add value from interaction and co-creation with the clients (Kowalkowski, Gebauer, Kamp, & Parry, 2017; Lightfoot, Baines, & Smart, 2013; Vandermerwe & Rada, 1988). In this tendency, many firms adopt organizational strategies and modalities such as Knowledge Intensive Business Services (KIBS), which are characterized by locating, developing, combining and applying different types of generic and technological knowledge; and make them available to solve specific problems of their customers. KIBS firms have been defined in different ways, however they contain points in common: they are companies that respond with services demanded specifically by other firms or organizations, they are intensive in knowledge by the form of transaction they establish between supplier and user, making complex cognitive processes oriented towards technological and non-technological innovations based on its key factor, the intellectual human capital (I. D. Miles et al., 2018; Muller & Doloreux, 2007).

The servitization strategies have been analyzed according to the type of valued logics that these kinds of firms pose in relation to their clients, and certain authors state that there are four types of product and service-dominant logic: product-based logic (PBL), service- based logic (SBL), virtual-based logic (VBL) and systemic-based logic (SYSBL). We are interested in three of these to characterize the firms we are analyzing, the PBL understands the source of value based on the capabilities that are offered and provided from within the firms to the clients where the services are considered as an aggregate of value to the products that are sold, and therefore, as a transfer of capabilities. In the SBL strategies the value emerges from the solution of the problems located in the client, the focus being the service and not the product. In the SYSBL strategy, the value emerges in the interaction between the use and the problems of the context, it is interactive and aims at the co-construction of knowledge to develop new products or improve them and the services between suppliers and users, approaching the product-service system modalities in an integral sense (Lindhult, Chirumalla, Oghazi, & Parida, 2018).

Promoting these strategies and translating them into competitive advantages at the firm level requires processes of organizational innovation and the generation of endogenous technological capabilities to integrate products and services that allow them to differentiate competitively and to satisfy customers (Bustinza, Bigdeli, Baines, & Elliot, 2015). Here, the analysis of human capital and its relationship with innovation processes appears as a key factor, both to consider the development of skills and the degree of complexity of the knowledge used and its relationship with problem-solving and sustaining or breaking organizational routines. The evidence shows that high professional skills are dominant in

technologically intensive product-service systems, such as those involving R&D, engineering and consulting, that require creative competencies, open to the resolution of complex problems, management of a mix of tacit and explicit knowledge and break of routines (Consoli & Elche, 2013).

The importance of the type of supplier - user relationship allows for exploring the specificity of the capabilities in these firms, the characteristics of their relationships with customers, and the generation of heterogeneous knowledge that does not require exclusively formal mechanisms of intellectual protection, significant investments in high-level human capital (scientists), incorporation of technologies and R&D areas (Bolisani, Paiola, & Scarso, 2013; Gallouj & Savona, 2009). In the case of KIBS firms, engineers, technicians and specialists appear as relevant intellectual human capital oriented to solve problems, transfer capacities and co-construct tacit knowledge with clients, who are more oriented to innovation and learning modes of the type doing, using and interacting (DUI) (Parrilli & Alcalde Heras, 2016).

Another specificity that the literature enunciates has to do with cooperation processes and knowledge networks in which these firms are dynamized, especially with university and science and technology institutions, for the development of new products and bi-directional schemes for the provision of services (Braga, Marques, Serrasqueiro, Braga, & Correia, 2017).

Finally, there are two issues to take into account in the analysis of servitization strategies in knowledge-intensive firms: on the one hand, the internationalization processes, as a driver of learning and innovations in contexts of scarce resources and capacities (Boehe, 2016); on the other, the size and organizational structure, which also appears as a differentiating factor with respect to those of manufacturers, since they are smaller and more dynamic (Baines et al., 2017).

Methodology.

For the study, firms from the nutrition and animal health sector in Argentina were selected. The selection criteria for the cases were that they should produce, commercialize and / or supply services related to the production of meat. A universe of 61 firms was formed based on secondary information from Business Chambers related to the sector in Argentina, a response of 40 was achieved (response rate of 85%). We did not accept firms in the sample that only commercialize goods from other manufacturing companies, whether they are for nutrition or animal health.

Out of the total of specialized supplier firms that we consider in this study: 30% are nutrition firms, 42.5% are animal health and 27.5% are dedicated to both activities.

The sample consists of 77.5% of companies with Argentine capital, and 22.5% of foreign direct investment (FDI). The Argentine companies are concentrated in the animal health sector with 38.7% of the cases, and mixed companies of health and animal nutrition (32.3%). Foreign companies are mainly concentrated in animal health activities (55.6%). The export of goods and services occurs in animal health companies, with a higher proportion of firms that export services than those of exporting products. No exports of services related to animal nutrition are reported.

Firms	Nutrition	Animal Health	Nutrition – Animal Health	Total
Argentine Firms	29,0%	38,7%	32,3%	100%
FDI firms	33,3%	55,6%	11,1%	100%
Products Exports	26,1%	52,2%	21,7%	100%
Services Exports	0,0%	75,0%	25,0%	100%

Table 1. Distribution of firms by type of activity and by origin of capital and exports.

Nutrition firms are medium-sized (31.6%) to large (50%), while animal health firms tend to be SME firms (40% small and 52.6% medium). Finally, nutrition and animal health present small companies (40%) and large (33.3%) in the distribution of proportions of the sample.

	Nutrition	Animal Health	Nutrition – Animal Health	Total
Small firms	20,0%	40,0%	40,0%	100%
Medium-sized firms	31,6%	52,6%	15,8%	100%
Large firms	50,0%	16,7%	33,3%	100%

Table 2. Distribution of firms by type of activity and size.
Reference: small up to 20 employees, medium more than 20 and up to 100 employees, large more than 100 employees

A structured survey form was applied with closed and open questions oriented to general descriptive questions of the firms (products, services, commercialization, exports, size, seniority), human resources endowment, R & D activities, laboratory and experimental farms, types of innovations made, technological cooperation. The people who responded to the surveys were general managers or production managers, R & D managers, technology management and innovation managers. The survey was conducted between 2016-2017 in person and / or by telephone.

The treatment of the data was done with descriptive statistics and multiple correspondence analysis was used (Greenacre & Blasius, 2006), which is a multivariate statistical technique that allows to summarize large amounts of information in a reduced number of dimensions or factors where it places the categories of the variables analyzed. The variables of the classification of the Oslo Manual, edition 2018, were used as variables for the assembly of dimensions, with a breakdown of product innovations, considering those referring to goods as innovations of products themselves, and those of services. In the same way we specify the non-significant improvements in products (goods) and services to capture the specificity of these results in the analyzed companies. From the results, two dimensions were determined, which achieved 84% inertia, and then clustering using K-means (Matoušek, 2000). The operational definitions of the variables used are explained in the Appendix.

Results.

Servitization Strategies

Based on the analysis of the types of services offered by the firms surveyed in the study, three types of strategies were generated according to the service-dominant logic evidenced in them (Table 3). Following Lindhult et al (2018), the firms that adopt Product-based logic (PBL) strategies include advice on their own products related to animal health (for example, custom formulations, product concentration tests), nutrition (for example analysis of samples, food, proteins, advice for balanced feed formulations, food formulation) and generics that are made from the sale of the products (example, training in the use of products, product management tips, after-sales monitoring).

Service-based logic strategies are characterized by evidencing services that are provided to customers as an added value, in terms of know-how, quality, productivity and other attributes that strengthen the existing user-supplier relationship. In the case of the firms studied here, the services they provide under this logic focus on laboratory and engineering services, veterinary advice services (animal health), nutritional counseling services and technical training.

The Product-Service System Based Logic strategies show in the study a more complex and co-constructive relationship between supplier-user based on product development and the presence of experimental farms where they are tested and another series of more complex services in terms of technology and knowledge.

Product logic (PBL)	Service logic (SBL)	Product-Service System Based Logic (SysBL)
Product logic (PBL)	**Laboratory and engineering services.**	Co-creation with users of products and services.
Services based on animal health products	Laboratory service	
Special formulations, customized	Technical service to fields	Testing and development of customized products in user
Product concentration tests	Laboratory support and research services.	

Clinical monitoring Serv. to third parties for injectables **Services based on nutritional products** Analysis of samples, food, proteins Advice for balanced feed formulas, Food formulation Control of mixtures Mix products according to equipment capacity Ingredient analysis service Formulation service and elaboration of diets and feeding plans **General Services based on products** Training in the use of products Product handling tips Control of materials Installation and maintenance of pumps for the application of liquid additives Post-sale monitoring Continuous technical support	Training and calibration in machines for vaccines Diagnostic service and information to clients. Diagnosis of Pathologies Plant design and improvements in plant stations **Veterinary services (animal health).** Health advice Veterinary Consultations Diagnosis of diseases Health Plans Regulatory compliance services. Facility operations and support service. **Nutrition counseling services.** Consultancy in the area of Animal Nutrition Engineering Validation of mixers Audit of balanced feed production. Plant audit service. **Technical training** Training biosecurity use of antibiotics	breeding sites and other experimental areas.

PBL = Product Based Logic, SBL = Service Based Logic, SysBL = Product-Service System Based Logic
Table 3. Strategies of Servitization of the firms by type PBL, SBL, SysBL and activities in each of them

Characterization of the analyzed firms.

The production of meat in Argentina has been relevant in the agroindustry economic base of this country, and the traditional production of bovine meat has incorporated other productions such as avian meat, pork, among others. Avian meat production has had a significant growth between 2001 and 2014, driven by the increase in domestic and international consumption, technological (genetic), nutritional and health improvements, among other factors. This impulse to the production of meat alternatives to the traditional one in Argentina, with its consequent expansion, formed a vertically integrated production pole. The co-evolutionary process between transformative firms (refrigerators) and specialized suppliers of inputs and services; being some of this type the companies of nutrition and animal (Lepratte, Pietroboni, Blanc, & Hegglin, 2015). This growth is due to several factors, fundamentally to a process of technological change in the sector of production of avian meat that is driven by the findings in the field of animal genetics and the improvement of nutritional quality and animal health. The first of these fields (animal genetics) is highly concentrated in large international players that, with closed technology packages, regulate the processes of innovation and technological change in the sector. In Argentina it is concentrated in a small number of licensees; whereas, there are windows of opportunity to carry out processes of incremental improvement and development

of new products and services in the second field, that is, of animal nutrition and health (Constance, Martinez-Gomez, Aboites-Manrique, & Bonanno, 2013).

The nutrition companies are engaged in developing and / or marketing food products that improve the nutritional quality and favor the functioning of the animal digestive system to achieve maximum productive potential. It offers a wide range of products ranging from digestive enzymes, metabolic regulator additives, liver protectors, amino acids, antioxidants, prebiotics and mycotoxin absorbers to food supplements, nuclei and vitamin supplements, mineral premixes, among others. In terms of services, they provide advice on nutrition and animal feed, custom formulations of food and premixes, services and field monitoring and analysis of raw materials and products.

Firms of animal health either produce and / or market products that improve animal health and welfare, such as vaccines to prevent diseases either in injectable presentation, tablets or powders for dilution in water and food to antibiotics, anti-inflammatories, antihistamines, antiparasitic, hormonal, disinfectants and biological products. They also cover different services that range from technical advice, field monitoring, vaccination services and training to more specific and knowledge-intensive services such as diagnosis and disease prevention.

Those dedicated to nutrition and health, elaborate and / or commercialize vitamin nuclei, pre-mixes, and additives that improve the nutritional quality of animals; and antibiotics mainly in the health products. Regarding the services, technical and nutritional advice stand out.

The PBL companies represent 67.5% of the firms in the sample, while the SBLs represent 17.5% and 15% of the SysBL type. As for the PBL strategy, there is a higher proportion of firms focused on animal health (37%), followed by those of nutrition (33.3%) and finally those of nutrition and animal health (29.6%). Regarding the SBL strategy, animal health firms accounted for the largest share of the distribution (57.1%), nutrition and animal health (28.6%) and underweight of nutrition (14.3%). Meanwhile, in SysBL strategies that represent greater complexity in user-supplier relationships, the highest proportion of firms that adopt this strategy are those of animal health (50%), followed by 33.3% of nutrition and 16.7% of the firms of nutrition and animal health.

	PBL	**SBL**	**SysBL**
Nutrition	33,3%	14,3%	33,3%
Animal Health	37,0%	57,1%	50,0%

Nutrition and Animal Health	29,6%	28,6%	16,7%
Participation over the total sample	67,5%	17,5%	15,0%

PBL = Product Based Logic, SBL = Service Based Logic, SysBL = Product-Service System Based Logic
Table 4. Distribution of firms by activity type and service logic

Small firms tend to be PBL (73.33%), and there is an absence of SysBL companies in this size. And they are strongly concentrated in health firms, in 80% of the cases. On the other hand, medium-sized companies have a high degree of specialization in PBL (73.68%) and in SysBL they account for 15.79% of cases and concentrate on healthcare (52.60%). Large companies are SysBL (50.0% of cases) and are concentrated mostly in the animal nutrition sector in 83.3% of cases.

Firms Size	**PBL**	**SBL**	**SysBL**
Small firms	73,33%	26,67%	0,00%
Medium-size firms	73,68%	10,53%	15,79%
Large firms	33,33%	16,67%	50,00%

PBL = Product Based Logic, SBL = Service Based Logic, SysBL = Product-Service System Based Logic
Table 5. Servitization strategies and size of companies.

The service-dominant logic in the national capital is concentrated in PBL with 70.97%, while the distribution of foreign firms is not as concentrated in PBL although it reaches 55.5% of the sample followed by the strategy SBL with 33.33%. Both exporters of products and services are concentrated in PBL as the first option followed by SysBL.

Variable	**PBL**	**SBL**	**SysBL**
Argentine Firms	70,97%	12,90%	16,13%
FDI firms	55,56%	33,33%	11,11%
Products Exports	73,91%	8,70%	17,39%
Services Exports	50,00%	25,00%	25,00%

Table 6. Relationship of origin and exporting behaviors and service logic.

The diversity of competitive strategies based on product - service systems (servitization) developed by the firms analyzed in the study lead to problematizing the cataloging of them according to traditional industry nomenclature (Miles, et al 2018). If we analyze them from the ISIC we find, on the one hand, that these firms elaborate products and, therefore, obey classification criteria such as manufacturing (Table 7). Animal nutrition would thus enter Section C Manufacturing, code 1080 "production of products prepared for animals", while those of animal health, correspond to Section C Manufacturing in class 21 "manufacture of pharmaceutical products, substances medicinal chemistry and botanical products for pharmaceutical use comprising the manufacture of pharmaceutical base products and pharmaceutical preparations".

From the perspective of the services, using the ISIC, the analyzed firms provide services corresponding to Section M Professional, scientific and technical activities, and within these, the code 7120 "Technical tests and analyzes", which includes activities such as: physical, chemical and other analytical tests of all types of materials and products (...), tests in the field of food hygiene, including testing and veterinary control activities in relation to food production ". Likewise, other services are framed in class 75 "Veterinary activities", which includes the "activities of medical attention and control of animals in agricultural establishments". Likewise, there are services developed by these firms that enter class 7490 "Other professional, scientific and technical activities n.c.p.", which include a wide variety of service activities that are usually provided to commercial clients. It covers activities in which more advanced levels of professional, scientific and technical knowledge are required, but not current functions that are usually short-lived. The following activities are included: agronomy and environmental consulting.

Finally, these firms based on their activities of R & D services, technical laboratories and experimental farms could fit the code 72 "Scientific research and development", in particular in "experimental research and development activities" in the category "sciences" and engineering ", which includes them in class 721" Research and experimental development in the field of natural sciences and engineering "(natural sciences, engineering and technology, medical sciences, biotechnology, agricultural sciences, interdisciplinary research and development centered mainly in the natural sciences and engineering".

Classification	Nutrition firms	Animal Health firms

Manufacture	Section C Manufacturing, code 1080 of "preparation of products prepared for animals"	Section C Manufacturing industry in class 21 "manufacture of pharmaceutical products, medicinal chemicals and botanical products for pharmaceutical use"
Services	Section M Professional, scientific and technical activities, 7120 "Technical tests and analyzes", 75 "Veterinary activities", 7490 "Other professional, scientific and technical activities", 72 "Scientific research and development", in particular in "research activities" and experimental development ", 721" Investigations and experimental development in the field of natural sciences and engineering "	

Table 7. Classification of firms analyzed according to the ISIC Nomenclature. By type of economic activity.

The specificity of innovation and service provision capabilities

In the analyzed companies, we find areas of knowledge production and technology development, considering different combinations of capacities, organizational modalities and technology management and innovation in them, based on: R&D areas, technical laboratories and experimental farms. 40% of firms have R&D areas that are oriented to develop new products or incremental improvements to products based on customer requirements. Some firms have an R&D strategy that is exclusive to develop their products, but others propose a mix, and carry out research for other firms in the country and abroad, thus exporting their services. Other firms (32.5%) have their R&D team external to the organization (outsourced) or in their parent companies, this is the case of foreign capital firms mainly.

The technical laboratories carry out support of research and development activities, and other functions such as: quality tests, safety studies, tests, product improvements, analysis of ingredients and samples. 70% of the firms have technical laboratories and stand out permanent work teams generally endowed with human capital with synthetic and analytical capabilities.

A specific feature of this type of firms is the presence of experimental farms that represent a field of production and co-creation of knowledge between firms and their clients, where activities such as product testing, special formulations tests, trials are carried out and handling of breeding techniques, weight analysis, mortality, among others. 42.5% of firms work with this type of knowledge production in experimental farms, and it is important to mention that in addition to their own farms, cooperation modalities exist using farms of clients, farms of universities and Science & Technology institutions (S&T Institutions).

	internal R&D	Non-internal R&D	Laboratories	Experimental Farms

Nutrition firms	33,30%	33,30%	66,70%	33,30%
Animal Health firms	41,20%	35,30%	76,50%	47,10%
Nutrition – Animal Health firms	45,50%	27,30%	63,60%	45,50%
Participation over the total sample	40,00%	32,50%	70,00%	42,50%
PBL (Product based logic)	68,8%	61,5%	60,7%	47,06%
SBL (Service based logic)	12,5%	30,8%	17,9%	23,53%
SysBL (System based logic)	18,8%	7,7%	21,4%	29,41%

Table 8. Relationship of R & D routines with activities type, and with products and services.

The Argentine firms in greater proportion have internal R&D (48.4%), as well as laboratories (71%) and experimental farms (48.4%). Foreign firms have R&D outside Argentina (88.9%), 66.7% laboratories and 22.2% experimental farms.

	Internal R&D	Non-internal R&D	Laboratories	Experimental Farms
Argentine firms	48,4%	16,1%	71,0%	48,4%
FDI firms	11,1%	88,9%	66,7%	22,2%
Participation over the total sample	40,0%	32,5%	70,0%	42,5%

Table 9. R&D, laboratories and experimental farms according to the origin of the capital

Servitization strategies and technological and non-technological innovation.

The specificity of the innovation processes based on relations of co-construction of knowledge and co-creation between the firms analyzed and their clients, mediated by technological capabilities that adopt different management modalities, through R&D areas, laboratories and experimental farms, connects us with other issues raised in this work, like the relationship between servitization strategies and the type of innovations made by the firms. In particular, how this relationship occurs and to what extent the human capital, the technological capabilities and cooperation modalities that they made influence the technological and non-technological innovations carried out by these firms, as well as other traditional factors such as: market orientation, size of the companies, seniority, among others.

From the point of view of innovation, companies innovate at a technological level in 67.5% of the cases and non-technological in 52.5% of these. The best results in terms of technological and non-technological innovation occur in animal health companies, meanwhile the companies of logic of systemic services have a high performance in both levels of innovation in 83.3% of cases.

Variable	Nutrition	Animal Health	Nutrition – Animal Health	PBL	SBL	SysBL
Technological Innovation	33,3%	40,7%	25,9%	66,7%	57,1%	83,3%
Non-technological innovation	33,3%	42,9%	23,8%	44,4%	57,1%	83,3%

Table 10. Technological and non-technological innovation and its activities of the firms, and with products and services.

In order to deepen what was affirmed above, a series of econometric models are proposed to verify the causality of certain variables on innovation results, according to the methodology proposed in the Methodology section.

Cluster analysis based on the typologies of innovations carried out, presents a distribution of three clusters and their corresponding proportions of cases in the sample, where the highest proportion is cluster 3 (47.5%), followed by cluster 1 (37.5%) and cluster 2 (15%).

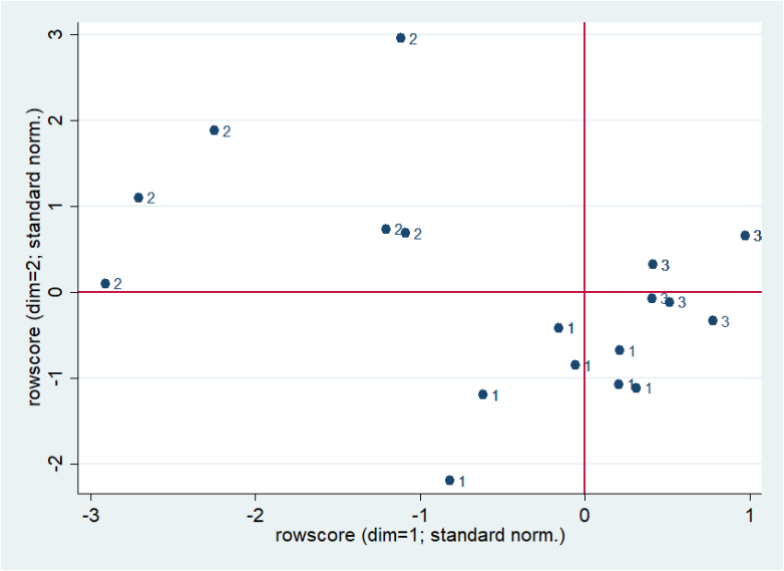

Figure 1. Position of the cases in relation to the dimensional axes and belonging to the cluster analysis.

When analyzing the averages of the incorporated variables, the results show that cluster 1 is of high performance in innovations in product, processes and organizational without having innovations in services. Cluster 2 is characterized by being an integral innovator, that is, in all the innovation variables analyzed, with a strong weight of innovations in services

and products. Cluster 3 is the least innovative with an orientation to innovate in low frequency in products and processes.

	Cluster 1		Cluster 2		Cluster 3	
Variables	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Products Innovations	0,67	0,49	0,83	0,41	0,21	0,42
Services Innovations	0,00	0,00	0,83	0,41	0,00	0,00
Products improvements	0,87	0,35	0,67	0,52	0,05	0,23
Services improvements	0,00	0,00	0,83	0,41	0,00	0,00
Process Innovations	0,53	0,52	0,50	0,55	0,11	0,32
Market Innovations	0,40	0,51	0,17	0,41	0,05	0,23
Organizational Innovations	0,53	0,52	0,50	0,55	0,32	0,48

Table 11. Cluster K-Medias and behavior (mean and standard deviation) in the variables used for the multiple correspondence analysis.

The presence of animal health firms is concentrated to a greater extent in cluster 2, while the greater frequency of nutrition firms is given in cluster 3. If we look at these logics, cluster 1 and 3 are dominated by the PBL logic, and Cluster 2 is the most homogeneous distribution and where there are more cases of SysBL.

Cluster	**Nutrition**	**Animal Health**	**Nutrition–Animal Health**	**PBL**	**SBL**	**SysBL**
1	20,0%	46,7%	33,3%	73,33%	13,33%	13,33%
2	33,3%	50,0%	16,7%	33,33%	33,33%	33,33%
3	36,8%	36,8%	26,3%	73,68%	15,79%	10,53%

Table 12. Relationship of the cluster with the activities, and with products and services.

When comparing the differences of means and proportions there is a difference between the clusters in the descriptive variables of the firms, noting that, cluster 1 is about companies of greater seniority and larger in terms of number of employees with high productivity, and they are characterized by exporting products. Cluster 2 corresponds to more recent firms, medium in size in terms of employees, low productivity in relation to the sample mean, which export both products and services, the latter with the highest results in the sample. Finally, Cluster 3 corresponds to companies created in the 1990s with a small size for the sample, but with a high productivity and in some cases, they export products, but not services. If we consider the logics

of services, there are significant differences according to the membership cluster, with the PBL being the least represented in cluster 2, the SBL logic emphasizing its participation in cluster 2, and finally cluster 3 having a greater amount of SysBL. The above confirms what has been expressed of the most homogeneous distribution of cluster 2. Regarding export routines, clearly those of cluster 1 are better exporters of products, and in turn those of cluster 2 are those that export more services with a clear difference in his favor.

Cluster	**1**	**2**	**3**	**Total**	**Significance**
Technological innovations	1,00	0,83	0,36	0,67	NS
Non-Technological innovations	**0,60**	**0,83**	**0,36**	**0,52**	**
Products Innovations	0,66	0,83	0,21	0,47	Ns
Services Innovations	**0,00**	**0,83**	**0,00**	**0,12**	**
Market Innovations	0,40	0,16	0,05	0,20	NS
Process Innovations	0,50	0,50	0,10	0,32	NS
Organizational Innovations	**0,53**	**0,5**	**0,31**	**0,42**	**
Products improvements	0,86	0,66	0,05	0,45	Ns
Services improvements	**0,00**	**0,83**	**0,00**	**0,12**	**

Table 13. Performance in proportions of the clusters in innovation variables.
** Statistical significance at 0.05, and the confidence level 95%. NS: No statistical significance

Variable / Cluster	**1**	**2**	**3**	**Total**	**Significance**
Foundation years	**1986**	**2004**	**1996**	**1993**	**
Employees	100,80	64,00	40,84	66,80	NS
Total turnover	146	16	45	78[1]	NS
Productivity	**1.296**	**208**	**1.165**	**1.071**[2]	**
Argentine firms	0,80	0,83	0,74	0,78	NS
Firms group	0,40	0,17	0,37	0,35	NS
PBL	0,73	0,33	0,74	0,67	NS
SBL	0,13	0,33	0,16	0,18	NS

[1] Total turnover in millions of Argentine pesos at 2017/04 (u$s 64,433).
[2] Productivity in millions of Argentine pesos at 2017/04 (u$s 64,43).

SysBL	0,13	0,33	0,11	0,15	NS
Sale of third-party products	**0,46**	**0,66**	**0,52**	**0,52**	**
Products exports	**0,87**	**0,50**	**0,37**	**0,58**	**
Services exports	**0,07**	**0,50**	**0,00**	**0,10**	**

Table 14. Performance in means and proportions of the clusters in descriptive variables.
** Statistical significance at 0.05, and the confidence level 95%. NS: No statistical significance

Regarding human capital, the significant differences between the clusters are in the proportions of "other professionals" related to natural sciences and agronomy, and administrators and organizers of companies.

Cluster 1 evidences a significant average presence of business managers and specialists in industrial organization. Cluster 2, on the other hand, is the one with the best performance in the levels of all the analyzed variables: presence of engineers, veterinarians, other professionals of natural sciences and agronomy. Cluster 3 does not stand out in any aspect as far as its human capital, having marked weakness in other professionals and administrators.

Variable / Cluster	**1**	**2**	**3**	**Total**	**Significance**
Engineers	0,73	1,00	0,58	0,70	NS
Veterinaries	0,73	1,00	0,58	0,70	NS
Other Professionals	**0,46**	**1,00**	**0,31**	**0,47**	**
Management / Industrial Organization professionals	**0,66**	**0,83**	**0,25**	**0,50**	**

Table 25. Performance in proportions of the clusters in terms of intellectual human capital.
** Statistical significance at 0.05, and the confidence level 95%. NS: No statistical significance

From the analysis of the variables of technological capabilities and cooperation to promote and support innovation, significant differences between the clusters are found in the presence of Service Laboratories, and links with Universities and business Chambers. From this, it arises that the firms of cluster 1 stand out for owned laboratories, R&D teams, owned or settled abroad, incorporation of technologies, and cooperation with universities and cameras. The firms of cluster 2 have the best performance in all the analyzed variables of technological capabilities and cooperation, except for their own R&D team and based abroad. Those in cluster 3 have low levels of capabilities and cooperation.

Variable / Cluster	**1**	**2**	**3**	**Total**	**Significance**
Laboratory	**0,87**	**1,00**	**0,47**	**0,70**	**

Internal R&D Team	0,53	0,33	0,32	0,40	NS
Non-internal R&D Team	0,40	0,17	0,32	0,33	NS
Software - hardware	0,47	0,67	0,32	0,43	NS
Machines and equipment	0,80	0,83	0,63	0,73	NS
Cooperation with Science and Technology Institutions	0,47	0,67	0,53	0,53	NS
Cooperation with Universities	**0,53**	**0,83**	**0,26**	**0,45**	**
Industrial sector association	**0,33**	**1,00**	**0,42**	**0,48**	**
Experimental farms	0,93	1,17	0,47	0,75	NS

Table 16. Performance in proportions of the clusters in technological capabilities and cooperation for innovation.
** Statistical significance at 0.05, and the confidence level 95%. NS: No statistical significance

Conclusions

The study shows that servitization in pharmochemistry firms of nutrition and animal health with veterinary and agronomic services is a complex phenomenon that includes a diversity of strategies, capacities and characterizations that need be analyzed in depth, particularly in terms of co-operative innovation processes with clients and other organizations such as science and technology and university institutions.

The nutrition and animal health firms in Argentina have developed a diversification process based on PBL, SBL and SysBL servitization strategies, which makes them an interesting firm's strategy to analyze in terms of upgrade processes that can be characterized as specialized suppliers of knowledge-intensive manufactures and services, especially in animal health. Human capital is a fundamental component, evidencing a mix of knowledge bases of the STI type (Science, Technology and Innovation) with engineers and scientists, and DUI (doing, using and interacting) with veterinarians, agronomists, administrators, industrial organizers, and specialized sales technicians. For this reason, it is interesting to deepen the dynamics and hybrid modalities of organizational areas destined to generate technological and non-technological innovations: R & D areas (internal and external), laboratory and experimental farms, and interactive processes and co-construction of products and services with clients.

From the point of view of the market dynamics of knowledge-intensive services, the diversification process evidenced by animal health suppliers is positive for SMEs of domestic capital, particularly recently created ones (cluster 2), since they

demonstrate the potential to promote upgrading processes by exporting products and services with a mix of PBL, SBL or SysBL strategies. This access to international markets with demands of greater complexity in terms of specificity of products and services, postulates the need to think about innovation policies that promote technological and innovation capabilities in knowledge-intensive service sectors related to the productive specialization profiles of the region.

References

Baines, T., Bigdeli, A. Z., Bustinza, O. F., Shi, V. G., Baldwin, J., & Ridgway, K. (2017). Servitization: revisiting the state-of-the-art and research priorities. *International Journal of Operations & Production Management*, *37*(2), 256-278. https://doi.org/10.1108/IJOPM-06-2015-0312

Boehe, D. M. (2016). The Internationalization of Service Firms from Emerging Economies: An Internalization Perspective. *Long Range Planning*, *49*(5), 559-569. https://doi.org/10.1016/j.lrp.2015.09.006

Bolisani, E., Paiola, M., & Scarso, E. (2013). Knowledge protection in knowledge-intensive business services. *Journal of Intellectual Capital*, *14*(2), 192-211. https://doi.org/10.1108/14691931311323841

Braga, A. M., Marques, C. S., Serrasqueiro, Z. M., Braga, V. L., & Correia, A. I. (2017). The Contribution of KIBS to Innovation and Competitiveness in Business Networks. En *Cooperative and Networking Strategies in Small Business* (pp. 63-80). Springer, Cham. https://doi.org/10.1007/978-3-319-44509-0_5

Bustinza, O. F., Bigdeli, A. Z., Baines, T., & Elliot, C. (2015). Servitization and Competitive Advantage: The Importance of Organizational Structure and Value Chain Position. *Research-Technology Management*, *58*(5), 53-60. https://doi.org/10.5437/08956308X5805354

Consoli, D., & Elche, D. (2013). The evolving knowledge base of professional service sectors. *Journal of Evolutionary Economics*, *23*(2), 477-501. https://doi.org/10.1007/s00191-012-0277-1

Constance, D. H., Martinez-Gomez, F., Aboites-Manrique, G., & Bonanno, A. (2013). The Problems with Poultry Production and Processing. En J. James Harvey S. (Ed.), *The Ethics and Economics of Agrifood Competition* (pp. 155-175). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-6274-9_8

Cusumano, M. A., Kahl, S. J., & Suarez, F. F. (2015). Services, industry evolution, and the competitive strategies of product firms. *Strategic Management Journal*, *36*(4), 559-575. https://doi.org/10.1002/smj.2235

Fry, T. D., Steele, D. C., & Saladin, B. A. (1994). A Service-oriented Manufacturing Strategy. *International Journal of Operations & Production Management*, *14*(10), 17-29. https://doi.org/10.1108/01443579410067225

Gallouj, F., & Savona, M. (2009). Innovation in services: a review of the debate and a research agenda. *Journal of Evolutionary Economics*, *19*(2), 149. https://doi.org/10.1007/s00191-008-0126-4

Goedkoop, M. J., Van Halen, C. J., Te Riele, H. R., & Rommens, P. J. (1999). Product service systems, ecological and economic basics. Product service systems, ecological and economicReport for Dutch Ministries of environment (VROM) and economic affairs (EZ), 36(1), 1-122.

Gomes, E., Cunha, M. P. e, & Vendrell-Herrero, F. (2018). *7th International Business Servitization Conference*. OmniaScience.

Greenacre, M., & Blasius, J. (2006). *Multiple correspondence analysis and related methods*. Chapman and Hall/CRC.

J-Figueiredo, R., Neto, J. V., Quelhas, O. L. G., & Ferreira, J. J. de M. (2017). Knowledge Intensive Business Services (KIBS): bibliometric analysis and their different behaviors in the scientific literature: Topic 16 – Innovation and services. *RAI Revista de Administração e Inovação*, *14*(3), 216-225. https://doi.org/10.1016/j.rai.2017.05.004

Kamp, B. (2016). Servitización: génesis, temas actuales y mirada al futuro. *Ekonomiaz: Revista vasca de economía*, (89), 252-279.

Kowalkowski, C., Gebauer, H., Kamp, B., & Parry, G. (2017). Servitization and deservitization: Overview, concepts, and definitions. *Industrial Marketing Management*, *60*, 4-10. https://doi.org/10.1016/j.indmarman.2016.12.007

Lepratte, L., Pietroboni, R., Blanc, R., & Hegglin, D. (2015). Socio-technical system innovation. An analysis of the dynamics of the poultry meat production sector in Argentina. *Revista Iberoamericana de Ciencia, Tecnología y Sociedad*, *10*(28), 57-83.

Lightfoot, H., Baines, T., & Smart, P. (2013). The servitization of manufacturing: A systematic literature review of interdependent trends. *International Journal of Operations & Production Management*, *33*(11/12), 1408-1434. https://doi.org/10.1108/IJOPM-07-2010-0196

Lindhult, E., Chirumalla, K., Oghazi, P., & Parida, V. (2018). Value logics for service innovation : practice-driven implications for service-dominant logic. *Service Business: An International Journal*, 1-25.

Lodefalk, M. (2017). Servicification of Firms and Trade Policy Implications. *World Trade Review*, *16*(1), 59-83. https://doi.org/10.1017/S147474561600029X

Matoušek, J. (2000). On Approximate Geometric k -Clustering. *Discrete & Computational Geometry*, *24*(1), 61-84. https://doi.org/10.1007/s004540010019

Miles, I. (2005). Knowledge intensive business services: prospects and policies. *Foresight*, *7*(6), 39-63. https://doi.org/10.1108/14636680510630939

Miles, I. D., Belousova, V., & Chichkanov, N. (2018). Knowledge intensive business services: ambiguities and continuities. *Foresight*, *20*(1), 1-26. https://doi.org/10.1108/FS-10-2017-0058

Muller, E., & Doloreux, D. (2007). *The key dimensions of knowledge-intensive business services (KIBS) analysis: a decade of evolution* (Working Paper No. U1/2007). Arbeitspapiere Unternehmen und Region. Recuperado de https://www.econstor.eu/handle/10419/29335

Parrilli, M. D., & Alcalde Heras, H. (2016). STI and DUI innovation modes: Scientific-technological and context-specific nuances. *Research Policy*, *45*(4), 747-756. https://doi.org/10.1016/j.respol.2016.01.001

Vandermerwe, S., & Rada, J. (1988). Servitization of business: Adding value by adding services. *European Management Journal*, *6*(4), 314-324. https://doi.org/10.1016/0263-2373(88)90033-3

Appendix

Variables of innovation results

Variable	Definition
Technological Innovation	binary variable of value 1 if it achieved innovation in products and / or innovation in processes and 0 otherwise.
Non-Technological Innovation	binary variable of value 1 if it achieved innovation in organization and / or innovation in marketing and 0 otherwise

Variables of servitization strategies, commercialization, size of firms, foundation years.

Variable	Definition
Servitization strategy: Product-based logic	binary variable of value 1 if you made at least 1 PBL activity defined in Table 3 and 0 otherwise
Servitization strategy: System-based logic	binary variable of value 1 if you made at least 1 SysBL activity defined in Table 3 and 0 otherwise
Servitization strategy: Service-based logic	binary variable of value 1 if it performed at least 1 SBL activity defined in Table 3 and 0 otherwise
Sale of third-party products	binary variable of value 1 if this activity is carried out by the company and 0 otherwise
Size firms	continuous variable that expresses the number of employees that the firm has at the time of the sample.
Foundation year	continuous variable that expresses the year of foundation of the company.
Services Exports	binary variable of value 1 if it managed to export products and 0 otherwise.
Products Exports	binary variable of value 1 if it managed to export services and 0 otherwise.
Products – Services Nutrition	binary variable of value 1 if the company specializes in animal nutrition products and 0 otherwise
Products – Services Animal Health	binary variable of value 1 if the company specializes in animal health products and 0 otherwise
Products – Services Nutrition and Animal Health	binary variable of value 1 if the company specializes in animal nutrition and health products and 0 otherwise

Variables of Human Capital

Variable	Definition
Engineering	binary variable of value 1 if you have this type of professionals within the company and 0 otherwise
Other Professionals: Bromatologist, Zootechnicians, Specialist in nutrition, agronomist.	Binary variable of value 1 if you have this type of professionals within the company and 0 otherwise.
Veterinaries	Binary variable of value 1 if you have this type of professionals within the company and 0 otherwise
Management / Industrial Organization professionals	Binary variable of value 1 if you have this type of professionals within the company and 0 otherwise

Variables of Innovation Capacities and Technological cooperation.

Variable	Definition
R&D team	binary variable of value 1 if it carries out R&D activities within the company and 0 otherwise.
Non-internal R&D team	binary variable of value 1 if its non-internal R&D activities within the company and 0 otherwise.
Laboratory	binary variable of value 1 if it has a laboratory and 0 otherwise.
Experimental Farm	binary variable of value 1 if you use experimental farm and 0 otherwise.
Software and hardware	binary variable that has value 1 in case the company has acquired software or hardware in the study period and 0 otherwise.

Machines and equipment	binary variable that has value 1 in case the company has acquired machines or equipment in the study period and 0 otherwise.
Cooperation with Science and Technology Institutions	binary variable that has a value of 1 if the company has had links with S & T agencies in the study period and 0 otherwise.
Cooperation with Universities	binary variable that has a value of 1 if the company has had links with universities in the study period and 0 otherwise.