Abstract. *Strategic management models have been evolving in the business domain on a continuous basis but the overwhelming majority of works in this field gives the impression that it is only the manufacturing industry that needs strategy and strategic models, or that the strategy in the professional services industry is the same as in the manufacturing industry despite their distinctive characteristics and managerial implications. By using the Porter's Five Forces framework for industry analysis, which evaluates a certain industry based on five parameters each focusing on different challenges a company can potentially face with, the paper aims at analyzing the strategic landscape of engineering consulting and design companies. The purpose of this paper is to discuss an interpretation and adaptation of Porter's Five Forces model to professional services industry, and in particular to engineering consulting and design industry.*

Keywords: professional services firms (PSFs), industry analysis, engineering consulting and design companies (ECDCs).

STRUCTURAL ANALYSIS OF ENGINEERING CONSULTING AND DESIGN INDUSTRY

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1. Introduction

Strategic management models have been evolving on a continuous basis since the late nineteenth century but the overwhelming majority of works in this field gives the impression that there are only the manufacturing or services industries that need strategy and strategic models, or that the strategy in the professional services industry (e.g. Professional Engineering Consulting and Design Services) is the same as in the manufacturing industry despite their distinctive characteristics, managerial implications and organizational responses.

By using the classic framework for industry analysis known as Porter's Five Forces, which evaluates a certain industry based on five parameters, the paper aims at analyzing the general and most common competitive landscape and adapting Porter's model for the case of the Engineering Consulting and Design Industry. The engineering consulting and design, although it is a niche industry, cannot be viewed in isolation since the industry's structure and trends are influenced by a wider range of stakeholders, encompassing clients, higher education institutions, supply industries, professional and trade associations.

The analysis in this report is supported by the general literature on Professional Services Firms (PSFs), scarce literature on engineering firms, also by author's own practicing experience of more than 20 years in the consulting and engineering design industry, both as a design engineer also as a general manager of an engineering company.

The analysis can be characterized as a descriptive one, starting with a general overview of the engineering consulting and design industry, containing a literature survey on the specific characteristics of Engineering Consulting and Design Companies – ECDCs (common with those of PSFs) and a description and classification of the engineering consulting and design services, and then continuing with an introduction of Porter's Five Forces framework adapted for the specific case of engineering consulting and design industry. The paper ends up with a set of conclusions and managerial implications, also with a set of proposed directions for further research on the industry.

2. Engineering consulting and design industry – a general overview

Within the Professional Services Firms (PSFs) sector, engineering consulting and design companies (ECDCs) are among the least studied entities (Rimmer, 1991). However, in the international management literature there can be found some books and papers approaching narrow and distinct directions of study such as characterization of consulting and engineering design organizations in developing countries (Aráoz, 1981; Malhotra, 1976; Kamenetzky, 1976), exploratory empirical study of the international consulting engineering design services industry from an U.S. perspective (Stanbury, 1992), strategic management in engineering organizations (Chinowsky and Meredith, 2000; Chinowsky, 2001; Veshosky, 1994), operational

strategy, flexibility and performance (Aranda, 2003), knowledge creation and management (Baark, 2002), pricing of engineering services (Farr, 2001; Stasiowsky, 1993; Sturts and Griffis, 2005), product design (Hales and Gooch, 2004; Reinertsen, 1997), costs control engineering design organizations (Pellicer, 2005), marketing practices and strategies of engineering design firms (Jaafar et al., 2008; Maliti, 2010; Shearer, 1990), critical success factors (Koutsikouri, 2006), impact of diversity, experience, compensation of human capital on firm performance (Laursen et al., 2005), relationship between intellectual capital and business performance (Huang and Hsueh, 2007), and the learning process during customer relationship (Salmi et al., 2005).

The ECDCs, among others of the same knowledge-based and professional type, are worthy of attention since they played and are still playing an important role in the economic growth of countries in the world today. That they have been unnoticed so far is probably because they are so obscure, small and hidden in statistics as services or, in the best case, as professional services companies.

As ECDCs belong to the PSFs category which in its turn is a sub-group of the *Knowledge-Intensive Firms (KIFs)* or *Know-How Companies* group, the following mutual characteristics of these types of companies relevant for the present analysis are presented (Løwendahl, 2005; Sveiby and Lloyd, 1987; Alvesson, 1995, 2004; Scott, 1998):

- Their business consists in creative, complex, and customized problem-solving. Most projects performed are prototypes. Hence, production processes are not easily industrialized.
- There is an informational asymmetry between the professional service provider (ECDC) and customer, which often favors the former over the latter.
- Both their inputs and outputs are intangible. For professional workers (engineers, designers) knowledge is simultaneously an input, medium and output of their work (Newell et al., 2002) and is characterized by a high degree of intangibility. Even though for ECDCs the outputs are in form of studies, drawings, plans, specifications, calculation reports, instructions, which are tangible, storable and reusable, the intangibility of outputs refers in this case to the lack of customers' capability to physically feel and assess the outputs because of the lack of specialized knowledge and information.
- Their key strategic resource is the human capital with its knowledge, competences, capabilities, skills, expertise and experience rather than the financial capital or machines. They build their strengths through highly qualified engineers and designers.
- Their number of highly qualified professional employees (engineers, designers) doing knowledge-based work out of the total number of employees usually amounts to 80-85% for large-sized firms and 95-100% for medium and small-sized firms. Fixed personnel costs represent about 65-70% of all fixed costs of the company due to professional hiring.

- Training and motivation of their professional engineers is the equivalent of what maintenance is for the machines and equipment in the manufacturing companies.
- Recruitment of highly qualified and experienced engineers and designers is the counterpart of investment in new machines and equipment in a manufacturing company.
- Their professional workers are the equivalent of the machines in the manufacturing companies.
- Research and development activities are the counterpart of investments in new products in a manufacturing company.
- Investments are written off in short periods of time, especially for computer hardware and software that have to be continually renewed in order to stay competitive.
- The information flow in an ECDC is similar to the flow of materials and goods in the manufacturing companies.
- The know-how of their personnel, which can only be considered on an "invisible" balance sheet, counterbalances the fixed assets on the traditional balance sheet of manufacturing companies.
- Selling consulting and engineering design services to potential clients is very different from the mass-marketing of consumer goods or services as it involves both interactions with the customer and a high degree of uncertainty in terms of what actually is going to be delivered.
- Demand of consulting and engineering design services is regularly characterized by uncertainty, unpredictability, severe fluctuations, stagnation, or even discontinuity over time, depending on the economic cycles and investment policies of the potential customers.

Engineering consulting and design services, as highly specialized activities, represent a key knowledge-intensive sector that emerged during a later phase of industrial development when a need for innovative solutions and improved design for construction projects, plants layout and technologies became evident. It has been seen as the key factor in the generation and definition of new technologies in advanced industrial economies and as a key factor in undertaking technology transfer in developing economies. The markets for engineering consulting and design services are therefore primarily related to the growth of industries (metals, mining, power, oil and gas, heavy machinery, cement, etc.) and construction sector, and business in this industry tends to fluctuate with the cycles of growth and stagnation in manufacturing and production in major markets.

Engineering consulting and design services are generally defined as highly specialized activities of intellectual nature, which identify, select, organize and apply technological engineering knowledge for purposes of investments and production. They are characterized by certain methods/methodologies of work and often by a multidisciplinary approach (engineering, architecture, economics, finance, project management, ecology). The ECDCs may provide any or all of a number of services, from consultancy to engineering, and these services can be categorized according to

the stage of a project for which the services are provided. As such, there are services related to formulation of the project, research operations which explore various technologies available for a specific operation resulting in the choice of product design and technology to be used, project evaluation, basic and detailed engineering and design, procurement of plant components, preparation of bid and contract documents, supervision of fabrication and construction, commissioning, testing and start-up of a new plant, training of personnel, services related to the operation and maintenance of an industrial facility.

Depending on the sector the ECDCs are active in, they can be categorized in:

- Civil (roads, bridges, railways, tunnels, airports, dams, harbors, docks, social utility buildings, water supply and treatment plants, sewerage systems, irrigation systems, land planning and architecture, commercial buildings, communication systems, hydrology, geology, etc.)
- Industrial (metals, mining, power, heavy machinery, ship building, aircraft, oil and gas, cement, glass, chemical, pulp and paper, nuclear, manufacturing facilities, power transmission and distribution plants, etc.)
- Military (guns, ammunition, defense systems, special machines and communication systems, etc.)
- Environmental (environment protection systems and plants, waste disposal and recycling, management and use of natural resources, etc.)

Engineering consulting services are particularly defined as activities involved in the identification and organization of technological knowledge, relating its possibilities and uses to the context of physical, technological, economic, social, and environmental requirements. Depending on the stage of a project for which the services are provided, consulting services can be grouped into three categories:

- *Pre-investment consulting services,* rendered before the materialization of an investment, in order to identify, prepare and evaluate projects and select the appropriate technologies. These services are provided (typically for industrial-type projects) before the actual start of engineering design and fabrication and comprise techno-economic, pre-feasibility, project feasibility and evaluation studies (including market, location, technological, economic, commercial, financial and environmental aspects), preparation of terms of reference and invitations for tender;
- *Project implementation consulting services,* rendered during the execution of the project. These services are comprised of *project engineering* (choice of appropriate technology and equipment, engineering surveys, specifications, tendering, bids evaluation and contracting, negotiation of financial, commercial, know-how agreements, information systems), *supervision of project execution* (procurement, fabrication, construction, erection, installation), and *commissioning and start-up* (including personnel training);
- *Consulting services for management and production,* rendered during the operation stage of an investment which has already been materialized. These services comprise technical assistance and troubleshooting during operation/production, production planning and control, cost control and optimization, product design and

development, process improvement, quality control and maintenance systems, sales and inventory systems, expansion programs, personnel training, management information and control systems, etc.

Engineering design services, rendered mainly during the project implementation stage (project engineering), are particularly defined as activities involved in the application of knowledge in order to develop data, diagrams, drawings, models, simulation and calculation reports, product specifications, materials and fabrication specifications, wear and tear parts specifications, painting, packing, labeling, and transport specifications, procurement specifications for special plant components and equipment, risk analysis reports, instructions for assembly, erection, installation, commissioning, start-up, operation, maintenance, with the purpose of implementing physical facilities for economic activities, and of optimizing and maintaining the existing facilities.

Nowadays, almost all countries have their own engineering consulting and design companies that were initially founded in order to assist local industries and organizations in the development and implementation of new technologies and products. It is said that engineering consulting and design services play a unique and crucial role in industrial development due to their presence at the junction of information and decisions flows circulating amongst productive units, capital goods manufacturing, and research and development (Figure 1). Engineering consulting and design services link these three parts of the economic system, and also may provide links with the financial system.

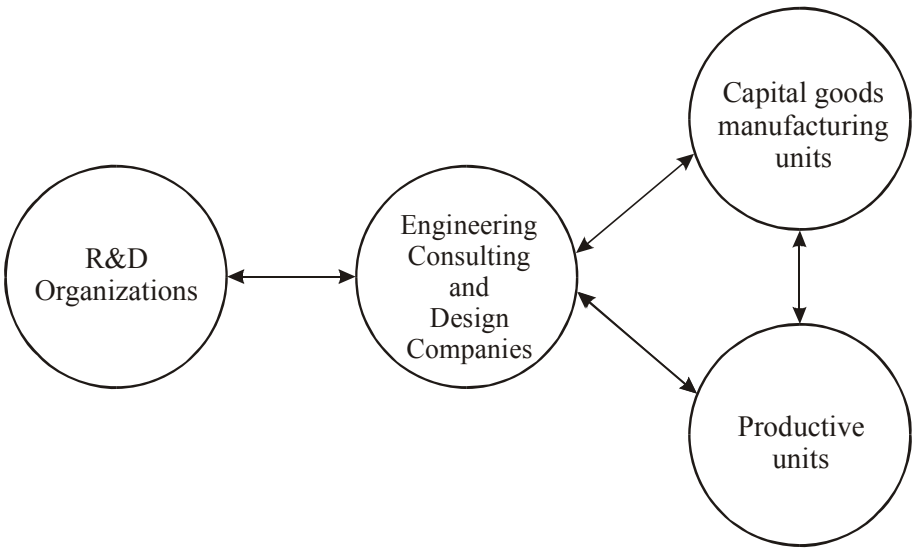


Figure 1. **ECDCs linking the three parts of the economic system**

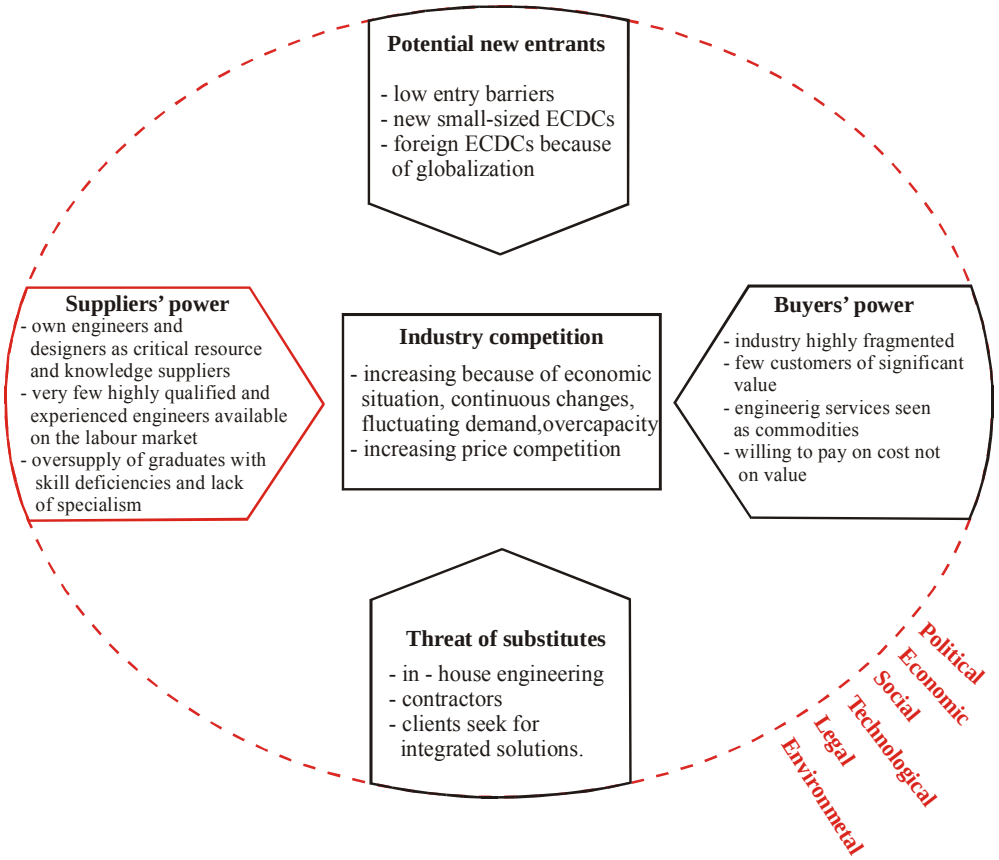
Since the outputs of the engineering consulting and design activities are not products that feed the final consumption in a society or industry but inputs to other activities (investments projects principally), their demand largely depends on the volume of these activities which are themselves related to the extent of actual or planned changes in a country or client industry (Aráoz, 1981).

In current times the services that the ECDCs aim to deliver are increasingly coming under pressure because of a continually changing environment. Because of the technological developments, globalization and changing roles of competitors, blurred identity of the industry, commoditization of design, loss of specialism, and shifting patterns of customers' demand, the ECDCs need to take notice of these changes and seek out viable strategies through which they are able to continue their endeavors to drive innovation and economic growth thus fulfilling their mission and the critical role that they play within the national context.

3. The Five Forces Model – the adapted framework

For the strategic analysis and development of strategies, companies can follow two different approaches: one looking at the organization itself (a resource-based view, or more specific, a knowledge-based view), or another looking at the environment in which they operate. This paper starts mainly from the latter approach, the one looking at the macro-environment in which ECDCs operate. For such insights, the industrial organization economics will be taken into account, especially Porter's Five Forces analytical framework, by emphasizing the specific aspects of the five forces which configure the competition in the engineering consulting and design industry (Figure 2).

Regardless the approach is, one can see that focusing strictly at the external environment will be neither correct nor relevant because of the distinguishing features of ECDCs and their managerial implications presented in the previous chapter. Therefore, it is argued that, a combined "outside-in" and "inside-out" approach, both industry-oriented and firm-oriented must be taken, connecting the industry-specific factors to firm-specific factors (Spanos and Lioukas, 2001). It is stated that the five forces that shape the competition in an industry are not independent variables but, on their turn, are strongly related and influenced by the external, macro-environmental factors (PESTLE – Political, Economic, Social, Technological, Legal, Environmental) such as globalization, relaxation, deregulation, economic situation, technological developments, environmental policies.



Source: adapted after Porter, 2008.

Figure 2. **The five forces that act in the engineering consulting and design industry**

It is argued that the specificity of Porter's Five Forces in case of engineering consulting and design companies is draws from the distinctive characteristics of this type of organizations.

3.1. The rivalry among existing competitors in the industry

In Porter's model this force describes the competition amongst the established rivals in a certain industry. Key in this respect is not only the number of competitors but also the size of the market and the product or service in question. These aspects dictate the intensity of competition and the basis on which companies compete.

Competitive moves by one company within an industry will eventually be felt and noticed by all the companies in that industry. Companies affected by such competitive moves will have to respond by taking similar or maybe more drastic countermoves. Porter states that "firms are mutually dependent" (Porter, 1980, p. 17).

The extent of rivalry among competitors is determined very much by the degree of mutual dependency or interaction among competitors and the probability of this, setting off retaliatory strategic moves among them.

The engineering consulting and design companies have long enjoyed a high degree of differentiation in the various sectors of the industry. In effect, a specific firm has had few direct competitors as each firm has managed to carve its own niche in the market (Løwendahl, 2005).

Nowadays, most ECDCs are intensely competing in an already mature industry consisting of engineering services in conventional (mature) engineering disciplines (mechanical, electrical, structural, civil). Besides the large and well established ECDCs in the industry, there is also a significant and increasing number of small- and medium-sized engineering companies that provide narrowly specialized services or in less engineering disciplines. Over the years, as the smaller players expand, gain more experience and improve their capabilities through joint-ventures and technology transfer, they tend to compete with the bigger players for larger projects and this intensifies the rivalry in the industry.

Lately, the differentiation among ECDCs has however started to diminish, thus gradually forcing companies to increasingly focus on price as a key competitive parameter.

In highly industrialized countries (e.g. USA, Canada, UK, Germany, France, Japan) factors like a company's past experience, its technical approach for tackling the specific project problems, and the experience, expertise and technical qualifications of engineers are given more importance in awarding engineering services contracts than the price quotation. In other words, the basis for competition is basically technical rather than financial. This is usually justified by the fact that the cost of engineering services is normally a small percentage out of the total cost of investment, while awarding the contract to technically un-qualified companies may result in serious mistakes, inadequate and deficient designs, and increased costs of construction which may be many times more expensive than the savings obtained by awarding contracts to the lowest price bidder.

If this development will continue, it will become increasingly critical for the financial success and even survival of any ECDC, thus forcing the ECDC to unambiguously formulate a strategic focus so as to enable the company to differentiate and rise itself above the increasing price competition, thereby maintaining the high profit business that will allow it to attract top engineers to further sustain future success.

Taking into account the global economic slowdown also the slow or erratic growth of the industry – which result in no or less investments projects – one may conclude that the engineering consulting and design industry has overcapacity and the competition among ECDCs is getting tougher.

3.2. The threat of potential new entrants

The new entrants in an industry usually cause an increase in the capacity of that industry thus leading to an overcapacity. In the classic sense of Porter's analysis this increase in capacity and entrants' eagerness to gain market share will compromise the level of returns that companies can ask and expect, and will result in a significant decrease of profitability of the companies in the industry. In the case of ECDCs, the occurrence of new entrants will mean that their ability to provide engineering services across industry groups is diminished.

The low capital intensity of engineering consulting and design services as professional services means that the barriers to entry in the industry are practically non-existent (Lorsch and Tierney, 2002). Thus, the number of potential new entrants will be great as the capital requirement to set up an ECDC is relatively low since they only need to finance the fixed costs (office rental, computers, printers, plotters).

The threat of newcomers in an industry depends on the extent of barriers to entry, which are very low in the least technically demanding engineering services like architecture, civil engineering for conventional buildings with simple structures, consulting for conventional technologies, etc.

However, while the entry barriers might be theoretically low, the intangibility of the outputs of some highly and strictly specialized engineering consulting and design companies can reduce to a significant extent the threat of new entrants due to the need for addressing *ex-ante* the uncertainty as regards the professional service to be delivered. As this is often done through evaluating a company's professional track record with past successful service deliveries and reference works, a new potential entrant in the industry will obviously not enjoy the potential customer's reliance on its output and will not have sufficient arguments against output uncertainty. Thus, a newcomer will have a serious disadvantage in comparison with the well-established and consolidated market players. Barriers to entry in the technically demanding engineering services are normally high, as the competition would have to rely on proven expertise of their engineers, past experience in similar projects as well as the capability to undertake large and complex projects.

The barriers to entry in the engineering consulting and design industry are not many. The first is differentiation which is expressed in terms of the advantage of being among the first entered in the industry in a certain market, customer service, and customer loyalty. The second barrier to entry is the learning or experience curve effect. This barrier is effective only in the early stages of the evolution of the engineering discipline in a certain region. As a discipline moves from one stage to another in its life cycle and since experience and knowledge in this field are not proprietary, the barrier becomes successively lower until there is negligible barrier to entry for a company. Therefore, threat of new entrants is, as expected, inversely proportional to the height of barriers to entry in the industry, which are in turn directly proportional to the technical/technological complexity of the engineering project.

Potential new entrants to the engineering consulting and design industry are usually the following:

- private, freelance, independent individual engineering consultants and designers who are former employees of ECDCs or professors from schools of engineering; these ones do not represent a major threat due to their low and limited capacity to undertake large projects.
- groups of experienced engineers and designers working for an ECDC and who, at a moment in time, decide to leave the company and start their own engineering services business which may become significant competitors for the "quitted mother-company" because the employees leave together with their knowledge, expertise, and sometimes, with a significant part of the portfolio of clients;
- some universities, which are increasingly pursuing additional incomes through the valorization of their research results and rare and sophisticated knowledge, while affording to charge sub-market prices can get involved in engineering consulting activities thus becoming competitors for the existing ECDCs;
- foreign engineering consulting and design companies which penetrate the national market.

The last potential new entrants are being increasingly taken into account because of internationalization and globalization, which result in expanding operations of international or multi-national ECDCs in foreign countries, on foreign markets, markets which traditionally have been shared by the national ECDCs. This phenomenon is possible in general when implementing large scale national or regional developments projects, fully or partially financed by foreign countries or institutions, or, in particular when implementing investment projects for creation of modern, state-of-the-art production units in a developing country which require expertise in engineering fields that the national or regional ECDCs do not have. Under these circumstances the national/local ECDCs would only play a supporting role for the foreign ECDCs or take over parts of engineering services within their range of expertise. It follows, therefore, that within the engineering consulting and design industry there are some engineering disciplines for which the majority of firms can offer professional services (mature or conventional engineering disciplines), while there are other engineering disciplines for which the majority of companies are neither professionally nor experience-wise capable of performing services (emergent engineering disciplines).

However, for foreign ECDCs there are more barriers to entry, especially in terms of protective legislation. Some countries have laws to protect the local industry from foreign competition, which normally result in a preferential treatment in favor of indigenous ECDCs.

To conclude with, the most important threats are the groups of experienced employees leaving the company and establishing their own engineering services business, and the foreign companies entering the traditional domestic market of national ECDCs. In the first situation the managerial challenge to be addressed is to successfully motivate and retain the highly qualified and experienced engineers thus

preventing them from leaving the company and becoming competitors. This requires carefully developed and successfully implemented human resources strategies within the company.

3.3. The threat of substitute services

According to Porter, "substitutes limit the potential returns of an industry by placing a ceiling on the prices firms in the industry can profitably charge" (Porter, 1980, p. 23). He also adds that "substitutes not only limit profits in normal times, but they also reduce the bonanza an industry can reap in boom times." (idem).

The degree to which the engineering consulting and design services can be substituted varies quite a bit. That is, however, if one potential customer expands the concept of service substitution to include the option of simply deselecting or not purchasing the service at all. A potential customer can deselect engineering consulting and design services when the customer company can manage in-house this kind of services by its own technical departments. In general, the degree of deselection is higher for engineering design than for engineering consulting services.

A major threat for ECDCs in current times is local and/or international contractors taking a proactive role in identifying projects and executing them on a turnkey basis including financing, project management, engineering design and construction. Usually such contractors will probably end up integrating backwards by creating full design units within their organizations or by forming strategic alliances with more than one ECDC. In such alliances the ECDC will not enjoy all the professional privileges that it does when operating as an independent entity.

In the same time, an actual trend in the engineering consulting and design industry, increasingly agreed and accepted by customers who seek for integrated solutions, is that the ECDCs increasingly bid and get involved in *"design & build"* contracts, meaning a quasi-forward integration, thus trying to counteract the big contractors' backwards integration. It is called quasi-forward integration because the ECDCs take the responsibility for the entire project execution from feasibility studies to commissioning and start-up, but the physical works such as land preparation, fabrication, construction, erection are carried out by specialized sub-contracting companies on behalf of the ECDCs.

3.4. The bargaining power of buyers

With respect to the power of buyers, Porter argues that „[b]uyers compete with the industry by forcing down prices, bargaining for higher quality or more services, and playing competitors against each other – all at the expense of industry profitability." (Porter, 1980, p. 24). The power of buyers is dictated by a company's dependence on a specific group of buyers. In cases where a specific buyer or group of buyers forms the primary source of revenue they are in the position to dictate price and product/service specifications.

The major issue in the engineering consulting and design industry from the financial standpoint is that it is common for the conventional engineering services providers to be seen not as knowledge providers, but as other commodity suppliers. Customers tend to be unwilling to pay a premium, in contrast to other PSFs or ECDCs active in emergent, rare, or high-tech engineering disciplines that tend to be paid based on the value of the services delivered to the client and not on the costs of delivery.

In general, the engineering consulting and design services are delivered on a market made up of numerous customers (national or foreign industrial production units of different sizes, governmental agencies, local or regional public authorities, financing agencies) for purposes of investment and production, and very rarely to private persons as customers. As such, an individual client or a small-sized company do not possess too much bargaining power when dealing with a large-sized ECDC since they do not represent a significant portion of the total market value and the ECDC has the option of targeting other customers or potential customers instead of spending too much time dealing with a difficult, uncertain, or financially weak customer. Another reason for which these are not powerful buyers is that, because of informational/knowledge asymmetry, they need the services of an ECDC to provide customized solutions to their complex problems.

As stated previously, ECDCs organize and apply technological knowledge for the purposes of investments projects and production. In the case of engineering consulting, they form an interface between the planning activities (selection of projects, their economic evaluation, choice of the most appropriate product design and process technology) and the implementation of projects (which includes detailed engineering and design, procurement of plant, preparation of contract documents, supervision of construction and erection, project management, commissioning and testing of plant and equipment, and its initial start-up). In the area of production, they provide valuable services for the proper operation and maintenance of the plants and equipment, provide solutions for the technology management problems, and provide training of personnel (Aráoz, 1981; Malhotra, 1976; Kamenetzky, 1976).

The ECDCs traditionally work on large investment projects, sometimes (but not always) financed by governmental agencies or other large institutions (complex industrial production units investing in capital goods, etc.). As such, a single project can represent a significant portion of revenue, thus reversing the balance of power between the ECDC and the customer organization, especially when other ECDCs are present in competition. This situation is also obvious due to the fact that many large projects in the engineering industry are granted through bids, which have potential suppliers accommodating their offers to the specifications of the customer.

Therefore, there is a special group of customers that presents more potential value, both in terms of revenue generation and more intangible, strategic value for the ECDC, and which dictates the rules of competition especially through the choice of the project's implementation approach (traditional consultant – client method, project management method, turnkey method). These big buyers (governmental agencies, large-sized complex industrial production units) become very powerful since the

volume of work undertaken by ECDCs adds up to a high percentage of the whole industry workload and they buy the majority of the services offered by the industry.

One of the reasons which lies behind this power is the fact that the "switching costs" to the buyer are practically non-existent. A governmental or financing agency will practically incur no costs if another project it has in plan will be awarded to another ECDC.

Another reason is the fact that most governmental and public agencies consider the engineering consulting and design services of the bidding companies as standard ones and not differentiated, therefore the award decision is highly price-dependent. On certain rare occasions, the services rendered by ECDCs are treated as differentiated and the price aspect is not a major issue and does not play a decisive role. This is the case when the required services are not in a mature engineering discipline but in an emergent one (e.g. biotechnology, nanotechnology, new sources of energy, etc.) or when the project is of very large scale and it has to implement components that call for advanced and complex technology.

A third reason is that when engineering services are critical to their business some of the buyers have the perceived capacity and motivation to fully or partially integrate backward and perform all or part of the required engineering services. This is the case of the companies who can manage in-house this kind of services by their own specialized departments or the case of some contractors executing projects on a turnkey basis, including engineering design.

Another factor contributing to the increase of bargaining power of buyers is simply the overcapacity of the companies active in the engineering consulting and design industry, especially in the mature engineering disciplines. The emergent engineering disciplines which require a certain set of rare expertise and experience being available at only few companies will have a better and friendlier competitive environment in which to survive from the buyers' power standpoint.

3.5. The bargaining power of suppliers

The stronger the power of suppliers in an industry, the more difficult it is for firms within that sector to make a profit because suppliers can determine the terms and conditions on which business is conducted. Increasing prices and reducing the quality of their products are potential means that can be used by suppliers to exert power over firms competing within an industry. If a firm is unable to recover cost increases by its suppliers through its pricing structure, its profitability is reduced by its suppliers' actions.

When it comes to the suppliers an ECDC may have, one can immediately think of those who regularly supply different materials required for production (inputs) and delivery of services. Obviously, they need some inputs of physical nature such as specialized software for modeling, designing, performing calculations; they need computers to run the software; they need paper, ink cartridges, printers, and plotters; they need also comfortable offices and excellent work conditions.

The suppliers of software, paper and ink cartridges, printers and plotters, offices and furniture are not powerful and have a relatively low bargaining power in relationship with an ECDC because there are many suppliers of the same or similar products on the market. Except for expenses with ink, cartridges, paper, utilities, and rentals, which represent costs in a low proportion out of the entire volume of expenses of the company, the biggest portion of costs are with personnel salaries and compensations.

The most important issue challenging the engineering consulting and design industry is the supply of knowledge and know-how. In the case of ECDCs we cannot speak of suppliers as such, as ECDCs cannot purchase the essential inputs required for the production of their services. They require mostly qualified engineers and access to knowledge. It is for this reason that is more correct to refer to inputs rather than to suppliers.

In this respect, a category of quasi-suppliers for ECDCs may be considered the universities and engineering schools. They are suppliers of knowledge as a result of their own research also of highly qualified knowledge personnel not directly to ECDCs but to labor market. However, by their own specialized departments, they can get involved to some extent in engineering consulting activities thus becoming competitors for the ECDCs in certain, mostly emergent engineering disciplines.

Another group of suppliers for large-sized ECDCs are the small-sized, strictly specialized, subcontracting engineering offices (e.g. geotechnical engineering, fire engineering, topographical surveyors, mapping offices, technical tests laboratories) that supply missing knowledge, or small-sized general engineering design offices that supply work for overloaded large ECDCs and that, in general, are considered as not being powerful suppliers due to four factors.

The first factor is that none of these suppliers is big enough to get a significant market share and form a monopoly on the services offered to the ECDCs in a specific region. Many of them are actively competing to offer their services to the engineering consulting and design industry.

The second factor is the fact that although these suppliers do supply services to other industries, their volume of work with the engineering consulting industry is substantial and therefore they cannot afford to risk losing work by being difficult, high demanding or over-charging bargainers. But, sometimes, when a big ECDC is overloaded, has exceeded capacity, projects deadlines are very tight, and there are few competitors of the same size, then the small-sized general engineering design offices might have a higher bargaining power as suppliers.

The five forces model recognizes that suppliers can become a firm's competitors (by integrating forward) as can buyers (by integrating backward). The third factor because of which the small suppliers of engineering services are not powerful is the ability of a good number of ECDCs to integrate backward into the supplier's own industry. This is a measure that sometimes seems inviting for an ECDC when it realizes that the suppliers try to overcharge the ECDC for their services. But, this action should be *ex-ante* carefully considered by estimating if it is possible to maintain a relatively constant workload in the long run.

The fourth factor is the relative inability of most suppliers to integrate forward into the engineering consulting and design industry. Even if some of them try and actually do, it is usually a short-lived and costly experience, which may seriously jeopardize the existence and survival of the firm.

As stated in the previous chapter, both the inputs and outputs of PSFs in general and ECDCs in particular consist in knowledge. In case of ECDCs the output knowledge is delivered to customers embedded in the form of feasibility studies, planning studies, technological solutions, technical specifications, conceptual/preliminary/final designs, workshop drawings, plans, calculations reports, diagrams, erection and installation drawings and instructions, operation and maintenance instructions, etc. which are storable and reusable. The knowledge-intensiveness and general nature of ECDCs mean that the only real and significant inputs for the value creation in ECDCs are the education, knowledge, qualifications, experience, skills, and capabilities of the professional engineers and designers that perform the engineering services by identifying, selecting, organizing, applying, and delivering the knowledge to the customers.

The major and most valuable asset of any ECDC is the highly trained and qualified professionals (engineers, designers) specialized in the fields of engineering in which the company is active. Such companies have all their value creation materialized through the mental efforts of their professionals during the process of organizing, applying, and delivering the knowledge to the customers. It is argued that perhaps more than anything else, professional services firms in general and engineering consulting and design firms in particular, stand out from most other companies because of the extreme significance they place on the quality and motivation of their personnel (Alvesson, 1995, 2004). As Maister (Maister, 1982) wrote, PSFs in general and ECDCs in particular compete in two markets simultaneously: the "output market" for its services and the "input market" for attracting, motivating, and keeping its productive resources - the professional workforce. These two markets are closely related: loss in one may affect the other. That is why it is of paramount importance for an ECDC to optimally position itself both on the "output market" and "input market" between which there is a close relationship.

For many high-tech or science-based knowledge organizations there is no direct link between the departure of key personnel and that of clients. In the case of ECDCs the inflow and retention of qualified personnel is crucial. For this reason many ECDCs are located in areas close to large universities or engineering schools, which facilitates the recruitment of good engineers and scientists. Thus, universities can be considered as knowledge quasi-suppliers for ECDCs whose strength is based on the strength and quality of higher education they provide. As one can see they are not direct suppliers and do not have bargaining power against ECDCs from this standpoint.

Drucker (in Kreiner and Mouritsen, 2003) emphasized the dependence of organizations on personnel and the strong bargaining position of large groups of

knowledge workers saying that knowledge workers are the owners of the means of production and thus they have to be treated as volunteers, not as employees. The pool of fresh and inexperienced engineers from which the ECDCs recruit is another type of supplier that is normally not powerful. This is particularly true in the mature engineering disciplines where the number of fresh and inexperienced engineers has more than saturated the labor market. In this situation ECDCs usually recruit fresh and inexperienced engineers, offer them minimum compensation packages, and enroll them in extensive on-the-job in-house training programs.

Highly qualified and skilled engineers and designers are the ones who enjoy the privilege of being the most powerful suppliers (of knowledge, expertise, experience, capabilities) to ECDCs when the economy is booming or there is a high demand for their expertise in a certain engineering field the ECDCs do not have in-house. On the other hand, during economic slowdown, the bargaining power of employees and potential employees is very low. This is because the demand for their services reduces as the ECDCs are facing difficulties in obtaining projects or are having few projects to handle with, thus not being able to fill the entire working capacity.

As such, looking at what Porter refers to as the bargaining power of suppliers becomes a matter of the distribution of power between the ECDC and the professional engineers they aim to attract motivate and retain (Lorsch and Tierney, 2002). As indicated previously, the bargaining power of employees (engineers, designers) is significant, as they essentially constitute the major asset base of the company, possessing a high degree of knowledge and informational power. They can exert a high bargaining power by demanding better compensations and rewards which, if not granted, essentially determine the engineers to quit the company with almost no loss of capabilities and join a competitor ECDC. Or some of the actual engineers and designers may leave the company and start their own business which will become a significant competitor for the "quitted mother-company" because the employees leave together with their knowledge, expertise, reputation, and sometimes with a significant part of the portfolio of clients.

This challenge might in fact be the most serious one an ECDC may face as the attraction, motivation and retention of highly qualified, skilled, and experienced engineers determines the reputation of the company and quality of services that the company can provide. Therefore, an ECDC must provide very good working conditions, attractive compensation packages and also challenging projects in order to attract and keep outstanding engineers and designers.

One of the most fundamental strategic management challenges involves the management of competences and other intangible resources, which are only partially controlled by the firm (Løwendahl, 2005). To the extent that the firm is highly dependent on competence resources that are controlled by the professionals, the organization is highly vulnerable to the exit of these professionals. Departure of their key professional workers is the same as disinvestments in a manufacturing company (Sveiby and Lloyd, 1987).

To conclude with, it is stated that the most important suppliers for a consulting and engineering design company are the existing professional employees or the highly specialized professional engineers and designers available or potentially available on the labor market. The bargaining power of engineers and designers in relationship with an ECDC depends on the economic and business conditions at a particular time.

4. Discussions and managerial implications

The managers of engineering consulting and design companies rarely imagine the challenges that await them. Of course, projects schedules are tighter, products are getting more complex, quality and performance requirements are becoming higher, and budgets are shrinking. But these are all simply constraints and engineers are used to dealing with constraints. Strangely enough, the biggest challenges for the managers of ECDCs today are not of technical but non-technical nature, which are often the stickiest. They need to take actions and pursue initiatives that will keep the engineering companies productive and competitive on the market.

The rivalry within the engineering consulting and design industry is continuously increasing because of the global economic slowdown, poor, discontinuous, or highly fluctuating demand of engineering services, overcapacity of ECDCs, industry fragmentation, globalization, deregulation, and increasing price competition. Thus, one of the most critical managerial challenges to be addressed is identifying and winning projects over the existing competitors in order to flatten the fluctuating curve of demand and fill the available capacity, while trying hardly to shift from selling services on an hourly rate basis to selling value added to customers.

The most important threats provoked by new entrants come from the powerful foreign companies entering the traditional domestic market of national ECDCs. This is very difficult to deal with because is not under the control of existing ECDCs but of governments, which may issue laws to protect the national industry. However, lately, by the increasing trend of deregulation at global level this is becoming more and more difficult to be achieved.

In general, as long as engineering consulting and design services are highly complex and specialized ones, they can be almost never substituted. Therefore, substitute services are not a great threat to this industry since eventually the ECDCs provides the most comprehensive and reliable services. Thus, this concept does not really apply *stricto senso* in the engineering consulting and design industry due to the fact that each service is unique and rendered according to specifications in order to meet the customer's requirements.

The managers of ECDCs should strive to change the potential buyers' perception on the engineering services they are able to deliver. First, the managers of engineering firms have to change the perception of buyers over ECDCs as not being commodity suppliers but as knowledge and customized solution providers to their complex problems. Secondly, by convincing the buyers of the value added they get together with solving of their problems by offering more services and a higher quality.

It is concluded that the most important issue today for an engineering consulting and design company is the suppliers of knowledge and expertise which are the highly specialized professional engineers and designers employed by the company or the professional engineers available or potentially available on the labor market. The most fundamental strategic management challenge involves the management of competences and other intangible resources, which are only partially controlled by the firm.

5. Conclusions and directions for further research

The conducted theoretical analysis of the competitive landscape of engineering consulting and design industry, which is characterized by a high degree of generality, shows that ECDCs in general are being faced with a number of challenges with strategic and managerial implications. It is noticed that the competitive forces are strongly interrelated and overlapping. The strength of each of the five competitive forces is a function of industry structure or the underlying economic and technical characteristics of the industry. The most critical seem to be the challenges arising from the input dependency the ECDCs face, i.e. the fact that the quality of the services rendered and firm's survival on the market is directly affected by the professional engineers and designers working at the firm and how well the company manages to motivate and retain them.

As one can notice the conducted analysis referred to the engineering consulting and design industry in general (regardless the country, economic sector, history, etc.) and revealed only the common features, challenges, and managerial implications resulting from the actions of the five competitive forces. However, detailed studies can be conducted at a global level by discussing the specificity of engineering consulting and design industry varying from country to country or, within a country the specificity and stage of life cycle of client industries the ECDCs provide services for (e.g. construction, mining, metals, power, etc.).

These discussions and their conclusions may depend on a large set of variables and parameters to be taken into account, such as: the industrial development status of the country (highly industrialized, developing, low-developed, or under-developed country), the development perspectives of the country and influence of government policies, the historical evolution of the engineering consulting and design industry in the country, the market sector within the ECDCs operate, the engineering disciplines in which they are specialized, the international linkage and technology transfer, the strategic approach and concentration on the development factors of the ECDCs, the general perception of potential customers regarding the engineering consulting services, the availability of professional workforce on the labor market and the coming "war" for staffing with engineering talents, the economic cycles, globalization, deregulation, relaxation.

The discussions from the article will be further developed and detailed, focusing on the Romanian traditional industrial engineering consulting and design companies (former technological engineering design institutes until 1989) providing

services for the metals, mining, oil and gas, power, heavy machinery and ship building industries, also on the engineering companies established after 1990, serving mainly the civil and environmental sectors. Interesting findings are expected due to the different historical evolution of these companies and their markets and client industries.

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