Consulting and Engineering Design in Developing Countries

Edited by Alberto Aráoz
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CHAPTER 7

REVIEW OF THE NATIONAL CASE STUDIES

ALBERTO ARÁOZ

The four national case studies carried out in Korea, Brazil, the Philippines, and Argentina describe the characteristics and evolution of a CEDO and analyze how it has performed in an investment project. This chapter reviews and compares these national experiences (Table 20) and derives some conclusions from the exercise, pointing to further research activities on the subject.

The characteristics of the four CEDOs differ substantially. Three are nationally owned and in the private sector; the Korean example (K) is a joint venture with a foreign CEDO, in which originally the local partner was the state. Three are medium to large organizations, ranging from 500 to 1200 persons; one, the Philippines CEDO (P), is small (30 persons). The Argentine example (A) is a builder–contractor, only recently counting engineering as an important activity, and the CEDO in Brazil (B) owns and runs a production plant. Perhaps the only mature one is B, which has mastered the technology of some processes and is able to undertake for them the complete range of C&E services, including basic engineering. The other CEDOs offer preinvestment, detailed engineering, and project execution services.

B and P have specialized in one market, whereas A and K serve diverse markets. The state is the most important client for all except P, which practically works for one private client, a petroleum refinery. Only K has a stable relationship with a foreign CEDO, but the others carry out projects in collaboration. B has been able to diminish its use of foreign CEDOs as its own know-how and expertise have increased.

K was explicitly founded by the state, whereas the others were founded by a few professionals. The founding partners of B and P were highly experienced. Three were founded around 1970, and, although A was founded in 1952, it took up engineering as an important activity only in the early 1970s. The original know-how was that of the founding partners in B, P, and A (not too high in this case), whereas in K it was brought in by the foreign associate.

Only B originally set out an explicit strategy for its evolution: to master the technology of the phosphoric-fertilizers complex through the sequence sulfuric acid–phosphate fertilizers–phosphoric acid (the goal now largely accomplished); and to work on petroleum refining (this goal being discontinued when the principal client created its own engineering division). K had a general idea of acquiring experience in a number of fields. P simply wanted to work for its sole client in areas well known to the partners.
<table>
<thead>
<tr>
<th>Present status</th>
<th>Korea</th>
<th>Brazil</th>
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<tbody>
<tr>
<td>Type of CEDO; size</td>
<td>Private CEDO; staff 500 (1978)</td>
<td>Private CEDO; controls, operates a sulfuric acid plant; C&amp;E staff 1200 (1977)</td>
</tr>
<tr>
<td>Ownership</td>
<td>Joint venture with Toyo Eng. Co. (Japan)</td>
<td>Fully national</td>
</tr>
<tr>
<td>Range of activities</td>
<td>Preinvestment studies, detailed engineering, project services</td>
<td>Complete range of C&amp;E services, including basic engineering, for sulfuric acid and phosphate fertilizers</td>
</tr>
<tr>
<td>Markets</td>
<td>Diverse; civil and industrial projects, for private and state clients; some exports</td>
<td>Sulfuric acid, phosphate fertilizers, phosphoric acid, Cl-Na; state almost only client</td>
</tr>
<tr>
<td>Relations with foreign CEDOs</td>
<td>Stable relationship with partner, Toyo Engineering Co.</td>
<td>Diminishing use of foreign CEDOs as own know-how and experience grows</td>
</tr>
<tr>
<td>Origins</td>
<td>Founded 1970 as joint venture of Korean government and Lummus Co. (U.S.)</td>
<td>Founded 1967 by a group of professionals from the state petroleum company, PETROBRAS</td>
</tr>
<tr>
<td>Original sources of know-how</td>
<td>Principally the know-how and expertise of the foreign partner, first Lummus, then Toyo</td>
<td>Know-how, expertise of partners (considerable); know-how licence for sulfuric acid with a U.S. firm, with full-disclosure clause</td>
</tr>
<tr>
<td>Strategy envisaged by founders (fields and activities)</td>
<td>To work as a multipurpose CEDO in various fields</td>
<td>To master technology of phosphate fertilizer complex, through sequence sulfuric acid—phosphate fertilizers—phosphoric acid; to work in petroleum refining (this failed)</td>
</tr>
<tr>
<td>Evolution</td>
<td>Served first state, later private sector; diversified its services, became multipurpose; some exports; big role expected now that firm is wholly in private sector</td>
<td>Period 1: rapid growth of market; many small projects, peripheral installations; most important market is detailed engineering for state sulfuric acid plants; period 2 (1972–75): sales multiply by five, larger contracts, start with phosphoric acid; period 3: fewer, larger projects, wider front as phosphate fertilizer and chlorine are started</td>
</tr>
<tr>
<td>Acquisition of personnel</td>
<td>Could get few qualified professionals; had to recruit from chemical plants and to hire fresh graduates who had to be trained in design skills</td>
<td>Rapid incorporation of manpower (origin not specified); policy to train well and to retain professionals, leading to heavy investment in human resources</td>
</tr>
<tr>
<td>Philippines</td>
<td>Argentina</td>
<td></td>
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<tr>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td></td>
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<tr>
<td>Private CEDO; engineering staff 30 (1978)</td>
<td>Private contractor with CEDO capabilities; staff 600 plus about 1500</td>
<td></td>
</tr>
<tr>
<td>(1978)</td>
<td>construction personnel (1978)</td>
<td></td>
</tr>
<tr>
<td>Fully national</td>
<td>Fully national</td>
<td></td>
</tr>
<tr>
<td>Detailed engineering, project services</td>
<td>Preinvestment studies, detailed engineering, project services, project</td>
<td></td>
</tr>
<tr>
<td></td>
<td>construction</td>
<td></td>
</tr>
<tr>
<td>One main client, Caltex (petroleum refining), and occasionally other</td>
<td>Very diverse; civil, infrastructure, industrial projects; state is most</td>
<td></td>
</tr>
<tr>
<td>clients</td>
<td>important client</td>
<td></td>
</tr>
<tr>
<td>Projects usually employ foreign basic engineering; no stable relation with</td>
<td>Most recent projects are in collaboration with foreign CEDOs</td>
<td></td>
</tr>
<tr>
<td>foreign CEDOs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Founded 1970 by two retired Caltex engineers</td>
<td>Founded 1951 by five partners, three of them with experience in electromechanical installations</td>
<td></td>
</tr>
<tr>
<td>Knowledge, expertise of partners considerable</td>
<td>Knowledge, expertise of partners</td>
<td></td>
</tr>
<tr>
<td>To work principally for Caltex in areas well-known to the partners</td>
<td>No definite long-run strategy except to make use of opportunities, adapting to a context that changes its nature every few years</td>
<td></td>
</tr>
<tr>
<td>Firm has always worked for the same client, Caltex, except on two occasions, and on the same type of project, even to this day</td>
<td>Firm took different jobs in construction, installation, in diverse markets; engineering was a separate activity started much later; many different types of projects were prepared (detailed engineering), wishes to look for opportunities in a not too stable context</td>
<td></td>
</tr>
<tr>
<td>Hire young graduates, train them; high turnover; regular use of</td>
<td>On forming engineering dept. in 1975, quickly acquired personnel, apparently from market; hired group of experienced managers; formulated a 2-year training program for young professionals (postponed)</td>
<td></td>
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<tr>
<td>experienced consultants for certain tasks</td>
<td></td>
<td></td>
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(continued)
<table>
<thead>
<tr>
<th><strong>Acquisition of knowledge</strong></th>
<th>Apparently much learning on the job from partner, foreign associates; much progress but not able yet to carry out basic engineering stage</th>
<th>Clear long-run strategy: choose areas where technology may be mastered, go from simple to complex; main instruments: full-disclosure clauses, get to be prime contractor, have own dept. for study and research, own sulfuric acid plant, much trained staff; support from clients' confidence; high profits reinvested in learning; reached basic engineering stage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relations with foreign CEDOs</strong></td>
<td>Close, stable relationship with partner, Toyo Eng. Co. (details not specified)</td>
<td>Look for full disclosure; have aggressive policy to learn as much as possible and to achieve higher responsibility in projects, if possible as prime contractor</td>
</tr>
<tr>
<td><strong>Government support on demand side (contracts, responsibility)</strong></td>
<td>Government demand very important, particularly during the first few years</td>
<td>Key role by granting contracts, allocating increasing responsibility, backing negotiations with foreign CEDOs; weak support in early years probably retarded technical progress of firm</td>
</tr>
<tr>
<td><strong>Govt. support on supply side (finance, incentives)</strong></td>
<td>Government created the CEDO, enacted legislation in 1968 favouring local C&amp;E</td>
<td>Seems to have been significant in SULFAB investment and apparently also in other cases</td>
</tr>
<tr>
<td><strong>Main problems faced in development</strong></td>
<td>Difficulty in hiring trained professionals; hesitation of investors to employ local CEDO</td>
<td>Risk aversion by state clients at early stage</td>
</tr>
<tr>
<td><strong>Some positive characteristics shown</strong></td>
<td>Good success in work; one of the few Korean CEDOs able to provide &quot;authentic engineering services&quot;</td>
<td>Good management; good market strategy; good strategies, procedures for learning</td>
</tr>
</tbody>
</table>

**EVOLUTION**

A and K became multipurpose CEDOs, working in a variety of markets and in the case of K exporting services. The variety is particularly striking in the case of A, showing the wish to profit from opportunities. Excepting P, which has shown almost no significant changes, the firms have progressed in the range of services rendered, and the projects undertaken have become larger and more complex. B has moved cautiously, mastering the technology and the whole project cycle in one area before moving on to another; it has been helped in this by the relatively large, fast-growing
Brazilian economy, which has assured a sufficient volume of work in new plant C&E.

All firms heavily recruited young graduates and found it necessary to put much effort into training them, particularly in engineering design skills. A prepared a 2-year training program for young professionals, which has been postponed until business again picks up. K has hired professionals from industry, and A has recruited several experienced managers for its expansion into engineering activities. P regularly uses experienced consultants (usually retired people) for certain tasks; it is not clear whether the other firms, which are larger, find it necessary to do likewise.
B is notable for its clear long-term objectives and for the strategies it adopted. It chose areas where technology mastery could be achieved; it went from the simple to the more complex; it obtained full-disclosure clauses in contracts with foreign CEDOs; it got to be the prime contractor; it devoted abundant resources to the training of personnel; it created its own Department of Industrial Processes, for study and research; and it became the controlling shareholder in a sulfuric-acid plant, which it now operates, using the plant not only for production but for experimental and demonstration purposes and retaining part of the profits for research and experimental work. It was strongly supported by the confidence placed in it by its clients and financial institutions and by substantial profits in its operations, which it has largely reinvested in training, research, and learning. As a consequence, it has reached the stage of basic engineering in sulfuric acid and in phosphate fertilizers. New goals are now to reach this stage in phosphoric acid and in the chlorine—soda complex, the latter as a prelude to going into pulp.

A acquired its engineering skills by recruiting experienced professionals and managers, and much of the expertise was acquired on the job. P has drawn on expertise of partners and consultants but has not devoted special efforts to technology acquisition. K has apparently learned from its foreign associate, as well as from its own experience.

Whereas K has a stable relationship with its foreign associate, and P seems to have no links with foreign CEDOs, A and B associate with foreign CEDOs through project work. B carries out an aggressive policy to learn as much as possible from the foreign CEDOs with which it works. It looks for full disclosure and aims at sharing the major decisions and in fact at having full responsibility by becoming the prime contractor.

With the exception of P, demand from public-sector investments has been crucial. A has prospered when this has been high; but there have been strong fluctuations, and no countercyclical government policy has existed for its benefit or that of other CEDOs. For K, government demand has become less important in recent years as private demand has increased.

In B, public-sector investors have played a key role by granting contracts, allocating increasing responsibilities, and backing up the firm's negotiations with foreign CEDOs. Such support was not fully given at first, and this hesitation somewhat retarded the firm's technological development. Confidence placed in B seems to have played a crucial role in enabling it to participate as an investor in the SULFAB project and to take up the turnkey operation. Such confidence has been important in the rest of its assignments in recent years. How to create credibility and confidence in prospective clients remains a most important question.

No indication of government support on the supply side has been given in A. In K, this support has been very important, first through the act of creating the firm by decision of the government and with its financial participation, and second through the 1968 legislation favouring local C&E. In P, the government seems to have played no role at all. In B, assistance of government financial agencies has been sizable, particularly in relation to the SULFAB project.
The following would appear to be the most important problems faced by the firms during development:

- Risk aversion of clients, which limits the market and limits the scope of responsibilities assigned to the CEDO (mentioned by B, P, and K);
- Fluctuations in government investments and hence in demand for C&E services (A);
- No explicit government policy that in practice favours local C&E;
- Difficulty in recruiting and training capable professionals (P, K); and
- Lack of senior professionals (P).

The CEDOs studied have all been successful and have shown good management characteristics, although the management style has varied according to the circumstances: A needed adaptability and a good eye for opportunities, whereas P with its sole client could principally concentrate on doing a good technical job. B is notable for its well-thought-out strategies regarding markets and technological learning.

**PERFORMANCE IN INVESTMENT PROJECTS**

An important question is how far the CEDOs have improved the way investment projects have been carried out, by increasing their social efficiency. There are indications that each one has improved social efficiency to a certain extent, although it is difficult to appraise the results from a mere reading of the studies.

B carried out the SULFAB project totally by itself, as a turnkey job, including the basic engineering. The technical performance was good; the work was finished on time and practically within the budget (other investments at that time in Brazil's petrochemical sector had large cost overruns), and the plant has performed well in operation. Purchases from local industry were not higher than in other cases — about 27% — so there does not seem to have been an extra impact here. However, one may point to other benefits such as the impact on the firm's technical progress during the investment work itself and during the operational phase afterward.

Two investment projects in which K participated were studied. In the first one, a styrene monomer plant, preinvestment work was done by the client; a foreign CEDO (in fact, K's associate) had responsibility for the basic engineering for some ancillary facilities. The government, which was the majority owner of the project, pressed for local purchasing, and, thanks to this effort, the share of local supplies was increased notably; K surveyed and recommended local suppliers whom it helped to comply with the requirements. These activities undoubtedly had a favourable impact on social efficiency. However, finance was a problem; financing and loans took priority over technical matters, and alternative technological choices had to be made according to the financial possibilities. K's technical performance was considered satisfactory. The second investment project was an ABS resin plant, and K was in charge of most stages of the project except basic engineering. Great efforts were made to increase the local component, and there were no obstacles on the financial side because the project was being self-financed by the client. Once again, technical performance was good. For comparison purposes, a turnkey
project with a foreign CEDO was briefly analyzed. It was a large fertilizer plant, and the engineering fee was also very large; some of it went to local CEDOs that were subcontractors. The local supply of components was considered to be lower than if local CEDOs had had a more important participation.

The case study from the Philippines is no doubt the most carefully documented as regards the analysis of an investment project. The preinvestment work was done by the local project owner with his own staff. The technology chosen was a process that was more adapted to local conditions and had a higher employment potential than more modern processes would have had. It was decided to undertake the project's engineering and execution principally with in-house capacity. This meant later that a possibility of financing by IFC had to be foregone. The owner's Planning and Projects Department prepared the basic engineering project and took up project management responsibilities. Detailed engineering was subcontracted to a local CEDO — the one studied — and the supervision of construction was given to a French firm by request of a financial source from that country (learning opportunities here were used well). Local procurement was maximized. There were problems with government programming that required changes in the project, but apparently this project has been successfully carried out.

**Conclusions**

The CEDOs under study show quite different characteristics (Table 20), which to a certain extent reflect the diversity of national situations. Although their development has been highly idiosyncratic, it is clear that they share certain problems and face them in not too dissimilar ways. Such behaviour is roughly in line with what is expected on the basis of empirical and conceptual analysis, as reviewed in chapter 1 and would tend to show that regularities exist, so that comparative research on these topics may be significant and useful. Even though these CEDOs are all independent organizations, a study of their experience may shed some light on captive CEDOs, particularly regarding the acquisition of human resources and technology.

The four CEDOs have been successful (one of them very much so) as judged by their growth and by the results of their project work; thus, one cannot learn much from them about unsuccessful CEDOs. What can be gleaned, however, from some of the national situations is that very few CEDOs are able to prosper and mature from a much larger field of candidates: markets for C&E services in developing countries — at least, markets for domestically produced services — are not large. This means that diversification may be needed if a high and stable income is to be achieved. This we find in three of the four CEDOs reviewed.

An interesting feature comes out clearly. Large public and private enterprises frequently use their own in-house C&E capabilities to carry out a substantial part of the preinvestment work for their investment projects, down to the choice and negotiation of technology and the purchase of basic engineering. Outside C&E services are contracted to provide some inputs for those tasks and later on to carry out detailed engineering and other project services. One or more CEDOs may be involved, including foreign CEDOs. To understand the present role and future prospects of
local C&E capabilities, one would have to learn about the usual practices of the major investors regarding the contracting of C&E services. This may need (as suggested by the Korean team) a longitudinal study in production branches.

The case studies have also supplied evidence of the positive role of domestic CEDOs when they are given the opportunity to disaggregate investment projects and engage local inputs. The tendency to do so seems to be present in all of the CEDOs reviewed, but it needs an enlightened project owner and the backing of authorities and local financial institutions if it is to be brought to fruition.

The important role of the state regarding CEDO development and performance, both as a client and as a direct supporter of CEDOs, is abundantly confirmed by the case studies. When state support has not been forthcoming, the result has been a long struggle in which the CEDO is forced to engage in whatever endeavour it can; like the luckless Spaniard in Manrique's famous poem, “Coplas,” “con oficios non debidos se mantiene” (with unwonted trades surviving).

Finally, the case studies have largely fulfilled their primary purpose of helping to produce an understanding of the problems in developing and using C&E capabilities in developing countries, to indicate the research-ability of the subject, and in general to contribute to a better formulation of an international collaborative project. The researchers who undertook the case studies were unanimous in their appreciation of the importance of the subject and, through their largely successful efforts, showed that it is possible to get access to the sort of information needed for a fruitful analysis of the subject. They identified important issues, recommended methods and approaches, and made concrete suggestions for further research, which they felt should be of an action-oriented nature. These contributions and those of the participants in the St. Jovite seminar are taken up in the next chapter, which deals with future research on CEDOs.