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URBAN INFRASTRUCTURE AND EMPLOYMENT IN PERU

by

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Employment generation in infrastructure depends on the nature of the terrain, climate, density of settlement, as well as the type and quality level of the specifications. In order to be realistic, the estimates given here come mainly from a project that was recently executed in Peru even though its density of settlement was rather low and although some of its standards appear too high. Thus we are reporting actual, not hypothetical, performance.

The project included, not only 500 lots averaging 116.2 m^2 or a total of 58,100 m^2, but also 37,000 m^2 for commercial and public buildings and 81,500 m^2 as open space for roads, parks, and the like. Estimates given here, however, refer only to that part of the infrastructure needed for the 500 lots. Trunk lines to distant sources of water or electricity are not included, nor are electrical substations. Elements such as utility meters that are usually regarded as part of the dwelling are also excluded. Infrastructure for drainage does not exist since the Lima area is rainless. The project was designed for completion within a year, but since the value of the sol changed rapidly during 1980, costs are converted to US dollars. Details can be found in Table 1.

Total cost was $887,000 or $1,774 per lot. Nearly 70 percent of the cost came from streets, curbs, and sidewalks with asphalt paving and underground electrical lines. A quarter of the total cost could have been saved by paving with concrete and by using aerial electrical lines. With such changes, the infrastructure could have cost only $664,000, or $1,328 per lot. Streets and electrical lines would then cost only 59 percent of

the total. Underground electrical lines have been commonly specified in Peru as a seismic precaution, and asphalt paving goes back to the days of cheap petroleum products, among other factors. The substitutions for these two elements are the only ones that we attempt for this report since conjectural estimates were not the aim.

In addition to total cost for eight categories of infrastructure, Table 1 shows the share of onsite wages in these costs and how many hours of employment of skilled and unskilled labor are involved. With that information the employment generator, $\emptyset$, can be calculated for each component and for the total. With this coefficient one can estimate employment generation, N, for a similar project at a later time when prices and wages have changed. Just multiply $\emptyset$ times the total cost, C, and divide by the unskilled wage rate, w_u.

$$N = \frac{\emptyset C}{w_u}$$

$$N = \frac{.174\ (887,000)}{0.796}$$

$$= 194,000 \text{ workhours}$$

One must simply make sure that none of the ratios, r, p, and q, that make up $\emptyset$, have changed. If they have, it is a simple matter to recalculate $\emptyset$ since $\emptyset = \frac{r(1 + q)}{(p + q)}$. The 1980 values for these ratios and the given project also appear in Table 1.

Table 1 — Infrastructure cost and employment generation for 500 dwellings on 116.2 m^2 sites, Lima, Peru, 1980.

Component	1 Cost C US$ of 1980 (Percent)	2 Cost: Onsite Labor W US$ of 1980 (Percent)	3 Onsite Employment: Unskilled N_u	4 Work Hours: Skilled N_s	5 Wages Share $r = W/C$	6 Skill Ratio $q = N_u/N_s$	7 Employment generator $\gamma = \frac{r(1+q)}{(p+q)}$
1. Earth moving.	66,804 (7.5)	3,159 (2.0)	--	3,731	.047	0	.044
2. Landscaping, public planting	36,739 (4.1)	7,970 (5.0)	8,817	1,125	.217	7.837	.215
3. Streets, curbs, sidewalks							
A. Asphalt	314,302 (35.4)	19,304 (12.2)	13,631	9,986	.061	1.365	.059
B. Concrete	245,300	37,217	32,543	13,365	.152	2.435	.149
4. Electricity							
A. Underground	303,616 (34.2)	74,434 (47.0)	51,958	39,071	.245	1.329	.238
B. Aerial	149,536	8,733	9,134	1,729	.058	5.283	.057
5. Water: street lines	40,145 (4.5)	12,156 (7.7)	13,646	1,530	.303	9.077	.301
6. Water: domestic connections	18,184 (2.0)	3,795 (2.4)	3,103	1,565	.209	1.983	.205
7. Sewerage network: street lines	72,465 (8.2)	27,156 (17.1)	30,860	3,065	.375	10.067	.373
8. Sewerage network: domestic connections	34,805 (3.9)	10,452 (6.6)	9,346	3,560	.300	2.625	.295
9. Totals (or weighted means)							
A. With 3A and 4A	887,060 (100.0)	158,426 (100.0)	131,361	63,633	.178	2.064	.174
B. With 3B and 4B	663,978	110,638	107,449	29,670	.167	3.621	.164
10. Total per unit							
A. With 3A and 4A	1,774	317	263	127	.178	2.064	.174
B. With 3B and 4B	1,328	221	215	59	.167	3.621	.164

Note: The ratio of skilled to unskilled wages, p, equals 1.0638.
Source: Data supplied by the Peruvian Ministry of Housing and Construction and the U.S. Agency for International Development.

Unusual for Peru among developing countries has been the high level of unskilled wage rates in construction. In 1980 it was the equivalent of US$ 0.796 per hour or $6.36 per day. This level is about 50 percent above that of countries with comparable characteristics like Colombia or Tunisia. On the other hand, skilled wages in Peru were only 6.38 percent above unskilled wages, while a 100 percent higher is more common elsewhere. The skilled wage rate was the equivalent of US$ 0.847 or $6.78 daily. Thus skilled wages are about 15 percent below those in comparable countries. For any activity that uses 3.6 times as many skilled workers as unskilled, labor costs will be the same in Peru as elsewhere. These are activities in which q, the ratio of unskilled to skilled workers (the reciprocal of 3.6), is .278. In general, one would expect a tendency to substitute comparatively cheap skilled workers for unskilled workers.

Such substitution has not taken place to a remarkable extent, however, as can be seen in column 6 of Table 1. Hence labor costs in Peruvian construction will be higher than those in comparable countries. Except for earth moving, none of the skill ratios, q, are below 1.0, which would mean less than one unskilled for every skilled worker. Earthmoving in this project was carried out only by skilled operators of heavy equipment worth $14,800. In the subsequent activity of landscaping and planting, 7.8 unskilled workers were used per skilled man. Least skill-intensive was the laying of water and sewerage pipes under streets, with 9 and 10 unskilled workers per skilled worker. After earthmoving, the lowest skill ratios of 1.365 and 1.329 were in laying asphalt streets and underground electrical lines, the two activities that appeared to be extravagant. For concrete street and aerial electricity the respective skill ratios would be much

higher, 2.435 and 5.283. As a result of this substitution, the overall skill ratio would rise from 2.064 to 3.621, (Rows 9A and 9B).

Although the modified design uses relatively more unskilled labor compared with skilled, it is not more labor-intensive. Its share of wages in total cost is 16.7 percent compared with 17.8 percent. Concrete streets have a wages share of 15.2 percent compared with only 6.1 percent for asphalt streets, it is true, but that is more than offset by the low 5.8 percent share of wages for aerial electrical lines, compared with 24.5 percent for underground lines. Altogether, infrastructure for the actual plan took 195,000 workhours, compared with only 137,000 hours for the modified plan. The modified plan implies the loss of 7,234 working days.

But the modified plan also means the saving of $223,000, which could be spent on another project and therefore make up for the loss of employment. If it were spent on more of the same type of project, preparing lots at a cost of $1,328 each, 168 more sites could be developed, an increase of 33.4 percent. An additional 46,000 workhours would be involved, bringing the total for a volume of $887,000 of the alternate plan to 183,000 workhours. This amount of work is still 6.1 percent below that generated with asphalt streets and underground electricity.

At this point a value judgment has to be made: Is a 6 percent rise in employment worth the loss of a quarter of the sites that could be developed and a one-third rise in price per site? Since economic development is about both employment and productivity, the answer would seem to be, no, the sacrifice of lots is too great. Moreover, it should be noted that the shift to concrete streets is actually employment generating. What the danger is from aerial electrical lines in a seismic area has not been quantified

in this study. What price in terms of lots is to be paid for the avoidance of how much danger?

Specifications for the infrastructure that goes with 500 lots can be changed in many ways and in different combinations. If the size, shape, and layout of lots is altered some percentage of all types of infrastructure can be saved. In addition, streets could be narrowed, and the installation of curbs could be postponed. With all the conceivable types of changes, how can one estimate possible employment effects without repeating costly studies?

Inevitably the engineers who design a development will include an estimate of the cost of each component. If a share for labor is not included in these estimates, an assumption that this share, or r, will remain the same for each component as in column 5, Table 1, is reasonable unless a drastic increase or decrease in mechanization is expected. For digging operations it will be 25-35 percent, for surface concrete work it will be about 15 percent, etc.

A similar assumption can be made for the skill ratio, q: It will remain the same per component unless there is contrary evidence. Per skilled worker 9 to 10 unskilled will thus be used in laying the major street pipes, but only 2 or 3 in making individual domestic connections. The ratio of skilled to unskilled wages and the level of both can be obtained by consulting published regulations and contracts.

With all that, employment generators can be reestimated where necessary and employment per component can be found. Total employment is simply the sum of that generated by all of the components. The overall

employment generators (lines 9A and 9B) should only be used if different types of projects are compared, and if time or information is lacking for a component by component assessment.