EMPLOYMENT IN CORE HOUSE BUILDING

A COMPARISON OF ESTIMATES FROM SIX CITIES IN SIX COUNTRIES

By

W. Paul Strassmann
Professor of Economics and Principal Investigator
Housing in Development Unit
Michigan State University
East Lansing, Michigan

1980

Report based on research sponsored by the Office of Urban Development, Bureau of Development Support, Agency for International Development, in accordance with Contract AID/DS-otr-C-0012.

1

EMPLOYMENT IN CORE HOUSE BUILDING: A COMPARISON OF ESTIMATES FROM SIX CITIES IN SIX COUNTRIES

How much will the construction of an identical core house cost in different countries, and how much employment will be created?[1] To answer this question we interviewed builders and construction workers in six cities on the basis of a floor plan and specifications developed by the Société Nationale Immobilière de la Tunisie (SNIT).[2] The cities were Colombo, Sri Lanka; Lusaka, Zambia; Medellín, Colombia; Nairobi, Kenya; Rawalpindi, Pakistan; and Tunis, Tunisia. Information was sought on alternative volumes built by contractors of varying sizes; and comparisons were made using adaptations of the specifications to local conditions and preferences. Before going into the effect of all these variations, we shall describe the basic floor plan and compare its cost and on-site employment for a single unit in the six cities.

The dwelling, as may be seen in Figures 1 and 2, is rectangular with a flat roof supported by six reinforced concrete posts and a collar beam. Inside is a 12 M^2 room, a 5.5 M^2 kitchen, a 1 M^2 entrance, and a 1.5 M^2 toilet connected to a septic tank. Each room has one window, and the kitchen has running water at a sink. Additional rooms can be built on the upper right (Figure 2) or on the roof. Specifications are summarized in Table 1. The dwelling is intended for a 77 M^2 lot, but site cost and

---

[1]The author is indebted to Michael Farbman of the Agency for International Development for helpful suggestions during all stages of this project. Surveys were organized with great diligence by Ehsan Ahmed, Pakistan; Norma Botero, Colombia; Ridha Ferchiou, Tunisia; Nimal Gunatilleke, Sri Lanka; Davinder Lamba, Tara Chana, and Suresh Amlani, Kenya; and Manenga Ndulo, Zambia. I am grateful to Ting-ing Ho and Nimal Gunatilleke for computations.

[2]Tunisie, Cinquième Plan de Développement: Le Secteur Habitat - Examen et Commentaires. Washington, D.C.:IBRD, Working Paper, 1977.

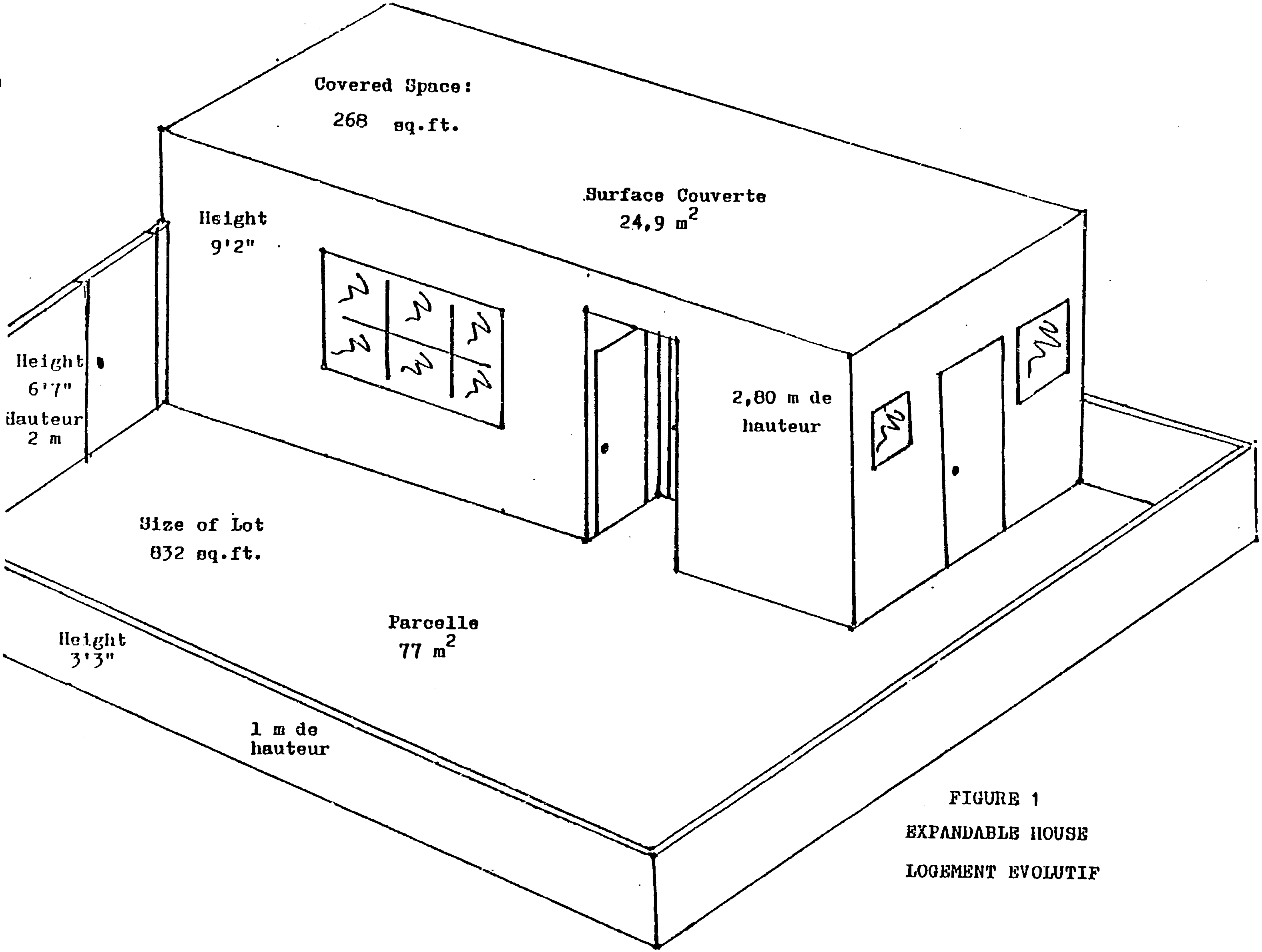

FIGURE 1

EXPANDABLE HOUSE

LOGEMENT EVOLUTIF

FIGURE 2. EXPANDABLE CORE HOUSE

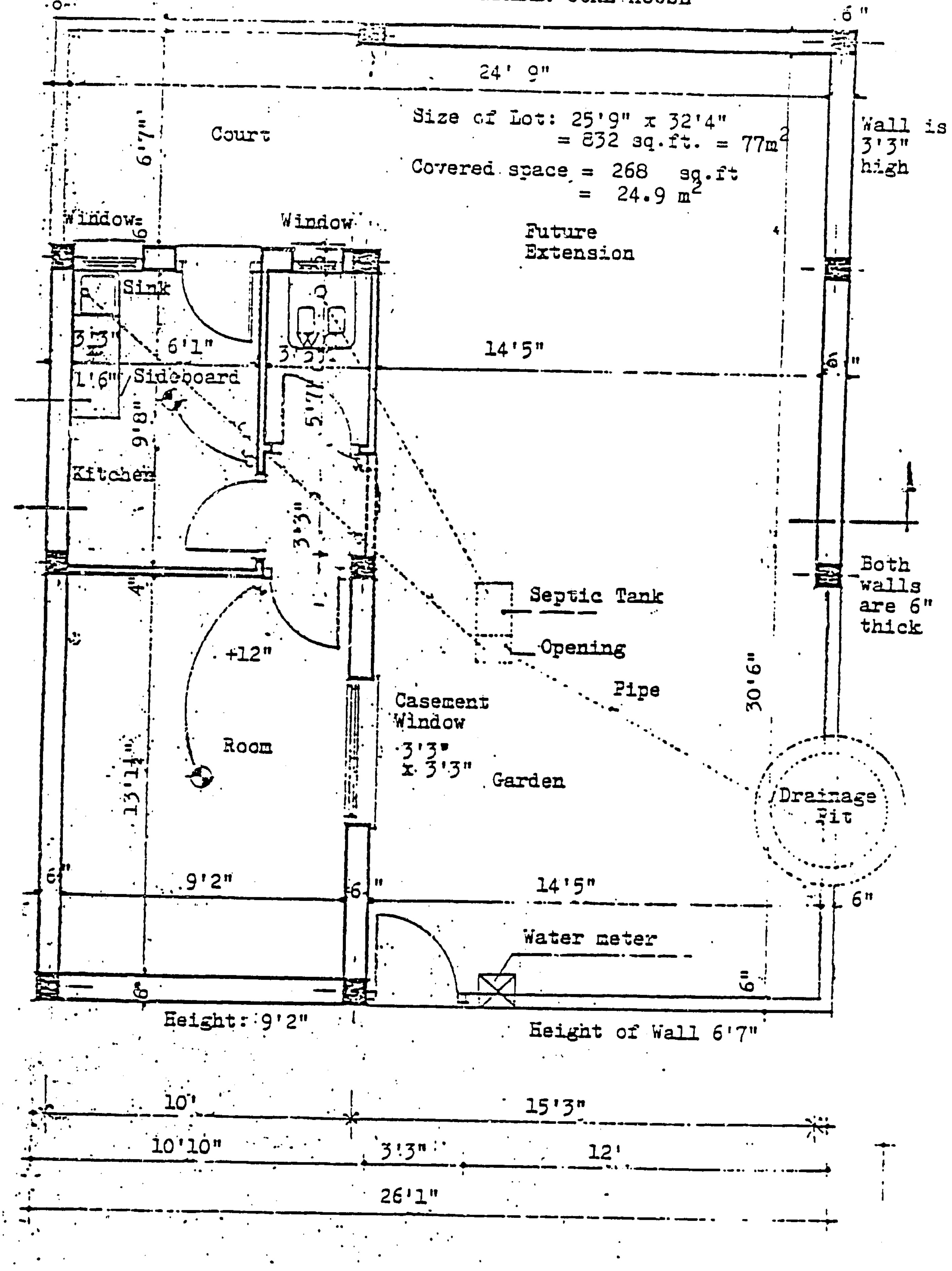

TABLE 1. EXPANDABLE HOUSE: SPECIFICATIONS

COMPONENT	UNIT	QUANTITY
1. <u>Site Preparation</u>		
2. <u>Excavation, Trenching</u>		
a. Holes 5' deep for six posts 20"x20" = 83.3 cubic feet.	cu.ft.	83.3
b. Trenches for the walls of fence and house = 78.0 cubic feet.	cu.ft.	78.0
3. <u>The Shell: Walls, Ceiling, Floors</u>		
a. Reinforced concrete collar beams and posts 6"x6".	cu.ft.	70.6
b. Roof panels	sq.ft.	226.0
c. Standard concrete, 15 pounds per cubic foot	cu.ft.	88.3
d. Lightweight concrete, 10 pounds pounds per cubic foot	cu.ft.	144.8
e. Bricks or blocks with holes for the housewalls, 9'2" high 50'4" long	sq.ft.	462.9
f. Concrete block fence 6"x 3'3" front 6"x 6'7"	sq.ft.	193.8
g. Partitions, hollow blocks	sq.ft.	215.3
h. Cement floor 4½", base 2"	sq.ft.	226.0
i. Plastering: Ceilings 205 sq.ft; walls --all interior and only the facade outside, 915 sq.ft. Bathroom excluded.	sq.ft.	1,120
4. <u>Carpentry</u>		
a. Formwork, shuttering, frames, window sills.		
b. Frames for windows, openings, and doors.		8
c. Casement window 3'3" high 3'3" wide		1
d. Window panes	sq.ft.	16.1
e. Garden door, 35½"x 79"	sq.ft.	19.5
f. 4 interior doors	sq.ft.	75.5
5. <u>Painting</u>		
a. Oil paint on doors, windows	sq.ft.	237
b. Whitewash	sq.ft.	1119.5
6. <u>Plumbing</u>		
a. Sink, sideboard, faucet and drain		1
b. Turkish toilet, tank, and drain 20 liters		1
c. Galvanized pipes	ft.	34.5
d. Two appropriate valves		
e. Cement pipes for sewage (to septic tank)	ft.	12
f. Recess for water meter.		1
7. <u>Electrical</u>		
a. Lights, wiring, switches, plugs		

related infrastructure are not included in the estimates. The wall around the property is made with concrete blocks and without the four posts shown on the plan.

Cost of building this house in the summer of 1979 ranged from \$3,117 in Colombo, Sri Lanka, to \$6,276 in Nairobi, Kenya. The average was \$4,338 (see Table 2, line 1). Currency conversion was made with official exchange rates; hence the difference between Kenya and Sri Lanka may partly reflect an overvaluation of the shilling and an undervaluation of the rupee. If the low and high values for Colombo and Nairobi are not counted, the average cost for the remaining four cities does not change much: \$4,159.

For each city we have details on hours of employment of skilled and unskilled workers by component and can aggregate that in the relation,

$$(1) \qquad N = \frac{r(1 + q)C}{(p + q)w_u},$$

Here N is onsite employment in workdays, C is the total cost given above, w_u is the daily pay of unskilled labor, p is the ratio of skilled to unskilled wages, q is the ratio of unskilled to skilled workers employed, and r is the ratio of on-site labor costs to the total.[3] The components, p and q, of this equation can come either from a survey of builders or from one of workers. Since much construction work is subcontracted to labor on a piece rate basis, builders are often uncertain about the relative pay and numbers of skilled and unskilled workers. Their estimate of p and q averaged 12 percent higher than that of workers, but these two overestimates almost offset one another. The employment generators (lines 6a

[3] W. Paul Strassmann, "Guidelines for Estimating Employment Generation through Shelter Sector Assistance;" East Lansing: Michigan State University, January 1980 (mimeographed).

Table 2. Cost of Construction and Employment Generation for a Standard 24.9 M^2 Dwelling Built with Reinforced Concrete Posts in Six Countries, Summer 1979.

Volume: 1-10 Units

	Colombo, Sri Lanka	Rawalpindi, Pakistan	Lusaka, Zambia	Nairobi, Kenya	Medellín, Colombia	Tunis, Tunisia	Average, Six Countries
1. Cost of construction, C	$3,117	$3,482	$5,107	$6,276	$3,794	$4,253	$4,338
2. Daily pay, w_u, of unskilled workers, According to:							
a. Workers	$ .94	$ 1.92	$ 3.05	$ 2.65	$ 3.30	$ 4.17	$ 2.67
b. Builders	1.02	$ 2.00	3.80	2.79	4.24	$ 4.70	3.09
3. Ratio of skilled to unskilled wages, p, According to:							
a. Workers	1.713	1.818	1.898	1.574	2.786	1.808	1.93
b. Builders	2.125	2.300	2.000	2.000	2.975	1.654	2.17
4. Unskilled workers employed per skilled worker, q, According to:							
a. Workers	1.50	1.73	1.50	3.00	1.46	.48	1.61
b. Builders	1.31	1.53	1.62	2.86	2.11	1.37	1.80
5. Ratio of labor costs to total cost, r,	.150	.185	.198	.352	.205	.314	.234
6. Employment generator, $\emptyset = \frac{r(1+q)}{(p+q)}$							
a. Worker-based	.117	.142	.146	.308	.119	.203	.173
b. Builder-based	.101	.121	.143	.280	.125	.246	.169
7. Workdays for the dwelling. According to:							
a. Workers	388	258	244	729	137	207	327
b. Builders	309	210	192	632	112	223	280

and 6b) are almost equal. If builders claimed to employ 14 percent fewer workers, it is because they claimed to pay 16 percent higher wages (lines 2a and 2b).

The average number of workdays needed for this building was 327 according to workers and 280 according to builders. In Nairobi over twice as many were used and in Medellín only 42 percent or 137 workdays. The average for the remaining four cities is 274 according to workers and 234 according to builders. Tunis is comparatively low, while Colombo is comparatively high. (Table 2, lines 7a and 7b. Hurried readers should now skip ahead to Table 7.)

Why does employment generation vary this much for building a very simple structure with well-known technology? The first clue can be found in Table 2, line 2, the level of unskilled workers' wages. It ranges from US$0.94 daily in Colombo to $4.17 in Tunis (average: $2.67). If builders are good at substituting labor and non-labor inputs for one another, and if these inputs are readily available, employment generation will fall as wages rise. If substitution is difficult, then a rise in wages (relative to other costs) means a rising share of labor costs in the total (line 5) and a higher total cost as well.

The wage level in Rawalpindi is 104 percent above that of Colombo, but the share of labor in total costs is only somewhat higher, 18.5 compared with 15.0 percent. About 130 onsite workdays have been replaced by better tools, management, etc., and the total cost is only 12 percent higher. Stated technically, the elasticity of substitution is somewhat below unity: percentage rises in wages are almost offset by equivalent percentage falls in employment.

The wage level in Tunis is far (117 percent) above that of Rawalpindi; nevertheless, 80 percent as many workdays are needed, and the share of labor rises to 31.4 percent of total costs, which in turn are 22 percent above those of Rawalpindi. The unskilled wage levels in Lusaka and Medellin are both somewhat above $3.00 daily, and the share of labor in total costs is close to 20 percent in both. Yet the house can be built for 26 percent less in Medellin, using 44 percent less labor. The skill premium in Medellin of 179 percent over unskilled wages is double that of Lusaka's 90 percent, but that does not account for most of the difference in workdays. Other things equal, with skilled wages at the Lusaka level, workdays in Medellin would have risen only to 173, still 29 percent below Lusaka. Medellin, an old industrial center with a renowned work ethic, seems to have a better organized construction industry and higher productivity than fast-growing Lusaka where 90 percent of adults grew up in villages. Thus, even for this simple dwelling, employment and costs per unit are greatly influenced by factors more complex than the relative prices and substitutability of different inputs.

Not only can labor and non-labor construction inputs be substituted for one another as their relative price and quality varies: The same is true of different types of labor.[4] As the skill premium rises, one expects builders to supplement skilled workers with unskilled helpers to a greater extent. One expects p and q (Table 2, lines 3 and 4) to rise and fall

---

[4]Researchers in this field have commonly assumed separability, that is, the assumption that changing the proportion of skilled and unskilled workers to one another will not change the proportion of labor costs in total costs. See the survey of the literature by Daniel S. Hamermesh and James Grant, "Econometric Studies of Labor-Labor Substitution and their implications for Policy," Journal of Human Resources, Fall 1979, pp. 518-42. Our findings partly contradict the assumption.

together. This tendency is not, however, pronounced. Nairobi has the lowest skill premium, only 57 percent, and yet builders say they use three unskilled workers for each skilled one. According to builders, Medellín is the only city besides Nairobi where more than two unskilled workers are used with each skilled one; and Medellín does pay the highest skill premium, nearly 200 percent. Qualitative differences are obviously involved in the relative meaning and worth of skills. Each city has its own pattern.

That pattern is summarized in the employment generator, Ø, which is independent of currencies, inflation, and exchange rates.

(2) $$\text{Ø} = \frac{r(1 + q)}{(p + q)}$$

(3) $$N = \text{Ø} \frac{C}{w_u}$$

Referring back to equation (1) above, one can see that Ø multiplied by total costs divided by the unskilled wage rate yields employment. The ratio C/w_u relates a construction project to a country's general level of development, the availability of unskilled labor compared with other factors of production. Given that level, Ø expresses the characteristics of a building industry in terms of all the factors discussed in preceding paragraphs -- skilled and unskilled labor, labor and non-labor inputs, etc.

The employment generators appear in Table 2, lines 6a and 6b. They are lowest for Colombo (.117) where the high level of workdays for the dwelling is still not in proportion to the very low level of wages. But without more substitutability and flexibility in building, employment cannot be higher. The employment generator in Medellín is low (.119) for a more specific reason, the difficulty of using fewer skilled workers, who receive an extraordinarily high premium in that city -- the price of keeping them from migrating to oil-rich Venezuela. That is, q stays low. The high employment generators of Nairobi (.308) and Tunis (.203) are associated with high (over 30 percent) shares of labor in total costs (high r's). Apparently their situation is the reverse of Colombo: With their high wage rates, more flexible builders would have held costs down by replacing more workers with non-labor inputs.

These diagnoses and their implied prescriptions are probably too general to be useful. If all stages of the building process are not affected uniformly, one can easily start making amends in the wrong place. One has to know which component of the dwelling could be made more efficiently with additional workers of all types, or perhaps with fewer skilled workers, etc. How do its p's, q's, and r's for plumbing, carpentry, the shell, and so forth, compare with the average elsewhere? Even such evidence is not conclusive since conditions differ, but its examination is the logical second step.

The Relative Importance of Components

About 60 percent of employment is generated in building the structure of the dwelling, the walls and the roof; and this basic shell also accounts for a comparable share of costs. If carpentry and plumbing are added, 90 percent of construction costs and 80 percent of employment are accounted for. The remaining activities -- site preparation, excavation, painting, and electrical installation are relatively labor-intensive, but they each account for only a very small proportion of total cost and employment.

Table 3 shows the share in total costs of the seven major components of a dwelling, as estimated in detail by construction firms of different sizes in six cities. The shares are averages for those firms that gave complete and internally consistent cost estimates.

Perhaps the most striking deviations from averages in Table 3 are the high shares in cost of carpentry and plumbing in Sri Lanka, over 50 percent, about double that in the other cities. In the case of Sri Lankan carpentry, the high cost is due to the lack of prefabricated doors, window frames, and the like, which may be employment generating on the site but are otherwise inefficient. Plumbing installation in Colombo, by contrast, does not take more workdays than are needed in Rawalpindi, Lusaka, or Nairobi; but the components, often imported, are relatively expensive. The share of labor costs in plumbing installation are 8.9 percent in Colombo and average 20.5 percent in the other five cities, more than twice as much. (See Table 4.)

In general, labor costs average 21.4 percent of total onsite costs, and their share is 23 percent in costs of the shell. Labor costs in plumbing, carpentry, and electrical installation are a much lower share; but painting, site preparation, and excavation have substantially higher labor cost shares. Table 4 shows variations from this general pattern. Especially striking is the variation in the share of labor in the shell, from 14 to 38 percent. In all cases whether total employment varies in proportion to that in the shell depends on the number of unskilled workers and their relative wages in the total share of labor, as we shall see.

An interesting phenomenon is the lack of variation in the skill premium. In the different cities with their divergent general wage levels

Table 3. Percentage Distribution of Costs by Component for a Standard 24.9 M^2 Dwelling Built with Reinforced Concrete Posts in Six Countries, Summer 1979.

Volume: 1-10 Units

Component	Colombo, Sri Lanka	Rawalpindi, Pakistan	Lusaka, Zambia	Nairobi, Kenya	Medellín, Colombia	Tunis, Tunisia	Average, Six Countries
1. Site preparation	0.7	1.3	--	2.8	2.9		
2. Excavation and trenching	0.1	0.2	0.4	1.2	2.8	69.8	63.0
3. The shell: reinforced posts and non-load-bearing blocks	40.9	68.6	58.7	64.6	62.9		
4. Carpentry	26.8	17.8	14.3	9.2	15.0	21.3[1]	17.4
5. Painting	2.3	1.6	6.6	5.9	3.4	--	4.0
6. Plumbing	25.9	6.7	17.6	9.3	9.0	8.9	11.3
7. Electrical	3.3	3.8	2.5	7.1	4.0	--	4.1
8. Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] For Tunisia, Item 4 includes 5 and 7.

Table 4. Ratio of Labor Cost to Total Cost, r
by Component for the Standard Floor Plan (Posts)

Volume: 1-10 Units

Component	Colombo, Sri Lanka	Rawalpindi, Pakistan	Lusaka, Zambia	Nairobi, Kenya	Medellín, Colombia	Tunis, Tunisia	Average
1. Site preparation	0.738	0.769	--[3]	0.765	0.708		0.745
2. Excavation and Trenching	0.632	0.769	0.849	0.774	0.419[2]		0.689
3. The Shell	0.139	0.173	0.144	0.381	0.221[2]	.319[1]	0.230
4. Carpentry	0.195	0.180	0.183	0.129	0.078	.307[1]	.179
5. Painting	0.393	0.235	0.510	0.443	0.415		0.399
6. Plumbing	0.089	0.160	0.247	0.248	0.103	.267	.185
7. Electrical	0.176	0.215	0.280	0.196	0.244		0.222
8. Total	0.150	0.185	0.198	0.352	0.205	.314	.214

Note: 1. For Tunisia Component 3 included 1 and 2, Component 4 included 5 and 7.
2. For Colombia the Components 2 and 3 have been modified to suit specific local requirements.
3. For Zambia Component 1 data was unavailable.

and in the various specialties, skilled workers get about twice as much as unskilled laborers and helpers. Apparently the extra effort needed to learn one trade is comparable to that for others, and the gain in productivity is in proportion. The major exception was Medellín, Colombia, where the skill premium ranges from 140 to 200 percent. The premium was highest for masons and lowest for electricians and plumbers.

The comparatively small variation in the relative skill premium does not necessarily mean little variation in the number of unskilled laborers and helpers used with each skilled worker. On the contrary, Table 5 shows substantial variation around the overall mean of 1.8. Note that the three poorer cities use only 1.5 unskilled workers per skilled man. Yet the share of labor in total costs of the three poor cities is lower, 17.8 percent, compared with 29.0 percent for the three richer ones. Displacing labor as wages rise is apparently not easy, or its cost share would be constant or falling. At this level of development, however, one learns to use the unskilled to better advantage and to replace more of the skilled with non-labor inputs.

For the principal component of the dwelling, its shell, 2.5 unskilled helpers are used with each skilled worker, primarily masons. The pattern from poor to rich countries is not consistent; for example, Lusaka has one of the lowest and Nairobi one of the highest ratios. The range goes from two to four unskilled workers per skilled man. In carpentry, plumbing, and the other late phases of construction, about two unskilled workers are used with every three skilled craftsmen, and the deviations are less than those for the shell. Skills are least needed in site preparation, excavation, and trenching, where 8 to 18 unskilled workers

Table 5. Ratio of Unskilled to Skilled Workers, q, and the ratio of Skilled to Unskilled Wages, p, by Component for the Standard Floor Plan (Posts)

Volume: 1-10 Units

Component	Colombo, Sri Lanka	Rawalpindi, Pakistan	Lusaka, Zambia	Nairobi, Kenya	Medellín, Colombia	Tunis, Tunisia	Average
1. Site preparation	9.490	--	--	--	15.000	--	12.245
2. Excavation and Trenching	--	--	8.000	18.500	10.500[2]	--	12.333
3. The Shell	2.775	2.202	2.000	3.814	1.923[2]	2.380[1]	2.515
4. Carpentry	.475	.276	1.000	.974	1.000	.292[1]	.670
5. Painting	.570	.604	1.000	.357	.600	--	.626
6. Plumbing	.660	.604	1.000	.967	.657	.304	.698
7. Electrical	1.000	1.139	1.000	0.000	.833	--	.794
8. Total	1.307	1.528	1.616	2.855	2.107	1.370	1.797
9. Ratio of Skilled to Unskilled Wages, p	2.13	2.30	2.00	2.00	2.98	1.65	2.17

Note: 1. For Tunisia, Component 3 included 1 and 2, Component 4 included 5 and 7.
2. For Colombia, Components 2 and 3 were modified to suit specific local structural requirements.

can work under the guidance of one trained man. These early stages generate only about 10 percent of total employment and show great variability in data. In general, it appears that in the higher-income countries unskilled workers need less supervision and are therefore used in greater proportion. (See Table 5).

Employment Generators by Component

The three ratios that have been discussed are r, the labor cost ratio, p, the wage ratio, and, q, the skill ratio. Together they make up the employment generator, $\emptyset = \frac{r(1 + q)}{(p + q)}$, the multiplier that will give the workdays created for any expenditure that has been divided by the unskilled wage rate, as already stated above. Table 6 shows what these multipliers are for the seven major building components.

The highest multipliers of 0.6 to 0.7 exist for site preparation and excavation, which is to be expected, given their labor intensity (few materials) and low skill ratio (high q's). Employment generation for those stages is six times as much per expenditure as in carpentry and plumbing where the generator is only around 0.1. The employment generator for that major element, the shell, is quite variable, and averages out as .174. It is low where materials are expensive and r is low, as in Colombo and Lusaka; and high where low productivity raises r, as in Nairobi. The overall employment generator of .169 primarily reflects that of the shell.

An unusually small amount of employment is generated by carpentry in Medellín and plumbing in Rawalpindi, while a comparatively large amount is generated by painting in Lusaka. A glance at the other tables suggests

Table 6. The Employment Generator Ø by Component for the Standard Floor Plan (Posts)

Volume: 1-10 Units

Component	Colombo, Sri Lanka	Rawalpindi, Pakistan	Lusaka, Zambia	Nairobi, Kenya	Medellín, Colombia	Tunis, Tunisia	Average
1. Site preparation	.659	--	--	--	.655	--	.657
2. Excavation and Trenching	--	--	.695	.736	.371	--	.601
3. The Shell	.107	.121	.108	.315	.131	.264	.174
4. Carpentry	.110	.088	.122	.086	.040	.199[1]	.089[2]
5. Painting	.226	.130	.340	.255	.173	--	.225
6. Plumbing	.051	.088	.165	.164	.074	.184	.121
7. Electrical	.114	.128	.187	.098	.189	--	.143
8. Total	.101	0.121	.143	.279	.125	.246	.169

Note: 1. For Tunisia, 4 includes 5 and 7.
2. Omits Tunisia.

that the carpentry involves substitution of prefabricated elements (low r), that the plumbers have unusual productivity (low cost percentage and low r), and that the painters lack that (high cost percentage and high r). These assertions have relative, not absolute significance, and must be verified by a detailed check with new projects before taking action. The objective of this type of study is to detect such potential weaknesses in the building process. More employment is desirable, but not at any cost.

Table 7. Typical Workdays per Housing Component at Two Levels of Development for a 24.9 M^2 Dwelling Built with Reinforced Concrete Posts.

Unskilled Wages per Day, US$ of 1979

	(1) $2.00	(2) $4.00	(3) Ratio 2/1
1. Site preparation	15	10	.67
2. Excavation and trenching	10	7	.70
3. The Shell	145	95	.66
4. Carpentry	25	7	.28
5. Painting	10	7	.70
6. Plumbing	40	8	.20
7. Electrical	10	9	.90
8. Total	255	143	.57
9. Cost of Dwelling, US$ 1979	$3,500	$3,800	1.09
10. Share of Labor Costs Percent	20.0	20.4	--
a. Share of Unskilled Wages, Percent	9.2	9.6	--
b. Share of Skilled Wages, Percent	10.8	10.8	--
11. Share of Unskilled Workers in Employment, Percent	63	64	1.02

Note: Comparing z with 1, the number of workers is over half, but the share of unskilled workers rises somewhat. As a result, the share of wages barely rises.

Source: The figures approximate those reported in Rawalpindi and Medellín but have been adjusted for a few omissions and anomalies. The Rawalpindi data, for example, omitted site preparation and excavation employment. The steep terrain of Medellín raised the amount of labor needed for these activities compared with other cities. Medellin also had an unusually high skill premium.