Economic aspects of new methods of building with particular reference to the British Isles, the Continent and America

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INTRODUCTION

The building and construction industry occupies a central place in the economy because of its importance as a producer of capital goods It plays a prominent role, particularly in programmes of economic development, in providing living and production facilities and a good part of the economic infrastructure The speed and price at which the industry is able to provide the variety of buildings and other structures required, therefore, are important factors conditioning the rate of economic development In these respects, however, the performance of the industry is often compared unfavourably with that of other industries

An examination of the prices of the output of building and other industries, for instance, reveals a clear tendency for the costs of building to rise at a relatively much faster rate than prices in general The implication, of course, is that productivity in building does not keep pace with productivity in other industries, or that the prices of the factors of production rise more rapidly in building than elsewhere Hence building tends to take a relatively larger and larger share of economic resources per unit of output

The purpose of this paper is to examine the influence of economic factors in determining the form which building methods take in different countries, and the influence these have in relation to innovation in methods of building It is intended to conduct this examination with reference to the conditions and experience in European countries and America but with particular reference to the countries of the British Isles

THE PRICES OF BUILDINGS AND OTHER GOODS

First of all, in order to try to assess the performance of the industry against others on a broad front, some figures to show relative price changes for buildings and other goods, in a number of countries over a fairly long period of time, have been brought together in Table 1 Naturally,

these figures must be interpreted with a great deal of caution since the measurement of price changes over the long period, for such a heterogeneous product as buildings, involves severe difficulties. These, of course, revolve around the problem of maintaining comparability in the series when large shifts take place in quality and standards, old materials go out of production and new ones are introduced. For the purpose of a broad comparison, however, it is unlikely that the "errors" in the estimates shown in Table 1 can be so large as to give an entirely misleading picture when comparing one with the other It should be noted, in particular, that the index of house building costs in Britain incorporates adjustments in respect of changes in standards between the nineteen thirties and the years following the second world war and changes in average house sizes since the early nineteen fifties

It will be seen that over the period since the first world war the increase in the costs of building would seem to have exceeded that of goods in general in Britain, America, France and the Netherlands by up to twice as much or more In America and the Netherlands the increase was more than twice as much, in Britain about one and three-quarter times and in France one and two-third times the increase for goods in general Figures for a shorter period of time for Germany and Switzerland show a similar trend. In this respect, therefore, it seems to be fairly generally true that a comparison of the relative performance of building against other industries is not a favourable one

THE PRICES OF MATERIALS AND LABOUR

As one might expect, the price of materials and components bought in by the building industry has not increased at the same rate as labour costs Thus the disparity between the price increases of buildings and other goods is to be explained by a rise in labour costs per unit of output —that is to say, labour costs per man unmatched by productivity improvements—rather than by increases in the costs of materials Though at the same time part of the increase can probably be accounted for by increases in the total input of materials in the form of engineering services and higher quality finishes

In Britain, for instance, over the period since the first world war, building materials have increased in price by rather more than five times, whilst building labour has increased by over ten times (Table 2).

TABLE 1

OUTPUT PRICE INDICES FOR BUILDINGS AND OTHER GOODS

(a) 1913–1962 (1913–14=100)

Year	GREAT BRITAIN			U S A		FRANCE		NETHERLANDS	
	General Building	House Building	Wholesale Prices (M'factures)	Building[1]	Wholesale Prices[2]	House Building	Wholesale Prices (Total)	House Building	Wholesale Prices (Total)
1913	100	—	100	100	100	—	—	—	—
1914	—	100	—	—	—	100	100	100	100
1949	473	434	279	352	203	13,692	11,544	511	254
1962	710	746	419	580	255	36,054	21,718	773	338

(b) 1950–1962 (1954=100)

Year	W GERMANY		SWITZERLAND	
	House Building	Wholesale Prices (Total)	House Building	Wholesale Prices (Total)
1950	—	87	94	94
1954	100	100	100	100
1962	154	120	132	104

NOTES [1] Not adjusted for productivity.
[2] Excluding food and farm products
SOURCES See Appendix

TABLE 2

BUILDING INPUT PRICE INDICES

Country	1962 Price Level			
	1953=100		1913=100	
	Building Materials	Building Labour	Building Materials	Building Labour
U S A.	108	146	437	854
Great Britain	122	162	525	1051[1]
Northern Ireland	117[2]	162 (155)[2]		
Irish Republic	115	145		
Austria	122	171		
Denmark	125	171		
Finland	113	159		
Italy	99	183		
Portugal	101	136		
Sweden	126	129		

NOTES [1] 1914=100 [2] 1954=100
SOURCES See Appendix

Similarly in America, over the same period, building materials have shown an increase of more than four times but labour about eight and a half times. Over the period since 1953 building materials prices in Northern Ireland would seem to have increased by about a fifth against a labour costs increase of three-fifths, and in the Irish Republic by about one-seventh against three-sevenths respectively. Similar large differential increases between the prices of building materials and labour have taken place in all other European countries for which figures are available except Sweden over this period.

Since there exists in the industry such a strong tendency for labour costs to rise at a much faster rate than materials costs, the first line of attack in trying to achieve economies would seem to be to try to develop or devise methods of building which would economise on labour

THE DEVELOPMENT OF NEW METHODS AND FORMS OF CONSTRUCTION

The development of new methods and their success depends upon the interaction of a number of factors It is a useful preliminary, therefore, to consider what these factors are in relation to the forms which new developments may take

First there is the fact that the industry cannot produce its product at a fixed location, as in a factory, but has to provide it at the place where it is wanted. The advantages which other industries may obtain from centralised production on a large scale in factory conditions, therefore, are not so easily achievable in building. Any economies of scale in prefabrication

and savings in site labour costs may well be outweighed by extra transport charges and other diseconomies

A second important factor is that building is a complex process requiring the assembly of a large number of different materials and components derived from a variety of different industries and the deployment of a variety of different skills Methods of building and the relative economy of different forms of construction, therefore, are determined to some extent by the size, composition and geographical distribution of demand, and the relative prices of alternative materials and of labour in building and non-building industries and occupations

It is possible to divide innovations into two broad groups First, there are those associated with the introduction of completely new materials, such as plastics, and the development of modifications to, and new forms and uses of, existing materials such as lightweight concrete. Secondly, linked perhaps with this first group, one can distinguish the development of new methods and forms of construction These may be a rationalisation of site methods of construction, or they may involve, perhaps, the prefabrication off the site of as much of the work as possible, so that the work on site becomes much more the work of assembly and erection rather than fabrication. It is with this second group that this paper is principally concerned

A factor strongly influencing the ability of the industry to innovate is the sharp division in the production process between design, manufacture and construction. At the edges, of course, this distinction may be blurred in as much as some manufacturers also build, some builders may produce materials and components and some builders also have their own design staffff To this extent there may be some integration of these processes, but by and large they remain quite distinct. Unlike other industries, therefore, there is no unified control over the whole process The ability of the industry to innovate and exploit possible economies is restricted by this tripartite structure

Innovation in site methods of building, apart from any limitations imposed by design, are under the control of the builder. Innovations in materials or forms of construction are largely dependent on materials manufacturers and designers. They have also to meet the conditions imposed by building by-laws and regulations.

TRENDS IN NEW DEVELOPMENTS

Changes in building methods have tended to evolve only very slowly. They remain labour intensive and involve very much traditional processes of mixing and putting together a wide variety of materials on site. Mechanisation has replaced a great deal of manual labour for such things as excavation, materials handling and concrete mixing, but apart from powered hand-tools the mechanisation of building craft processes has made only very limited progress.

There has, of course, been a long-standing trend for many components to be prefabricated. Thus, for instance, joinery in the form of doors,

staircases and window frames has long been factory made, similarly precast concrete goods, plasterboard and metal components These have gradually been incorporated into traditional forms of construction. Similarly new materials have found their place in traditional forms. In recent years a great deal of effort has gone into attempts to take the trend towards prefabrication much further very rapidly. These have taken the form of attempts to produce sets of parts which can be fitted together easily on site, and the development of larger individual units

On the Continent, in particular, large precast concrete panels for floors and walls—with door and window openings, internal linings, and pipes and ducts for gas, electricity, water and drainage services cast in—are used extensively for the construction of multi-storey blocks of flats. In some countries complete room units are prefabricated and transported to site In Sweden, for instance, complete bathroom, lavatory, kitchen and boiler units—so called "Heart" units—completely fitted out and decorated are built and transported considerable distances, simply requiring connection to drains and main services on site [1] In Russia complete building "boxes" have been put together and completely finished in the factory, transported to site and stacked up by special cranes [2]

Recent years in Britain have seen the third officially-encouraged drive since the first world war to devise non-traditional systems of building suitable for "low-rise" development—in particular, one and two-storey housing. Generally speaking, these have taken the form of framed structures—either timber, steel or concrete frames—clad with a variety of materials ranging from the traditional brick, so that the house is not always identifiable as non-traditional, to plastics materials. In the traditional house, of course, the structure and cladding are built as one in the form of load-bearing brickwork.

Against this background one can examine more closely the reasons why prefabrication seems to have been taken much further in some countries than in others and greater success achieved. France, Scandinavia, America and the Communist bloc countries in particular, are places where these developments seem to have made most progress. Although even in these countries, apart from Eastern Europe possibly, it must be remembered that the proportion of work carried out by these methods, even in a well-defined sector like housing, still remains very small.

THE STRUCTURE OF COSTS IN BUILDING

Building is, of course, highly labour intensive and the unit cost of labour has shown a strong long run tendency to rise at a faster rate than the cost of materials Nonetheless, the proportion of total cost taken up by labour is generally smaller than the cost of materials. Hence any savings achieved in site labour costs has a smaller effect on total costs than a similar proportionate saving in materials

[1] Skanska Cementgjuteriet (Hjartat), *System Building* (Interbuild 1963)

[2] "Russian Monolithic Box Units", R M E Diamant, *Architect and Building News*, 2 December 1964

In Northern Ireland and Britain the ratio of labour to materials for the industry as a whole is about 3 4 and in the Irish Republic possibly the same or even higher (Table 3) The figures for the Irish Republic, it should be noted, would seem to include under materials the total labour and materials in subcontract work.

TABLE 3

THE COSTS STRUCTURE OF CONSTRUCTION INDUSTRIES IN THE BRITISH ISLES

Percentages of Gross Output

Country	Year	Materials, etc	Labour	Work Given Out	Transport	Apparent Overheads and Profits*
G Britain	1958	38 0	30 7	18 5	1 0	11 8
N Ireland	1962	41 9	31 4	17 8	0 6	8 2
Irish Repub	1962	53 6	34 6	n/a	n/a	11 8

*Taken as the difference between net output and labour costs

SOURCES Board of Trade, *Census of Production 1958, Part 128 Construction*
Ministry of Commerce, *Census of Production of Northern Ireland 1962*
C S O (Dublin), *Irish Statistical Bulletin*, Vol XXXIX, No 3, Sept 1964

For one and two-storey housing the ratio of materials to labour costs is generally higher still but with a wide range between countries (Table 4) Of all the countries for which figures were available, only one, Austria, did not conform to this general picture The figures for Britain show that the house comprising a certain amount of prefabrication gave a higher ratio than the traditional type This is partly a reflection, of course, of the fact that the prefabricated elements are valued as materials, though they incorporate a higher proportion of labour than normally.

In multi-storey flat building the ratios are even more pronounced, and in respect of the methods using large factory-made concrete panels rise to as much as 8 1 at one extreme in East European countries (Table 5). Typically, however, materials seem to amount to about two or three times the costs of labour

In these circumstances, therefore, it would seem that there is more scope for economy in reducing the material content of building than by reducing labour Further, it is clear that prefabrication increases the costs of materials delivered to site This, of course, must not be so large as to offset any savings in cost arising from the elimination or reduction of site processes if the new methods are to be successful.

TABLE 4

LABOUR AND MATERIAL CONTENT OF ONE AND TWO-STOREY HOUSES

Country	Materials Costs as Percentage of		Labour and Materials Costs as Percentage of Total Costs
	Traditional	Non or Semi-Traditional or with Partial Prefabrication	
Great Britain	125–176	229[1]	84 9 and 85 1
Irish Republic	126–167	–	88 0–88 2
Austria	84	–	81 0
Greece	155	–	79 0
France	157	–	77 0
Spain	210	–	83 0
West Germany	247	–	84 6
Netherlands	193–386	–	89 4
Sweden	—	238	81 0
U S S R	—	222[2]	82 0
Hungary	—	230–233 & 483[3]	67 6–70 0
Rumania	288	–	73 7
U S A	142–151		68 4–77 7

NOTES [1] Highly prefabricated internal panels
[2] Prefabricated timber frames and panels
[3] Non-Traditional

SOURCES U N *Housing Costs in European Countries*
U N *Government Policies and the Cost of Building*
S J Maisel, *Housebuilding in Transition* (University of California Press, 1953).

BUILDING MATERIALS REQUIREMENTS

One of the difficulties, of course, is that building materials are heavy and bulky and hence the transport costs incurred in moving these any considerable distance are high relative to the value of the materials or components themselves. Further, the massive materials such as stone, concrete and brick tend to have advantages over their lighter substitutes Particularly important is the fact that most buildings are required to have a long life and to involve the minimum of maintenance This factor tends to favour the traditional massive materials over their lighter substitutes. An additional factor is that minimum standards for sound insulation seem to be more easily achieved using those materials which provide a lot of weight in the structure, and weight for weight the prices of the lighter materials tend to put them at a very great disadvantage.

TABLE 5

LABOUR AND MATERIAL CONTENT OF MULTI-STOREY HOUSING

Country	Material Costs as Percentage of Labour		
	Traditional Masonry	In Situ Poured Concrete	Large Factory-made panels
	%	%	%
Great Britain	162	138	—
Netherlands	242–252	215–254	189–289
Sweden	207–217	161–171	252–304
Finland	200–246	187–243	—
Italy	153	—	—
Yugoslavia	295–413	—	212–877
Czechoslovakia	286–295	—	389–811
U S S R	261–282	—	300–413

NOTE Sub-contractors' costs are included
SOURCE Derived from *Housing Costs in European Countries* (U N)

TRANSPORT COSTS

Prefabrication may be expected to provide some advantage in avoiding the waste which occurs with on-site methods and conditions On the other hand, the fabrication of concrete and plaster involves the absorption of large quantities of water which increases the weight and hence the costs of transport. Often, too, extra costs are incurred in handling the prefabricated units and in providing extra reinforcement or packing to stand the stresses of transportation and handling so that even lighter materials do not necessarily possess any advantage in this respect

In addition, materials travelling to sites via factories will often end up travelling greater distances However, there is little information to suggest how important transport costs might be In France the maximum economic supply range of a factory prefabricating large concrete panels is estimated at about 50 km , where the units prefabricated weigh between 3 and 5 tons. But with prefabricated large hollow brick panels, which are three or four times lighter than concrete panels of the same dimensions, the range may extend to 150 km [3] This latter method is said to have achieved considerable success in recent years In Canada a factory's selling radius for prefabricated timber houses is said to be 200-350 miles [4] In Britain the cost of transporting large panels to site is said to be about £30 per dwelling when the trip is 10 miles and the tractors can make four trips daily, and roughly

[3] U N *European Housing Trends and Policies in 1961 and 1962*, p 54
[4] R E Platts, *Prefabrication in Canadian Housing* (National Research Council of Canada, 1964)

£60 if sites are 25-30 miles from the factory.[5] This only represents a small proportion of total cost, but the distances quoted are very short Longer distances coupled with the extra costs of factory production can make an appreciable difference to total costs It is only where the building demand is sufficiently large and favourably situated that these methods become competitive The building of multi-storey blocks of flats, for which the large panel methods are particularly suited, provides a concentrated demand of repetitive work and it is in this field that "system-building" has had most success The success of system-built houses has been much less evident

LABOUR REQUIREMENTS

It is clear that non-traditional methods of building are able to economise on site labour and, in particular, skilled labour Table 6 sets out some figures illustrative of relative skill requirements for different forms of construction in Europe. It can be seen that the total skilled labour requirement for traditional methods of building are a very high proportion of the total, from 60-80 per cent or more, and even for the super-structure alone are little less than half. For two-storey housing the proportion amounts to as much as three-quarters

The figures show that the non-traditional methods reduce the total labour required and, also, apart from the East European figures, that the proportion of skilled labour required falls. It is also apparent, however, that the superstructure generally requires less than half of the total labour and that the skill requirements for finishing the building are higher than for the superstructure

The success of non-traditional systems of building, therefore, will depend to a large degree on the extent to which they are able to reduce the total skilled labour required Many are successful in reducing the skill requirements for the superstructure but leave a considerable part of the finishing work to be performed in traditional ways. The total impact on final costs is, for this reason therefore, likely to be much less favourable.

RELATIVE LABOUR COSTS

Skill Differentials The actual effect of reducing the skill content of work on site on final costs will depend on the relative costs of skilled and unskilled site labour. Obviously, the higher the skill differential the more incentive there is to develop and use methods which are able to substitute unskilled for skilled labour

Taking the bricklayer as representative of the skilled building craftsman the differential for skill at the turn of the century was as much as 50 per

[5] D Bishop, *Systems of Construction—An Assessment of Economic Performance*, Building Research Current Papers, Construction Series 7

TABLE 6

SKILL REQUIREMENTS FOR DIFFERENT FORMS OF CONSTRUCTION IN EUROPE

Man-Hours per Square Metre of Gross Floor Area

Country and Type of Construction	Superstructure			Whole Building		
	No of Examples (Sites)	Total Man-Hours	Skilled as percentage of Total	No of Examples (Sites)	Total Man-Hours	Skilled as percentage of Total
Multi-Storey Dwellings:						
Traditional—Masonry		Hours	%		Hours	%
Netherlands	2	5 3	59—72	2	13 2—14 5	70—77
Sweden	2	4 5—5 0	46—76	1	10 7	89
U K	1	13 4	46	—	—	—
Finland	1	11 7	48	—	—	—
Italy	1	7 0	43	—	—	—
Yugoslavia	5	15 0—19 1	45—70	2	39 5—40 0	62
Czechoslovakia	4	6 0— 9 6	59—68	3	19 5—20 6	57—68
Non-Traditional—In-Situ Poured Concrete						
Netherlands	3	4 4— 6 8	36—57	3	13 6—16 2	61—69
Sweden	2	4 6— 5 0	44—58	—	—	—
U K	1	7 2	39	—	—	—
Finland	1	8 6	40	—	—	—
Large Factory-Made Panels						
Netherlands	2	5 9— 7 9	10—33	2	11 4—17 1	30—68
Sweden	2	2 0— 4 6	15—30	—	—	—
Yugoslavia	2	3 4—17 5	73—97	2	20 9—43 0	61—72
Czechoslovakia	7	1 2— 4 5	50—92	6	8 8—14 8	69—81
Two-Storey Housing:						
Traditional—						
Netherlands	1	4 8	75	1	11 5	80
U K	2	4 2— 5 7	74—76	—	—	—

SOURCE U N *Housing Costs in European Countries*

cent in Ireland and 40 per cent in Britain In America at about the same time the differential was as much as 60 per cent (Table 7)

TABLE 7

SKILL DIFFERENTIALS IN CONSTRUCTION 1900–1964
BRITISH ISLES & U S A

(Time rates of pay of Building Labourers expressed as percentages of time rates of pay of Bricklayers)

	1900	1907	1913	1924	1933	1938	1950	1963	1964
N Ireland (Belfast)	50	50	50	62	63	65	77	81	79
S Ireland (Dublin)	53		60		70	72	81	86	87
Scotland (Glasgow)	55		52	76	74	74	84	89	89
England (London)	67	66	68	76	75	75	85	89	87
(Grade A areas)[1]	60		68	76	76	76	84	89	87
U S A (Whole Country)[2]	—	37	38[3]	—	—	47	57	69[4]	—
(Chicago)	—	—	—	—	60	60	73	70	—
(New York)	—	—	—	—	30	57	66	83	—

NOTES [1] Prior to 1924, Newcastle [2] Average of rates in large cities, in 1961, 52 cities with populations of 100,000 or more [3] May 1914 [4] July 1961.
SOURCES See Appendix

As in other industries, however, there has been a strong tendency for the differential to narrow. Thus in 1964 in Britain and the Irish Republic the differential amounted to little more than 10 per cent. In Northern Ireland, however, the differential has not narrowed so much and remains twice as large, some 20 per cent In this respect, at any rate, there should exist in Northern Ireland a rather stronger incentive towards the use of those methods which are more intensive users of unskilled labour. In America the differential has narrowed very considerably, though, at an average of some 30 per cent, is much larger than in either Britain or Ireland

In continental European countries the same trend is evident though the picture is a little more confused in that the trend has not been consistent over the last few decades. Over the long period, however, all countries may be said to exhibit the same tendency, with the sole exception of the Netherlands, where, since the early nineteen thirties there does seem to have been a definite tendency for the differential to widen (Table 8).

TABLE 8

SKILL DIFFERENTIALS IN CONSTRUCTION IN EUROPE AND OTHER COUNTRIES
(Hourly Rates of Pay of Unskilled Building Labourers expressed as Percentages of Hourly Rates of Pay of Bricklayers and Masons)

Country	1924	1933	1938	1950	1963
W EUROPE					
Austria (Vienna) ..	—	75	—	95	85[1]
Belgium (Brussels) ...	91	77	80	80[2]	87
Denmark (Copenhagen)*	—	72	72	88[3]	83
Finland (Helsinki) ..	—	—	—	88	87
France (Lille) .	—	78	88	—	—
(Paris)	—	—	—	88	—
Germany—Federal Republic	—	—	—	61[2]	83
Italy (Milan)	67	63	63	92[3]	85
Netherlands (Amsterdam)	81	93 (91)*	92	79	76[4]*
Norway (Oslo)	—	91	94	89[3]	—
Portugal (Lisbon)	—	60	—	64	70
Spain (Madrid)	—	66	—	—	84[4]
Sweden (Stockholm) (a)	91	91	91	94	94
(b)*	—	63	60	62	79
Switzerland (Basle)	—	80	80	85	83
E EUROPE					
Hungary (Budapest)*		46	55	—	75[1]
Poland (Warsaw)*		—	54	—	—
Czechoslovakia (Whole Country)		—	—	—	86 (88)*
Yugoslavia (Belgrade)*		—	60	—	—
OTHER COUNTRIES					
Australia (Melbourne)		74	70	77	83
Canada (Ottawa)		35	50	48	62
New Zealand (Wellington)		—	81	94	89

*Average Earnings
NOTES [1] Whole country [2] 1952 (Germany—Westfalen Lippe) [3] 1959 [4] "Class I areas".
SOURCES See Appendix

On the whole the present-day differentials in Europe are somewhat higher than in Britain and the Irish Republic but not quite so high as in Northern Ireland.

It will be appreciated that these remarks about skill differentials are based largely on an examination of hourly wage rates in various countries Actual earnings might, of course, show a different picture It is perhaps unlikely that they would contradict the evidence for a narrowing of skill differentials; their actual size may well be shown to be different The figures in Table 8 for Denmark and Sweden, for instance, which *are* based on average earnings, do exhibit the tendency for the differential to narrow,

but the Swedish figures of both wage rates and earnings show that the size of the earnings differential is much larger than the differential between time rates In Britain, however, the recent Ministry of Labour enquiry into average earnings by occupation in the construction industry[6] shows that the average hourly earnings of unskilled men were some 87 per cent of those of skilled men which is about the same as the wage rates differential

On-Site and Off-Site Labour Costs Most of the building methods which are able to economise on skilled site labour and make a relatively greater use of cheaper unskilled labour, will probably do so by bringing into use, via prefabricated units, the labour employed in other industries

It has already been noted that it is difficult to depart from the use of traditional materials to any large extent because of technical reasons, not to mention conservative attitudes, and that the prefabrication of these materials is likely to lead to diseconomies in the way of extra material requirements and transport costs The productivity and cost of off-site labour, however, may be such as to outweigh such diseconomies. There are difficulties in making an adequate comparison of the relative costs of on-site and off-site labour, but an attempt is made here to do this since it does seem that the comparison is informative.

The disadvantages of using wage rates instead of earnings again apply but there is no adequate alternative in the absence of comprehensive occupational earnings statistics Table 9 compares the skilled and unskilled labour costs of workers in the building industry with those of workers in other relevant industries

It will be seen that in Britain at the present time the wage rates of both skilled and unskilled building workers are above the wage rates of workers in the other industries The same was generally true at the end of the war though the disparity was much less marked and in some cases the difference was in the other direction. On this evidence, therefore, and other things being equal, there should have been a growing incentive over the post-war period for the industry to adopt off-site methods. Such an incentive would be strengthened, of course, if the ratio of skilled to unskilled labour in factory production were more favourable, and if, as is likely, productivity per man were higher in factory conditions. On the other hand, overheads are probably higher and, together with transport and other diseconomies, probably high enough to produce overall disadvantages from the cost point of view. The recent occupational earnings enquiries in Britain would suggest that even from the point of view of labour costs alone, however, the situation in Britain is an unfavourable one. Admittedly in some of the industries as defined one is dealing with large aggregates, but on the whole they do show higher earnings for both skilled and unskilled off-site workers (Table 10).

[6] *Ministry of Labour Gazette*, January 1965.

TABLE 9

COMPARATIVE SKILLED AND UNSKILLED WAGE RATES FOR ON-SITE AND OFF-SITE LABOUR IN BRITISH ISLES 1946 AND 1964

Shillings per Hour

Trade	1946						1962 and 1964					
	Skilled			Unskilled			Skilled			Unskilled		
	Britain	N Ireland	S Ireland	Britain	N Ireland	S. Ireland	Britain	N Ireland	S Ireland	Britain	N. Ireland	S Ireland
	August		Jan	August		Jan	April 1964		Jan 1962	April 1964		Jan 1962
ON-SITE LABOUR												
Building	2 3–2 6	2 4–2 6	1 7–2 5	1 9–2 1	1 7–2 0	0 9–1 9	6 1–6 2	6 0–6 2	4 7–5 5	5 3–5 5	4 6–4 9	3 8–4 8
Constructional Engineering	2 3–2 4		2 4[1]	1 9–2 1		1 7[1]	6 0–6 1		5 6	5 3–5 5		4 7[1]
OFF-SITE LABOUR												
Metal Trades (Engineering)[2]	2 1–2 3	2 3	1 5–2 2	1 8–1 9	1 8	1 0–1 7	5 0–5 1	5 1	4 4–5 7	4 3	4 3	3 5–4 6
Timber Trades (Sawmills)	2 3–2 5	2 3	2 2[1]	1 9–2 1	1 8	1 9	6 0–6 1	6 0	5 5	5 1–5 2	5 1	
Vehicle Building	2 5		2 2[1]	2 0–2 1			5 3–5 4	5 3	5 7[1]	4 6	4 6	5 3[1]
Building Boards Manufacture	2 3			2 0			5 8	5 8		5 0	5 0	
Cement Manufacture				1 9–2 0	1 9		6 0	6 0		5 1	5 1	
Concrete—ready mixed							5 3–5 4	4 6		4 8	4 0	
precast				1 9–2 0			5 0–5 4	5 4	4 7	4 9	4 9	2 8
Structural Clay Products	2 0–2 1			1 9			5 2	4 8–4 9		4 8	4 4	
Plastics Fabrication							4 6			4 3		

NOTES [1] Dublin [2] Skilled-labour rates—Fitters and Turners

SOURCES Britain and Northern Ireland—*Time Rates of Wages and Hours of Work*, 1st August 1946 and 1st April 1964 (Ministry of Labour) and private sources for Northern Ireland

Ireland—*Some Statistics of Wages and Hours of Work in 1946* (Department of Industry and Commerce).
Statistics of Wages, Earnings and Hours of Work, 1962 (Central Statistics Office, Dublin).
Irish Trade Journal and Statistical Bulletin, Vol XXXV, No 3, September 1960

TABLE 10

OCCUPATIONAL EARNINGS IN GREAT BRITAIN, JUNE 1964

Pence per Hour (Adult Males)*

Industry	Skilled	Unskilled
Constructional Engineering	108 4	74 8
Other Construction	86 3	75 4
TOTAL CONSTRUCTION	86 8	75 5
Engineering and Other Metal-Using Industries	102 0—109 5	71 7—76 1
Iron and Steel Manufacture	92 5—107 7	75 9—82 5
Shipbuilding	89 7— 99 9	64 9—76 1
Chemical Manufacture	101 7—113 9	89 2—98 9

*The ranges of figures given represent the average hourly earnings of time workers and piece workers respectively

SOURCES *Ministry of Labour Gazette*, January 1965, and *Statistics on Incomes, Prices, Employment and Production*, No 11, December 1964

In Northern Ireland the labour costs situation, judging by the basic wage rates, would seem to be less favourable than in Britain Although skilled wage rates are much the same as in Britain, and hence off-site labour cheaper, unskilled rates are as high as or even higher in off-site occupations The use of off-site processes, therefore, is likely to be less worthwhile than in Britain, other things being equal

In the Irish Republic also the relative pattern of wage rates would indicate an unfavourable environment for off-site processes But in contradistinction to the picture in Northern Ireland, it is the skilled rates off the site which are as high or higher than on-site rates, whilst unskilled rates off-site are probably generally lower.

Figures to make a similar comparison for other countries are not readily available, a comparison has been made, however, in terms of average earnings of all male workers in certain industries Naturally the figures must be examined with caution since they represent broad industry groups which do not have the same coverage in each country and involve different compositions of skilled and unskilled labour These figures are presented in Table 11.

Within each country the average earnings in construction are compared with the average earnings in manufacturing as a whole and then with average earnings in four industry groups involved in processing basic categories of material relevant to building, namely, wood; clay, cement and other non-metallic mineral products, metals and chemicals Average earnings are compared for a recent year and a year preceding or following the last war. These have been arranged in three broad groups according

TABLE 11

RELATIVE LABOUR COSTS PER MAN* IN CONSTRUCTION AND OTHER INDUSTRIES

Average Earnings in National Currency per Hour[1]

Current Labour Costs Ratio— Construc Other	Country and Currency	Year	Construc-tion	Manu-facturing	Wood-working	Clay, Cement and Non-metallic Mineral Products	Engineering and Metal Products	Chemical Industry
HIGH	U S A (cents)	1937 1947 1963	90 168 327	62 124 246	— 113 204	— 119 248	— 128 261	— 123 272
	Canada (cents)	1945 1960 1963	81 194 214	69 178 195	68 160 —	— 184 —	71–82 211–214 —	71 — —
	Denmark (ores)	1963	859	821	777	746	840	736
	Norway (Krones)	1938 1946 1963	2 18 3 25 10 60	1 63 2 52 7 96	— 2 27 7 01	— 2 47 8 02	— 2 63 8 35	— 2 75 7 99
	Sweden (Kronas)	1939 1962	1 89 9 77	1 33[5] 7 39	1 10 6 64	1 12 7 06	1 3-1 4 7 43	1 37 7 04
	Czechoslovakia[2] (Korunas)	1963	1520	1407	—	—	—	—
	Hungary[2] (Forints)	1963	1753	1675	1472	1575	1547	1546
	Poland[2] (Zlotys)	1962	2091	1911	1493	1711	1847	1746
INDEFINITE	Finland (Markkas)	1963	3 33	2 65	2 96	3 40	3 63	3 67
	Netherlands (Cents)	1947 1963	91 86[4] 276	94 271	87–93 250	— 277	— 272	— 283
	Germany— Federal Rep (Marks)	1946 1963	0 87 3 88	0 96[7] 3 77	0 80 3 18	0 92–0 96 3 42–3 92	1 00–1 03 3 72	0 99 3 95
	France (Francs)	1946 1963[6]	46 5[4]–39 4[8] 333	30 3 265	— 296	— 340	— 363	— 367
LOW	U K (Shillings)	1938 1963	1 4 6 7	1 5 7 4	1 4 7 0	1 3 7 0	1 6 7 6	1 4 7 5
	N Ireland (Shillings)	1963	5 5	6 1	5 7	5 6	6 4	6 8
	S Ireland (Shillings)	1937 1962	1 3 4 5	1 2[5] 5 0	1 3 4 3	1 1 4 9	1 2 5 2	1 2 5 1
	Switzerland (Francs)	1939[4] 1962[4]	1 46–1 11 4 61–4 01	1 54–1 17 4 48	1 44–0 99 4 61–3 82	1 47–0 12 4 87–4 08	1 48–1 19 5 05–4 23	1 55–1 30 5 44–4 72
	Belgium[3] (Francs)	1962	265	275	230	270	268	291
	Yugoslavia[2] (Dinars)	1963	26,000	28,000	22,200	23,400–25,300	31,200–32,600	32,500

NOTES [1] Except where otherwise indicated [2] Average monthly earnings [3] Average earnings per day
[4] Range of skilled to unskilled [5] Includes mining [6] Converted back to old currency (1 new franc equals 100 old francs)
[7] Includes building [8] Wage rates
*The figures for U S A , Denmark and France cover all workers

SOURCES *Yearbooks of Labour Statistics 1949-50* and *1964* (ILO), *Northern Ireland Digest of Statistics, September 1964*

to whether the current ratio of earnings in construction are generally higher or lower than, or about the same as earnings in other industries

In America, Scandinavia and East European countries labour costs in building are generally higher than in other industries In West Germany, the Netherlands, France and Finland building labour costs are higher than in manufacturing as a whole, but lower than in some individual industries, and the picture is, therefore, less definite than in other countries In the United Kingdom, Northern Ireland, and Irish Republic and other West European countries, on the other hand, labour costs in building would seem to be lower than in other industries [7] When the comparison is made for the years preceding or following the war the picture is very similar, except for the Irish Republic where, on average, building labour costs in 1937 were, if anything higher than in other industries, rather than lower. In the United Kingdom the picture was less clear-cut than it is now.

LABOUR COSTS—SUMMING UP

To sum up this discussion of labour costs one might say that the relative pattern of rewards for skill in building in different countries would suggest a greater incentive towards the development of non-traditional methods in America, Europe and Northern Ireland than in Britain and the Irish Republic The relationship between on-site and off-site labour costs would suggest most incentive in America, Scandinavia and the East European countries

BRITISH EXPERIENCE

In Britain after the first world war several alternative methods of house construction were evolved using concrete or steel, and several thousand of them were built. These proved to be more expensive than comparable brick houses and they fell into disuse in the late twenties [8] Similarly, after the second world war, about 2,000 proposals of non-traditional methods were investigated and about 100 of these were approved and built, at least as prototypes [9] Again, however, these were not cheaper than traditional methods, they were regarded as inferior substitutes by most people, and few of them were able to retain a market when the initial post-war shortages of skilled labour and materials began to be overcome.

Site experiments carried out after the war with a number of the non-traditional systems[10] showed that striking savings could be achieved in site labour, particularly skilled labour At its highest this amounted to as much as 50 per cent compared with a traditional brick house, though more typically the figures were between 10 and 20 per cent. Savings in total costs, however, were much less definite. Difficulties were experienced in making a suitable comparison because the houses were experimental and

[7] Compare also earnings by occupation in the U K (Table 10)

[8] Cf *Tomorrow's Houses* (Ed John Madge), Pilot Press (London 1946)

[9] O J Cox, "Factory Production in Housing", *Contract Journal*, 12 April 1962

[10] Ministry of Works, *New Methods of House Construction*, National Building Studies, Special Reports Numbers 4 and 10 (HMSO 1948 and 1949)

the prefabricated components not in normal production A straight comparison of prime costs showed only two out of fourteen with any advantage and these involved the site placing of concrete, whereas the others were precast It was thought that the costs of the precast components might be reduced if larger scales of production had been in operation Even when estimates were made, however, on the basis of the costs of well-established concrete products, only the most favourable comparison gave the non-traditional any advantage, and then not by a large margin In general, therefore, it was not possible to overcome the obstacle of a high ratio of materials to labour costs

Later, extensive site experiments involving the building of over 400 houses of four basic types, one traditional brick and the others involving varying degrees of prefabrication, were carried out in the nineteen fifties [11] Again, however, it was clear that any savings in labour costs were insufficient to overcome increased materials costs Indeed in the case of the most prefabricated system tested, the cost of materials supplied to site were equal to the whole cost of the completed traditional superstructure

Recent experience of local authorities in England, examined region by region, has been that the tender prices of industrialised systems for building ordinary two-storey three-bedroomed houses are still higher than those of traditional methods by, on average, between eight and nine per cent

EUROPEAN AND AMERICAN EXPERIENCE[12]

One of the principal reasons put forward for the development of non-traditional methods on the Continent is that of shortages of skilled labour and the ability of systems, particularly large panel methods, to make use of unskilled labour both on site and in the factory Thus France, where there have been shortages since 1945, was one of the first countries to adopt industrialised building methods on a large scale The result appears evident in the fact that the annual rate of dwelling construction was stepped up from 70,000 to well over 300,000 in the ten years from 1950 to 1959. Labour shortage also seems to have been a reason in Scandinavia coupled with the relative cheapness of off-site labour and severe winter conditions which have provided an added incentive for the introduction of new methods In the Netherlands off-site methods have not proved cheaper, as the earlier comparison of labour costs might have suggested, and it is only since 1959 with some development of labour shortages that non-traditional methods have had a greater use

In Germany the relative costs of site and off-site labour would seem to have given little incentive and labour which has been supplemented by the inflow of refugees from East Germany has not been short It is said, however, that labour is now becoming scarce and there is a greater tendency to adopt non-traditional methods Similarly, in other countries where

[11] D S I R , *A Study of Alternative Methods of House Construction*, National Building Studies, Special Report No 30 (HMSO 1959)

[12] References for this section are given at the end of the paper

there have been labour surpluses and building labour has been relatively cheap, such as Italy, Spain and, to some extent, the countries of the British Isles, the development of new methods has been slower

In Russia and Eastern Europe severe climatic conditions have been a factor together with the centralised direction of building programmes and, presumably, the apparent favourable relationship between the costs of building and other labour in most of these countries, though in Poland non-traditional methods are not said to be cheaper. In Yugoslavia, where relative labour costs are unfavourable, developments have been only very limited.

In the U S A. the predominant factor has been the high cost of site labour compared with factory labour. A further factor has been the relative costs of building materials Thus in the U S A , timber, which lends itself to prefabrication, is relatively cheap The most usual type of house is a single-storey building with a timber frame and clad externally with timber or a brick veneer Similarly, timber prefabrication is used extensively in Canada and Sweden where, although much of the housing is in masonry and precast concrete, over 50 per cent of single-family dwelling production is of prefabricated timber In the U S A the figure is about 35 per cent and about 15 per cent in Canada In Canada the proportion has been growing rapidly in response to winter building conditions and some cost advantage though the wide geographically dispersed demand is a big obstacle.

In Italy, on the other hand, the plentiful supply and general location of good quality clay deposits, suitable for the manufacture of traditional and semi-traditional structural components, has been a factor militating against non-traditional methods, as has, similarly, the existence of the relatively cheap brick in the United Kingdom

CONCLUSIONS

The consistent theme running through the experience of European countries where non-traditional methods have been most widely adopted is that of labour shortages In countries where labour shortages have not existed or have been less acute, and where the costs of building labour have not risen disproportionately higher than the costs of other labour, then there has been little departure from tradition.

Natural resources of materials and the relative prices of alternatives have also been important explanatory factors, since some are more amenable to prefabrication and can bear the costs of transportation more readily than others Climatic conditions have also influenced the development of methods to overcome the severity of the winter It is evident, too, that factors associated with the dispersal of population and the concentration of demand also play some part

In the British Isles, although non-traditional methods will undoubtedly satisfy the desire to speed up the construction process, and thus, incidentally, produce returns for expenditure more rapidly, their general application is not likely to arise in the near future on simple economic grounds

because of the unfavourable relative pattern of labour and materials costs that exists Apart from some radical innovation in materials, able to transform traditional structures and produce an alternative acceptable both economically and otherwise, only a sharp rise in the costs of building labour relative to labour in other industries is likely to alter this situation appreciably. Economy is likely to be best sought in the evolution of traditional processes, although undoubtedly a great deal can be done in creating a favourable environment.

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APPENDIX

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