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Cost versus Production: Labour deployment and productivity in social housing construction in England, Scotland, Denmark and Germany

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Abstract

Labour deployment on representative large-scale housing projects is analysed to reveal distinct differences between England, Germany, Scotland and Denmark. In the light of the debates on convergence/divergence of HRM systems and generally different production systems, the paper is apposite in demonstrating structural differences in the organisation of the construction process, their implications for efficiency and productivity, and their impact on employment and contract relations, innovation and skills.

The effects of the overriding cost rationale of the British system are illustrated in terms of labour deployment and the efficiency and productivity of the site construction process. Labour deployment is based on the rationale of extensive subcontracting, with main contractors providing the management and cost function whilst their productive capacity rests on subcontracting supply chains. The main contractor has come to specialise in two areas, costing and the management of the process. Subcontractors provide all production personnel and thus the production knowledge for carrying out the work packages and stages. On the continent, in contrast, the economic rationale is different, as main contractors do not depend nearly as much on the production capacity of subcontracting.

Abstract 183 words
Main text excluding tables and references 5332
Key words: labour deployment, productivity, social housing, European construction.

Introduction

Since the in-depth research by Lemassany and Clapp in the 1970s little has been added to the works study tradition of analysing and comparing projects based on resource inputs (Lemassany and Clapp 1978). The BRE Calibre project has echoes of this tradition in applying modern ICT methods to comprehensive data collection, but the analytical framework and criteria used show significant differences in their focus primarily on waste minimisation (Calibre 2000; Winch and Carr 2001). Considerable comparative work has been carried out by Proverbs et al, yet their approach relies on the experience and skill of the estimating departments of large contractors and their methodology suffers from not comparing like with like (Proverbs et al. 1999).

Labour deployment in the English construction process, based on a high degree of subcontracting, has however hardly received academic scrutiny, though the rise of self-employment in the sector has been examined and the UK system distinguished from the continental system in being dominated by a craft- as opposed to an industry-based approach (Winch 1998; Clarke and Wall 1996 and 2000).

In this paper, the labour resource inputs of four social housing projects in England, Germany, Scotland and Denmark are analysed. A detailed comparison of the inputs of the main contractors and subcontractors reveals great differences in the labour deployment and efficiency of organisation of the construction process. Operative hours worked to complete one square metre, operative hours per dwelling and the speed of construction in square metres completed per working day are calculated and compared. The results demonstrate that the English system operates with a high labour input and in the case study presented delivers with remarkable speed. The

German and Danish projects demonstrate similarity in their results with respect to speed and labour efficiency, even though the building technology differs.

The paper draws on a study of social housing projects in Britain, Denmark, Germany and the Netherlands[1] and is the second of two dealing with the concern to control costs and contract relations in the British case at the expense of considerations of production and the ways in which this determines all aspects of the construction process. Our first paper, “Cost versus production: disparities in social housing construction in Britain and Germany”, examined differences in the structure of expertise and skills within firms, the nature of subcontracting and the composition of the construction team in Britain and Germany (Clarke and Herrmann 2004). Here our concern is with the effects of this in terms of the efficiency, productivity and organisation of the site process, drawing out in particular differences between Britain, Scotland, Denmark and Germany in labour deployment and the sequencing of production. The paper represents an apposite contribution to the on-going debate on productivity comparisons in the construction industry (Gruneberg and Ive 2003, Edkins and Winch 2001, Gluch et al. 2001, Proverbs et al. 1999). Labour input is regarded as the most reliable measure of productivity and our calculations, based on detailed examination of projects, reveal the significant differences in labour intensity, as measured by operative hours per square metre, in the English case as compared with the Scottish, German and Danish cases. In this respect our results are significant for the debates on the convergence/divergence of HRM systems and on qualitative

[1] This was part of a larger study of social housing projects in Britain, Denmark, Germany and the Netherlands supported by the Engineering and Physical Sciences Research Council (EPSRC) and the former Department of the Environment, Transport and the Regions (DETR) and entitled ‘Standardisation and skills; a transnational study of skills, education and training for prefabrication in housing.’ It was conducted in partnership with researchers in each of these countries including: in Denmark Prof. Sten Bonke and Prof. Elsebet Frydendal Pedersen of the Technical University of

differences in productive systems (Burchell et al. 2003, Rubery 1992, Wilkinson 1998, 2003).

The case studies

Before discussing the details of our findings, it is important to note two key differences in our cases: the sequencing of the work and the skills deployed. In the English brick and block case, sequencing is traditionally 'sequential' or horizontal, that is houses are developed in batches with the trades following each other and a small number of houses completed before moving on to the next batch. In the Scottish, German and Danish cases in contrast, housing units are developed vertically rather than horizontally so that the whole building structure proceeds upwards, implying a very different trade sequencing (Clarke and Wall 1996). A second key difference is in the skills used and the nature of their deployment. In the Danish and German cases, skills are negotiated at an industry level by the social partners (employers' associations and trade unions) and the entire workforce is expected to be skilled, that is formally qualified through the recognised training schemes in place. This is not the case in England and Scotland, where those 'skilled' may simply have picked up their skills and training provision is much more limited, though Scotland does have more of a tradition of training and apprenticeship and of directly employing the workforce.

Large-scale housing projects of 131 units in England (henceforth referred to as UK1), 68 in Germany (D1), 56 units in Scotland (UK8) and 60 units in Denmark (DK1) were selected on the basis that they represented typical examples of housing schemes

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Denmark; in Germany Prof. Wolfgang Richter of Fachhochschule Dortmund; and in the Netherlands Dr Anneke Westerhuis of CINOP.

in their respective countries, that is: brick and block building schemes in England; a sand lime stone technique with external insulation in Germany; a prefabricated timber-frame system clad with bricks in Scotland; and large pre-cast concrete element construction in Denmark. All projects chosen were ‘traditional’ in their national context, yet they incorporated innovative elements to varying degrees. The sources used for our analysis were extensive site documentation, recording the site management present during the construction period, the directly-employed workforce of the main contractors, and all subcontractors working on site with their personnel. Each case will be described in turn before comparisons between the schemes are brought out.

England: UK1

UK1 is a large regeneration project in north-west England carried out in three phases. A 1960s development of 650 flats was demolished and 131 terraced dwellings, in total 9212 m², were built in two phases, divided into 79 and 52 dwellings. Phase three entailed the modernisation of about 100 of the original flats and was carried out by the same main contractor. 62 flats were modernised, two storeys were taken off and a pitched roof put on. The refurbishment of an existing community centre was also part of phase three. 34 houses for sale were included and the main contractor’s private housebuilding company won the contract. The main contractor succeeded in shortening the original contract programme for phase one and two from 83 weeks to 69 weeks, a reduction of 14 weeks or 17%. This target was achieved because one show flat had to be completed early on. The finishing trade subcontractors came on site early and the main contractor’s great concern was to keep these firms continuously employed, indicating the high volatility of the English subcontracting system. Phase two was started four weeks before the contractual date for possession of the site, resulting in a substantial overlap between the two phases.

A total of 22,193 operative days and 883 site management days were worked in producing the 131 dwellings and the 9,212 m², resulting in an average unit size of 70 sq.m. (Table 1). This amounts to 169 operative days or 1,355 hours per dwelling, taking the length of a working day as eight hours. If management input of 6.7 days per dwelling is included, the result is 175.7 person days and 1,409 hours in total to produce one dwelling. To complete one square metre of space, 20 hours were spent. The breakdown between skilled and unskilled operative input results in 6,719 days or 30.3% of labouring work out of the total labour input. This calculation is based on the assumption that 80% of the groundwork operatives were classified as labourers not having formal qualifications and on the addition of the brickwork labourers. The result is that skilled labour input of 118 days was required to produce one dwelling.

Research in the 1970s by Lemassany and Clapp showed that resource inputs into public and private house building in the mid-1970s were around 130 skilled operative days per unit and 190 total operative days including unskilled work, that is 31.6% of unskilled labour (Lemassany and Clapp 1978). A comparison of both data sets gives an indication of the change over 30 years. The time required to produce one dwelling has only been reduced by 14.3 days, from 190 to 176 operative days (Table 1). This 7.4% change in total (9.2% for skilled labour) over a period of 30 years supports the proposition that the UK house building industry has not significantly improved in terms of productivity or, by implication, innovated. There have of course been major improvements in the use of off-site manufactured products (e.g. heating, double glazing), but one would have assumed that changes in site processes through higher mechanisation, the use of lifting equipment, etc. would have significantly reduced daily labour input.

Table 1

This low productivity improvement indicates relatively low levels of investment in capital and labour. The effect is the high labour intensity to be observed on UK1 and the loss of control of the main contractor over the labour process, resulting in dependence on a few large subcontract packages. Graham Winch has identified this latter aspect as one of the main problems of the UK industry. “British construction firms have largely abdicated responsibility for the detailed management of the labour process…So long as the required output is achieved…the gang is left to organise its own work pattern.” (Winch 2001).

The UK1 site was in operation for 324 days, not including weekend work. No data are available for weekend work as the main contractor was not on site, but this was said not to have been substantial. On two occasions major work was carried out over the weekend; road works were required to connect up to the public sewer system and this was carried out over two weekends to minimise disruption for the public. Otherwise subcontractors worked an eight-hour day and rarely worked over the weekend, though the brickwork firm might make up for lost days during the week due to rain and, for instance, complete gable ends in order to keep up the programme and prevent delay to the roofer’s work.

Calculating the average labour presence on site results in the high number of 68 operatives on site every day, the highest labour deployment level on all our selected sites for all countries, the other three sites varying between 29 and 37. Fig. 1 shows the total person days worked, including all operative and site management input. The finishing phase is drawn out over a long time and ends rather slowly compared with the high level of labour activity at the start, in clear contrast to labour deployment on continental sites described below. On UK1 the number of operatives employed in the last few weeks before completion is relatively small, being under 50 operative days on average per week and much smaller than on the German example analysed. One would expect the main contractor to try to shorten the finishing phase, yet, as apparent from the graph, all that occurs is a gradual decline, not an abrupt ending.

Fig. 1

UK1 is a typical brick and block development built in sequences and very streamlined. The site location, however, makes it unusual; a large amount of external works was required to retain the steep slope, an added complexity in terms of the comparability of the data, as elaborated below. The main contractor had only a few years before expanded into new build, having successfully operated in the repair and maintenance sector. This large project required that the firm's most experienced site management staff was in charge, well able to complete the project in the best possible way. However, the main contractor's function was of a purely managerial and financial nature, providing only supervisory and support staff; the site management team consisted of: a senior project manager with a trade backgound; a graduate site manager; a school leaver site-management trainee with A levels; and, for a large part of the project, a finishing foreman. The firm had directly employed semi-skilled operatives on site only as support staff, for most of the building period, classified as ‘labourers’ and comprising: one forklift driver, one pick-up driver, one to two storepersons and one general ‘sweep up’ labourer who used the plant, forklift and pick-up truck (as a taxi to get home).

Labour activity was very high on this project. For nine weeks in the middle of the building period, from weeks 26 to 29, 37 to 40 and in week 42 more than 500 person days were worked on site, equivalent to more than 100 operatives on average on site per day (Fig. 1). All the main trades and finishing trades were present, just under 20 different occupations. The demand on management was very high, to coordinate and supervise all the different works packages from piling, groundworks, drainage, roadworks and plastering, to carpentry and all the second fix services.

Figure 2 reflects the pattern of labour deployment produced through the system of constructing houses in batches, the method of sequencing the building process on UK1. The work of the main trades continued up to the end of December into weeks 47 and 48, that is for two-thirds of the contract time. A very large number of bricklayers were working on this site for six weeks from 37 to 42, with 30 bricklayers and 13 labourers. Brickwork on the superstructure was completed around week 46. The second phase of the project, 52 dwellings, had started four weeks early and a large concentration of resources took place in order to complete the shells in phase 2. The sequencing of the work meant that the 131 dwellings were produced in a ‘rolling’ programme involving the completion of four dwellings per week. According to the contract programme, the contractor planned to hand over the completed houses to the client continually, starting in week 32.

Fig. 2

The system of sequencing the building work on brick and block low-rise housing means that the different trades are involved in a different order from that on vertical construction. The overlap of main and finishing trades on UK1 was substantial, resulting in the very high peak of operatives employed between week 25 and 46. The finishing trades had already started in week 9 and the plasterers, for instance, completed the first houses in week 9 and stayed continuously on site until week 62, with their numbers increasing substantially in the course of the building process. A high number of carpenters worked on this site, peaking between weeks 27 to 30, when an average of 15 operatives worked each day over a four-week period.

This case study provides clear evidence that the productive capacity of the main contractor depended to a large degree on two firms, a civil engineering firm carrying out the groundworks and a large brickwork subcontractor. The groundworks contractor exhibits consistently high labour activity on site up until week 58, or about 10 weeks before completion. This subcontract package comprised a large variety of external work – all site setting out, foundations, brickwork up to dpc level, block and beam floors, main drainage and house drainage, road access, flagging, paving, road surfacing and the building of boundary walls. The site was on a steep slope requiring substantial ground and external works, in particular retaining walls that were constructed either in precast concrete elements or as brickwork. The project manager commented that more brickwork had gone into the retaining wall structures than into the properties; this is not the norm for housing sites. The groundwork subcontract was originally for £1,052.500 and increased during the building works to over £1.4 m, from an original 35% of total subcontract value. This was caused by additional work added, the largest item being the brickwork boundary wall around the whole housing estate.

The labour input of the groundworkers was equivalent to 24.7% of total operative time on site. They operated in three gangs of two to three operatives, led by one stonemason and two bricklayer forepersons with a total labour input of 5,301 operative days, or an average of 16 operatives at any one time. The groundworks package included a substantial amount of brickwork. Two gangs of bricklayers, made up of two to three bricklayers and one labourer, were on site for almost the whole building period. The site diary, however, does not include them under groundworkers, but under bricklayers. Therefore this one subcontractor‘s input is very high. The site diary allows superstructure brickwork to be separated from substructure, such as boundary wall and brickwork. This results in 1,590 bricklayers days and 716 labourers, which, added to the groundworks, amounts to 7,601 operative days. This groundworks subcontractor was then responsible for 34% of total operative input.

The amount of labour deployed was very high indeed on this site. At the peak there were 30 groundworkers daily on site for 15 days, 25 for 25 days, 22 for 20 days and 20 for 83 days, totalling 3,175 operative days and 22 groundworkers on average on 143 days out of a total of 324 days that the site was operating (Table 2). These were concretors, drainlayers, paviours and plant operators, though all were classified as groundworkers and most likely the majority of them also as labourers.

Table 2

The main characteristic of the brick-and-block low-rise building method is the low level of mechanisation in the UK; plant on site is minimal. On UK1 two forklifts and one pick-up truck were the only plant for moving and lifting materials. Forklifts can still reach the top lift of the scaffolding and can serve bricklayers with bricks, blocks, and mortar and roofers with felt, battens and tiles. Mobile cranes are required to lift the roof trusses into place for carpenters to erect the roofs. The groundwork subcontractor used excavation and loading plant for some time. The overall use of plant is limited and high labour levels, in particular of untrained labour, are deployed instead, particularly on the superstructure phase. This is nowhere more evident than in the deployment of groundworkers on this site, markedly different from the situation to be observed on German sites.

Germany – D1

The German project D1 provides a strong contrast to the organisation of the production process on UK1. It was part of a large new suburban development on a greenfield site built on the edge of Münster in North-Rhine Westphalia. All flats have been publicly funded and built to two different specifications according to the funding regulations, with rents fixed at two levels for 4.25 Euro and 5.5 Euro per sq.m. The contract was awarded for a fixed price of the low level of 900 Euro or £600 per square metre. The five building blocks on D1 consisting of 68 units were constructed out of large Dutch sand-lime stone blocks, measuring 600 x 900 x 100 mm, with a slurry finish on the inside and externally rendered over mechanically fixed insulation; one block had brick cladding and all blocks were clad with cedar at the top floor. The floors/ceilings and walls were made of precast concrete elements with hollow core for running services inside. On top of the floor were two layers of mineral wool to provide impact sound insulation and then 60 mm screed. All buildings were covered with turf roofs.

Labour deployment on the German project differs from the English pattern (Fig. 3). The most intensive building period was shifted from the beginning of the building process to the second half, to give an end-loaded pattern compared with the front-loaded one of UK1, whereby high levels of labour deployment were in place for the first two-thirds of the building process. The German site operated with much less labour in the first half, until week 28 in February when on average 55 operatives were on site per day. A high level of labour deployment followed, only dropping off in week 50. Overall there was less labour deployed on D1 than on the English site, though the English scheme was also 61% larger than the German one, 9,212 square metres compared with 5,712 square metres. The building method of low-rise terraced housing in Britain lends itself to the sequencing of the work. In contrast, on the German D1 site the one 2-storey and four 3-storey blocks were only partially undertaken sequentially.

Fig. 3

The main difference, however, between UK1 and D1 lies in the employment relations on site. On D1, the main contractor's directly employed workforce carried out 3,523 operative days or 34.5% of total operative time on site, predominantly to build the superstructure. The main contractor directly employed skilled operatives in the main trades: bricklayers, concretors and carpenters.

Scotland - UK8

In spite of the very different building methods, a much stronger similarity emerges between D1 and UK8, a 4-storey timber-frame structure in Scotland. UK8 was a social housing project with 56 flats in a large inner-city redevelopment area. The scheme comprised in total 4,426 sq.m with an average flat size of 79 sq.m. and was built in 66 weeks, or 286 days on site, on a brownfield site with a steep gradient.

Fig. 4 shows a similar pattern to the German project in the way the project is organised in the first stage. The start in the groundwork phase is slow and less labour intensive. With between 60 and 90 personnel days per week for a third of the construction period, 20 out of 60 weeks, the project resembles the German case even though it is not carried out by the firm's own personnel. A rapid increase in the deployment of labour follows from week 27 to 40, from the second third of the building period onwards, and after week 57, nine weeks before completion, the site began to operate with much less labour.

Fig. 4

The Scottish site did, nevertheless, operate with a large proportion of directly employed personnel later in the construction process: 27.4% of total operative input on site was carried out by directly employed carpenters, joiners, plant operators, trainees and labourers (Fig. 5). The firm's own workforce carried out more work in the finishing phase, the erection of the superstructure being part of the timber-frame contract. Subcontract labour of the timber-frame manufacturer erected the timber kit, with 1,932 hours spent by the manufacturer's subcontract carpenters in building the superstructure – representing 14% of all the carpentry and joinery input.

Groundworks, brickwork and carpentry and joinery represented 38.5% of operative input, a far smaller proportion than on UK1 (Fig. 5).

Fig. 5

The total operative input required to produce the 56 units in Scotland was 68,582 hours, or 1,225 hours (144 days) per unit. Adding site management time of 3,409 hours amounts to 1,285 hours or 151 days per unit. It took 16.3 days to produce one sq.m and 15.4 sq.m were produced per day. The labour input per square metre is, therefore, 11.5% higher on UK8 and 39% higher on UK1 than on D1 (Table 3).

Denmark: DK1

DK1, our Danish case, is part of a huge new suburban development of about 670 flats and houses, in total 65,000 sq.m, to be developed in annual stages over a 10-year programme, including facilities such as kindergarten, etc. (shops are outside the scheme). Phase one and two have been completed and phase three, consisting of 60 flats (5,200 sq.m), was built in 51 weeks. This Danish scheme is considerably different from the English project, but bears similarities with the Scottish and German sites in having again a back-loaded system, the most intensive period on site being in the finishing phase and also ending abruptly in week 50/51 (Fig. 6).

Fig. 6

A total of 8,910 operative days and 650 site management days were worked to complete the project on the 250 days the site was operating. 148.5 operative days were required to produce one unit or 1.7 days to produce one square metre; including site management, this amounts to 159 days per unit or 1.8 days per square metre. On the basis of a 7.5 hours working day, from 7 am to 3 pm, 1,114 hours of operative time were used to produce one unit, 12.9 hours per square metre or, if site management is included, 1,193 hours and 13.8 hours per square metre.

Comparing the different projects

Stability of employment on the German site contrasts sharply with subcontracting on the English site. In effect what we observe is the predominance in Britain of contract relations or contracts of service compared with employment relations or contracts of employment in Germany (Deakin 2000). Not only is all work subcontracted in the British case, but most of those employed by subcontractors are themselves self-employed and therefore under a contract of service. In the German case, not only is more than one-third of the labour input carried out by the main contractor's own direct employees, but those employed by subcontractors are also directly rather than self employed.

On the German project D1 a total of 10,205 operative days and 317 site management days were invested in building 64 flats and four terraced houses as environmental pilot projects or a total 5,727 square metres, including all communal areas of 193 square metres. The result per dwelling is 150 operative days or 1,170 hours, or if we add 4.7 days site management time, a total of 154.7 days, or 1,207 hours per dwelling, allowing for a 7.8 hour day as laid down in the collective agreement. To produce one square metre took 13.9 hours of operative time and in total 14.3 hours including site management. The operative input per square metre is 39% higher on UK1 than on D2, in spite of potential economies of scale to be achieved (Table 3).

Table 3

The proportion of site management to operative input is 3.11% on D1 and 3.98% on UK1. Yet in Germany far less labour was on site per day, 37 operatives on average for the 275 days the site was operating, compared with 68 operatives on UK1 for 324 days. The speed of construction, however, differed greatly: 20.8 square metres were produced per day on D1 and 28.4 square metres on UK1. The English project progressed 36.5% faster than the German scheme. Many technical factors may contribute to these differences between UK1 and D1, the most important being the difference in site conditions and site gradient; UK1 was a brownfield site on a steep gradient, D1 a greenfield site on flat ground with only minor problems in the groundworks stage caused by the high water table. There were also differences in terms of the potential to achieve economies of scale and, though minimal, in working hours.

Across the three countries, therefore, the comparison shows that Denmark produces housing with considerably less labour input on site, the German scheme being 7.8% higher, the Scottish 20.2% and the English 49.6% (Table 3). Variations in the speed of construction show a similar pattern, with UK1 standing out as different. Many factors may contribute to explaining the speed at which projects proceed including, in no order of importance: the building form and method, technology and machinery in use, the site gradient and site conditions (brownfield, inner city), the availability of labour and skill, working time, the completeness of design information and the quality of the design.

This difference in labour input is mainly explained by the higher degree of prefabrication and direct employment used on the Danish, German and Scottish sites. A timber-frame kit was used in Scotland and concrete elements in Denmark for the erection of the superstructure. On both projects, in Scotland and Denmark, the manufacturer took on the task of erecting the superstructure with the prefabricated components. DK1 is a 'traditional' project in Denmark. Unlike the UK, housebuilding with precast concrete elements has never ceased in Denmark and experience and skill in this building method have thus been retained. A breakdown according to trades shows that concretors and concrete element installers are the dominant trades in the superstructure phase, bricklayers being only employed to add the brick skin to the outside (Fig. 7). The main contracting firm used its own directly-employed carpentry and joinery teams, but they had to bid for their work packages against external trade contractors.

Fig. 7

Conclusions

The paper has shown the high labour intensity in the English case compared with that in Germany, Scotland and Denmark, with 39% more labour required to produce one square metre compared with Germany and 50% compared with Denmark. At the same time the nature of labour deployment is qualitatively different, being front-loaded in England, whilst in the other countries it is end-loaded in the sense that there is a gradual build-up of labour on site. The most extreme and ideal case as far as site management is concerned is the Danish, with an abrupt.ending to the project facilitated by extensive prefabrication, in particular the use of bathroom pods.

The organisation of the labour process described here for England has tended to fix the industry at its present low level of productivity. The fragmentation of knowledge, through the separation of engineering, building technology, production and cost knowledge lies at the heart of the problems (Clarke and Herrmann 2004). But together with this has gone an emphasis on cost exclusive of production that has encouraged the system of endless subcontracting, including labour-only, of all activities, rather than direct employment. Through this the main contractor loses control of the site production process and the workforce loses stability of employment through the firm. This is nowhere more evident than in the comparisons of labour deployment presented here.

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Table 1 Operative input

	UK1			Lemassany/Clapp	% change since 1970s
	Days per scheme	Days per dwelling	Hours per metre	Days per dwelling	
	(131 units)	(av. 70 sq.m.)			
Operative	22,193	169			
Skilled operative	15,474	118		130	9.2
Unskilled operative	6,719	51			
Site management	883	7			
Total labour input	23,076	176	20	190	7.4

Source: Lemassany, J. and Clapp, M.A. (1978) *Resource inputs to construction: the labour requirements of housebuilding*, BRE current paper 76/78.

Figure 1 Labour deployment at UK1

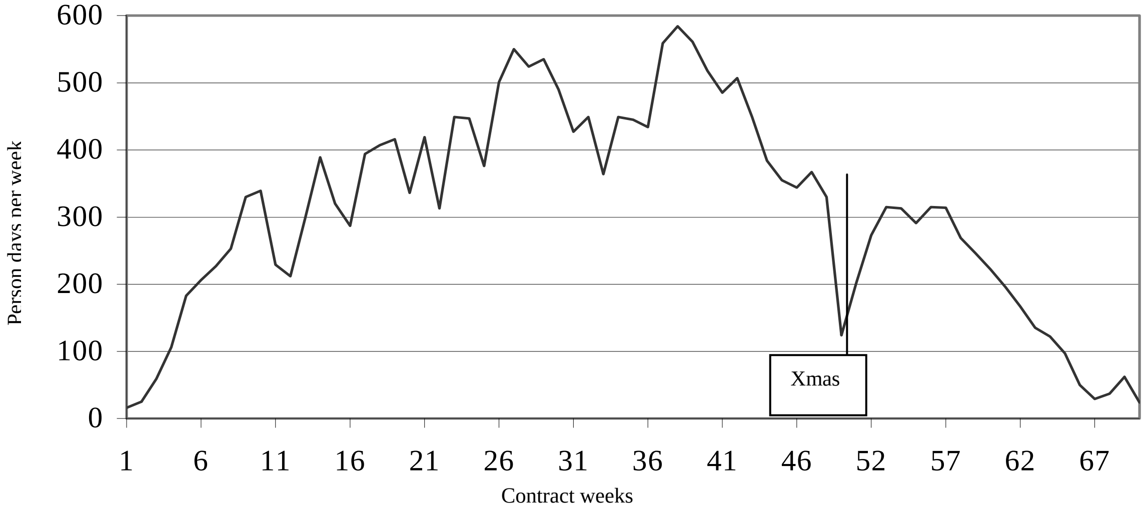

Figure 2 Main trades and finishing trades: the sequencing of work on UK1

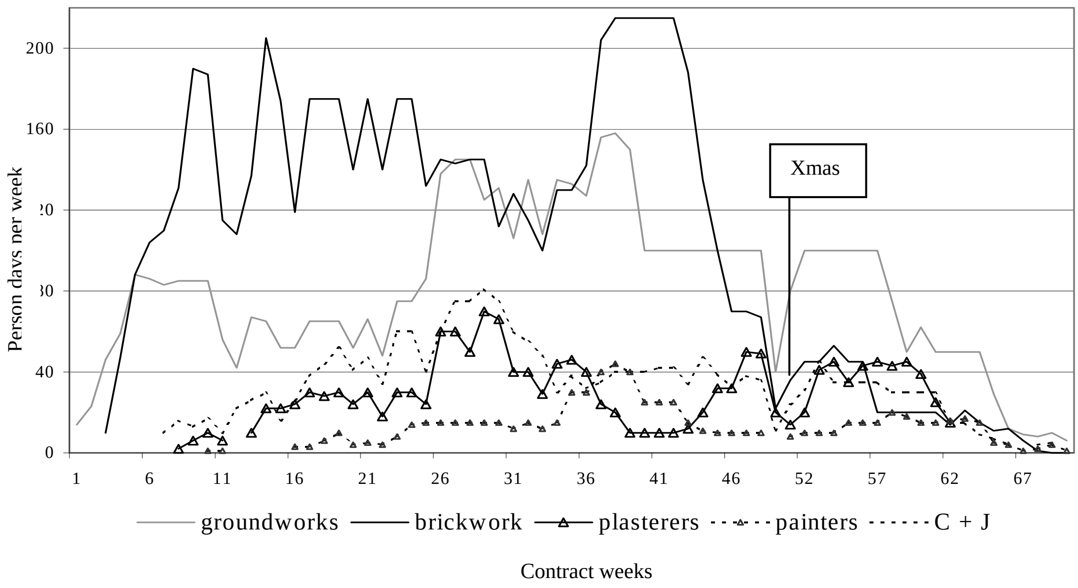

Table 2 Groundworkers' presence on site on UK1 at periods of different intensity

	Input of groundworkers at periods of different labour intensity				Total
	Period 1	Period 2	Period 3	Period 4	
Operatives on site per day	30	25	22	20	
Number of weeks	3	5	4	17	
Number of days	15	25	20	83	143
Operative days worked per week	150	125	110	100	
Total number of days x operative	450	625	440	1660	3175

Figure 3 Labour deployment on the German site, D1

Table 3 Productivity comparisons of English (UK1), Scottish (UK8), German (D1) and Danish (DK1) projects

	Operative hours per sq. m.	Index of labour input (DK=100)	Operative hours per dwelling	Sq.m. completed per day
UK1	19.3	149.6%	1,355	28.4
UK8	15.5	120.2%	1,225	15.5
D1	13.9	107.8%	1,170	20.8
DK1	12.9	100%	1,114	20.8

Figure 4 Labour deployment on the Scottish site, UK8, with directly employed personnel

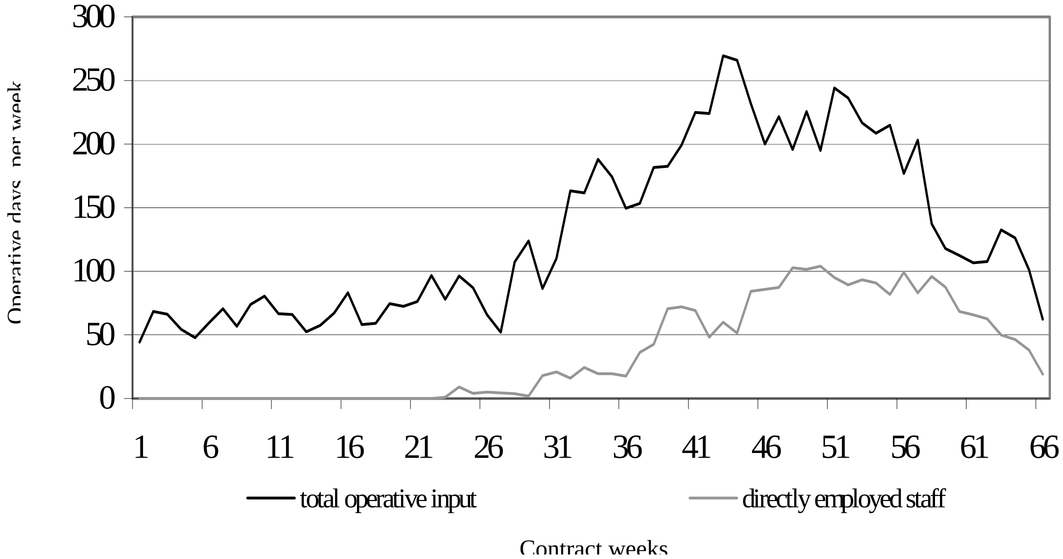

Figure 5 Labour deployment of the main trades on the Scottish site, UK8

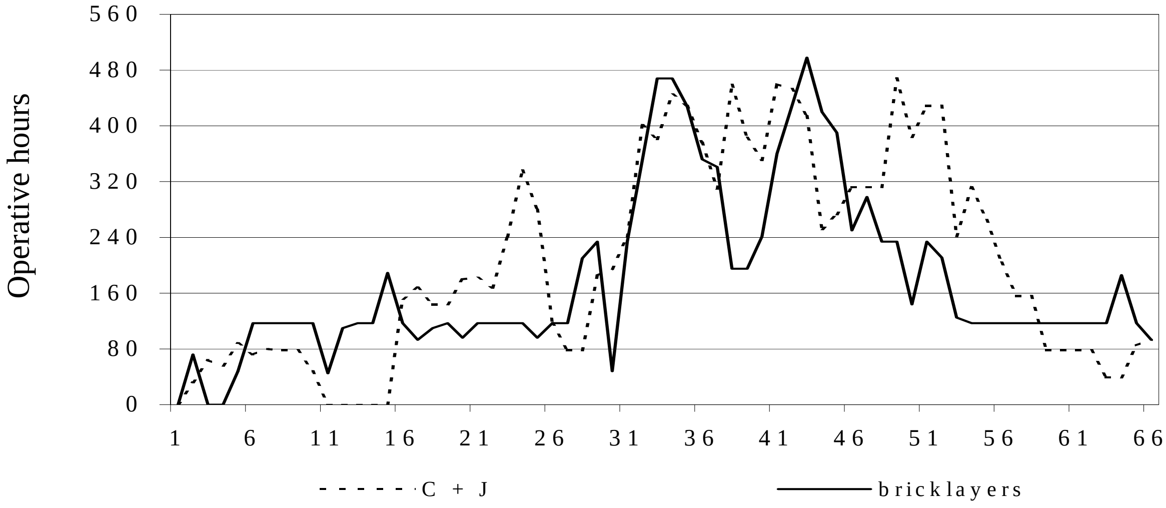

Figure 6 Labour deployment on the Danish site, DK1

Figure 7 Labour deployment according to trades and subcontracts on the Danish site, DK1