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The Construction Skills Network programme 2015-2017

Final Report Bid Package 5 –
Productivity Review/Workshop

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The study should not be regarded as a policy statement by CITB

Summary

In November 2014, Whole Life Consultants Ltd (WLC Ltd) were awarded a contract by Experian to identify trends in construction labour productivity that could be used to inform both the updated CSN model produced by Experian and the Labour Forecasting Tool produced by WLC Ltd on behalf of the CITB. WLC Ltd were to undertake a review of recent literature on the subject of construction labour productivity to supplement WLC Ltd's existing, extensive knowledge. They were also asked to establish and convene an expert panel of industrialists to enrich an in-depth view of likely industry performance on a rolling five-year basis that would enrich the modelling of productivity trends in the CSN model and identify the steps CITB could take to improve labour productivity and skills.

This report concludes that productivity is best measured at the macro level in terms of GVA per cost of labour and at the micro level in terms of earned hours divided by actual hours. It identifies the external and internal factors that affect labour productivity determined both from a literature review and from a workshop attended by members of the expert panel, and presents the results of an analysis of ONS statistics to identify trends over the past 35 years. The analysis demonstrates that productivity measured in terms of construction output per hour worked has increase by an average of about 0.5% pa since 1978, and that there is a very strong positive correlation between productivity and the volume of activity in the construction industry. In terms of GVA per person employed, productivity has increased by an average of about 1% pa since 1998, the earliest date for which consistent data is available.

It is concluded that a) despite the shortcomings of ONS data, nothing better is currently available; b) there is a need for industry-wide training in productivity improvement; and c) whilst tier 1 contractors may have no direct interest in improving productivity at the task level, since a large proportion of their work is subcontracted, tiers 2 and 3 contractors should be well-disposed to the notion of productivity improvement.

The principal recommendations are:

1. The changes in productivity implicit within the CSN model should be compared with the recent average annual increase of 1% derived in this report.

2. An annual increase in productivity of 1% pa should be built into the labour coefficients in the LFT.

3. CITB should engage in an industry wide consultation to determine precisely what statistics would be of greatest use and develop a specification for the data that would be of real value to the industry. Depending on the outcome, they should then enter into discussion with the ONS to explore how the recommendations might be implemented.

4. CITB should consider hosting a conference for clients, contractors and their supply chains to increase awareness of the external factors that affect productivity, to identify potential barriers and to promote strategies for minimising their impact.

5. CITB should enter into discussions with trade associations and training providers to explore the potential for creating a greater emphasis on productivity improvement in labour force training.

6. CITB should promote the development and delivery of training programmes for site based managers of all levels to improve their management skills in general, and to increase their understanding of the factors that affect productivity and the steps that need to be taken to improve it.

7. Research is required to quantify the productivity improvement brought about by off-site manufacture.

8. CITB should explore the appetite for the development of a productivity benchmarking tool that could serve both to collect national productivity data based on earned hours and to motivate the industry to improve productivity at the task level.

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1. INTRODUCTION

In November 2014, Whole Life Consultants Ltd (WLC Ltd) were awarded a contract by Experian as part of Experian's renewed Construction Skills Network programme 2015-2017 for CITB. Bid Package 5 of Experian's contract with CITB required WLC Ltd to identify trends in construction labour productivity that could be used to inform both the updated CSN model produced by Experian and the Labour Forecasting Tool produced by WLC Ltd on behalf of the CITB. In the work package, WLC Ltd were to:

- undertake a review of recent literature on the subject of construction labour productivity to supplement WLC Ltd's existing, extensive knowledge;

- establish and convene an expert panel of industrialists to provide an in-depth view of likely industry performance on a rolling five-year basis that would enrich the modelling of construction labour productivity trends in the CSN model and identify the steps CITB could take to improve construction labour productivity and skills.

The panel is to meet up to twice a year to maintain a continuing dialogue with CITB on the subject of construction labour productivity.

This report describes the output from work package 5. It is divided into six further sections: Expert Panel, Definition of Productivity, Factors Affecting Productivity, Productivity Trends, Conclusions and Recommendations, and Next Steps. The outputs from the Expert Panel workshop have been incorporated in the relevant sections of the report.

For convenience in the rest of this report, the term "productivity" will be used as short hand for "construction labour productivity" unless otherwise indicated.

2. EXPERT PANEL

2.1. Remit and constitution

Following extensive consultation with Experian and CITB, the people in Table 1 were invited to become members of the panel.

Table 1: Invited panel members

Name	Organisation	Role
James Hastings	Experian	Director
Caroline Blackman	Laing O'Rourke	Director, Offsite manufacture
Tim Broyd	Foresight, UCL and VP Institution of Civil Engineers	Professor of Built Environment – Construction futures
Paul Phillips	Morgan Sindall (Infrastructure) Plc	Director of National Frameworks
Steve Ward	6ix Consulting	MD
Brian Green	Independent Consultant	
Michelle Baddeley	UCL	Prof of Economics and Finance of the Built Environment
Michael Ball	Henley Business School	Professor of Urban Property and Economic
Julia Evans	BSRIA	CEO
Joe Martin	BCIS	Director
Nick Hopcraft	Highways England	Head of Commercial Strategy
Rob Francis	Skanska UK	Director, Innovation and Business Improvement
Tony Blanch	Costain	Business Improvement Director
Kate Davies/Kate Pegler	ONS	
David Crossthwaite	Aecom	Associate Director
Jim Meikle	UCL	Research Fellow
Lee Bryer	CITB	R&D Operations Manager

All except Paul Philips, Michael Ball and David Crossthwaite were able to accept our invitation. Caroline Blackman, Kate Davies and Kate Pegler were unable to attend on the day of the workshop.

The remit for the panel agreed with Experian and CITB is provided in Appendix A.

2.2. First workshop

With the agreement of CITB and Experian, the first workshop, held on 9 September 2015, was co-hosted by UCL and facilitated by Malcolm Horner. It was attended by all but two of the Panel

members. Outputs from the workshop in the form of keywords captured on flipcharts are provided in Appendix B, and feedback from the workshop in Appendix C.

Our interpretation of the high level conclusions is as follows:

1. There is considerable concern about the accuracy of ONS statistics, although they are the most consistent set of historical data available. It was suggested that RIDDOR[1] might provide access to useful data.

2. Productivity improvement on site is not a main priority for major contractors/development managers such as Skanska and Costain, because a) very high percentages of their work are subcontracted and b) there is no financial imperative because clients are more interested in end-to-end productivity in all phases of project development rather than simply construction. However, whilst tier 1 contractors may have no direct interest in improving productivity at the task level, tiers 2 and tier 3 contractors who seek competitive advantage should readily embrace the need to improve productivity.

3. In this context, procurement route and client relationships have a major role to play.

4. Many external factors such as the price of land and the economic cycle are also major influencers.

5. People should think in terms of more than one industry, recognising the differences between housebuilding, non-residential building, infrastructure and repair and maintenance. However, this view was not held unanimously.

6. Off-site manufacture is likely to have a major impact on productivity.

7. The effect of BIM on productivity is as yet unknown.

8. There is an urgent need for better training in leadership and management for those occupying supervisory positions and above.

Other outputs from the workshop are interwoven into the remaining fabric of this report.

[1] Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

3. DEFINITION OF PRODUCTIVITY

3.1. Introduction

Productivity may be viewed as one dimension of performance. Other dimensions include health and safety, quality, profitability, customer satisfaction, and corporate social responsibility. Productivity is usually regarded as a measure of an organisation's efficiency. In its broadest sense it can be viewed at a variety of scales ranging from National to task level. Productivity measured at the national or macro level is used to make international comparisons and to track national industrial trends, whilst productivity at the task or micro level is used to inform management decisions "at the coal face". Between these two ends of the spectrum, productivity may be measured at the organisation level or the project level to compare either inter- or intra- organisational performance. Best and Meikle (2015) provide a comprehensive overview of how to measure construction performance, though little insight is provided into the measurement of labour productivity at the task level.

No matter the units of measurement, productivity like efficiency should be measured as the ratio of input to output. Curiously, whilst this is the case in some other countries, notably the USA, in the UK, the inverse is used, and productivity is most frequently measured as output/input. The rationale for this is doubtless that an increase in output/input corresponds to an improvement in performance. For the purposes of this report, the UK definition is adopted.

Productivity should not be confused with "output" which can be increased or decreased simply by increasing or decreasing resources, or "productive time" which measures how long workers spend on value adding activity but not how much they produce. Activity sampling and its derivatives such as Calibre which use the productive time approach have been criticised in the literature (Thomas, 1991).

Since productivity is a measure of output/input, the next two sections review possible indicators of input and output. These are followed by commentary on a series of potential measures of productivity leading to a concluding section outlining our preferred and recommended measures.

3.2. Measures of output

Output may be measured in terms of:

- total output or value measured in cash terms;
- Gross Value Added (GVA) which is the total output minus the value of all bought in services;
- earned value, i.e. the amount a contractor will be paid for the work completed;
- earned hours, i.e. the labour hours predicted to be required to complete a given quantity of work;
- quantity of work completed, e.g. m3 of concrete poured or m2 of brickwork laid.

Total output includes the value of materials incorporated in the work completed which may confound measures of labour productivity. Gross Value Added is a measure that is simple to derive, and which can be used at the macro level, but lacks the required granularity for use at the micro level. In theory, its use is only valid if the contribution to GVA of any one input is independent of the contributions from other inputs (Crawford and Vogl, 2006) Earned value and earned hours are widely used in the

petrochemical industry (Page, 1982), but have found little favour in construction, possibly through a lack of familiarity, whilst quantity of work completed is a measure that is readily available since it is required for the interim and final valuations that are an integral part of the construction procurement process.

3.3. Measures of input

Input may be measured in terms of:

- numbers employed;
- numbers of hours worked;
- cost of labour.

The numbers employed is more likely to be used at the macro level when international comparisons are made, since this is a reasonably reliable national statistic for many countries. However, it fails to take account of differences between numbers employed part-time and full-time. For this reason, when relevant statistics are available, the numbers of hours worked is frequently the preferred measure of input at both the macro and micro levels (Ruddock and Ruddock, 2011). The number of hours worked may be measured in terms of total, available or productive time, (Horner and Talhouni, 1995). Total time is the time for which an employee gets paid, available time is total time less unavoidable delays, principally due to weather and paid meal breaks, whilst productive time is available time minus avoidable delays, or the time during which an employee is engaged in a value-adding activity. However, hours worked take no account of the difference in hourly costs between normal and premium time working (payments made for overtime working), or in additional payments made for productivity-related pay, working conditions, or a host of other variables.

3.4. Measures of productivity

3.4.1. Overview

As we noted in Section 3.1, productivity can be measured at many levels. We have chosen to focus only on the macro and micro levels, since intermediate levels can be accommodated by either macro or micro level measures.

At the macro level, the main options are Total Factor Productivity, or Gross Value Added per numbers employed or hour worked. However, we also include a commentary on the advantages of using GVA per cost of labour, which is not a measure we have found anywhere in the literature.

At the micro level, we evaluate the relative merits of measured output per hour of input, earned value/actual cost and earned hours/actual hours worked.

3.4.2. Total Factor Productivity

Views as to what is an appropriate measure are many and varied. Crawford and Vogl (2006) advocate the use of Total Factor Productivity (TLP), but recognise the difficulty in assembling the necessary data. It takes account not only of all the tangible inputs, capital, labour and materials, but also intangible inputs representing technological progress such as quality of management,

knowledge, techniques and best practice. Technological progress causes the change in output that is not accounted for by changes in the tangible input factors. Productivity measured in terms of TLP can be maximised by finding the optimum equilibrium between capital, labour and materials inputs and by increasing technological progress.

3.4.3. Gross Value Added per number employed or hours worked

Gross Value Added per number employed or per hour worked is widely used by the UK Government not least because it is easily derived from the statistics produced regularly by the Office of National Statistics (ONS) and the Organisation for Economic Cooperation and Development. Gross Value Added can only be maximised if other factors of production are optimised. For example, additional investment in mechanisation is only worthwhile if the increase in GVA is greater than the cost of the additional investment. Gross Value Added per hour worked tends to be favoured over GVA per numbers employed for the reasons outlined in Section 3.3.

3.4.4. Gross Valued Added per labour cost

Gross Value Added per labour cost has the advantage that for the client it demonstrates the efficiency with which the contractor uses his labour resource. It is simple to measure, being the contractor's invoiced cost to the client minus the cost of bought in goods and services (including subcontractors) divided by the total labour costs. It is as easy to measure at the project level as it is at the organisational or national level, and can be applied throughout the supply chain, so a contractor can use it to measure the efficiency of his subcontractors. The fact that it is dimensionless is an added advantage.

3.4.5. Output per hour worked

This is a traditional measure of productivity which is fundamental to a wide range of "standard estimating books both in the UK and the USA, and which historically lay at the heart of payment by results schemes. Nowadays, its use is rare except by researchers, and indeed, we know of no organisation regularly using such a measure. The reasons for this are not only the perceived lack of a commercial imperative, to which reference was made in Section 2.2, but also the difficulties in and resultant resistance to collecting the necessary data. Data collection is difficult not only because of the sheer number of activities that have to be measured on a typical construction site, but because of the need to assign work force hours to each activity. The recording of time spent on an activity is popular with neither management nor operatives, and may be impossible in activities such as steel fixing, where allocating hours to different diameters of rebar fixed in the same structural element is simply not feasible.

3.4.6. Earned Value/Actual Cost

Earned value is the value of work output in a given time, usually measured by multiplying the quantities of work completed by the corresponding unit rates in the bill of quantities. It is therefore relatively easy to measure, since it is required for valuation purposes. Actual cost is more difficult to measure at an activity level partly for the reasons outlined in section 3.4.5, but also because of the need to assign the costs of material and plant to an activity. In many cases, this is not straightforward. For example, how is the cost of re-used timber or the cost of a crane to be assigned to a single, particular activity? Thus, on the rare occasions when earned valued analysis has been used, it is typically applied only at the project level.

In the context of labour productivity, it suffers from the inclusion of material costs and value in the measure. Whilst innovation in materials technology can improve labour productivity, the inclusion of material costs in a measure of productivity can seriously hampers its ability to shed light on labour performance.

3.4.7. Earned Hours/Actual Hours

Earned Hours/Actual Hours is often referred to as the Productivity Index or PI. The Earned Hours are either the hours estimated to complete an activity or job, or more usually in the petrochemical industry, the “norm” or “standard time” to complete a task. The total earned hours are calculated by the quantity of work completed multiplied by the corresponding “norm” for each activity. Again, difficulties arise at the lowest level of granularity in assigning hours to tasks, but the technique can be applied relatively easily at the gang or trade level, since recording the total quantity of work completed by a gang or trade in a given period of time is reasonably straightforward. Measuring the PI at site level is even simpler.

3.5. Concluding remarks and recommendations

The choice of measure for labour productivity depends not only on its purpose, but critically on the data available. It may well be that two measures of productivity are required: one to inform the CSN model, and one to measure the impact of CITB strategy on performance. The expert panel emphasised the shortcomings of the data available from the ONS and elsewhere, a view reinforced by Briscoe (2006). It was suggested that CITB might wish to write a specification for the data that would overcome the perceived shortcomings. It was also suggested that it might be possible to develop a productivity benchmarking tool that would allow data at the task level to be collected from contractors in a consistent way and at the same time encourage them to improve their productivity.

In order to measure labour productivity trends across the construction industry, Gross Value Added per hour worked is attractive for the following reasons.

- It is the most consistent set of data available over a significant period of time.
- It is a measure widely recognised and used by Government.
- It is not distorted by the inclusion of the value of bought in services such as materials.
- It is measured in the same units as the implied labour coefficients implicit in the CSN model and explicit in the LFT.
- It relies on the same ONS data that is used to “power” the two models.

If CITB decided that it wished to evaluate the impact of training on productivity, we would recommend the used of the Productivity Index, Earned Hours/Actual Hours. Although no “norms” currently exist in the construction industry, a starting point would be the values that could be derived from standard estimating books such as Spon’s. If sufficient real data could be collected consistently, the norms could be progressively updated as more data became available. In this context, we recommend that CITB should explore the industry’s appetite for the development of a productivity benchmarking tool based on earned hours. The tool would allow contractors to input data in a consistent way and to observe where their performance lay relative to the whole population. It would be designed to preserve commercial confidentiality and would serve both to motivate the industry to improve its performance and to collect robust productivity data at the national level so that trends could be analysed with more certainty.

4. FACTORS AFFECTING PRODUCTIVITY

4.1. Introduction

More than 70 factors affecting productivity have been reported in the literature (Shaddad & Pilcher, 1984). In this report, we have focussed only on those which our reading of the literature, our experience, and the output of the workshop suggest are most relevant to the CSN and CITB's emerging strategies. For the purposes of analysis, we distinguish between external factors and internal factors. External factors are those over which neither a contracting organisation nor CITB has direct control, but where they might wish to influence the decisions of others. Internal factors are generally within the control of contracting organisations, and are those where CITB may be in the best position to provide support to the industry.

The following sections draw heavily on our knowledge of the literature from over thirty years research into the subject, supplemented by our review of recent literature conducted under this commission and the outputs of the Expert Industrial Panel workshop reported in more detail in Section 2.2. We have limited our analysis to those factors which are most relevant to CITB's strategy (CITB-ConstructionSkills Corporate Business Plan 2012-2014), or which are important because of their impact on other factors.

4.2. External factors

In order to provide a structure for this Section, we have drawn on a framework developed by the Swedish Transport Agency, dealing in turn with the economic cycle, competition, community, and creativity and innovation.

4.2.1. Economic cycle

The expert panel were unanimous in their view that the economic cycle had a major impact on the productivity of the industry. Our analysis of ONS statistics reported in Section 5.2 supports this view.

4.2.2. Competition

Competition is potentially an important driver of productivity improvement, but as noted in Section 2.2, it does not seem to have the impact that might be expected. This is due in part to the complexities of productivity measurement referred to in Section 3, and in part to the current industrial environment where developers have more interest in end-to-end productivity than performance in any one phase of a development.

4.2.3. Community

Community refers to the impact on a contractor of the behaviour of those with whom he interacts. The relationship between a contractor, his clients and his supply chain are normally regulated through a variety of conditions of contract, the choice of which depends on the procurement route chosen. The relationship may be interpreted as a reflection of the prevailing culture in the construction industry which may range from adversarial to trusting. In recent years, there has been an increasing recognition of the impact of trusting relationships on productivity (Bennett and Jayes (1995), HM Treasury (2014)). Partnering and alliancing are modern forms of contract designed to share risk in a more equitable manner than traditional ICE and JCT forms of contract. Co-location of client, designer and contractor teams lead to joint ownership and resolution of problems, increased awareness of the

impact of delays, and an increased commitment to making the design ready before construction begins (Constructing Excellence, 2015).

4.2.4. Creativity and innovation

There is considerable evidence to show that creativity and innovation are important drivers of productivity improvement (Innovation Report 2014), though there is evidence to suggest that this may be a function more of productivity than process innovation (Hall, 2011). Innovation may embrace both products and processes. It can provide significant competitive advantage to rival organisations, but can be constrained by regulations that restrict creative freedom. It is necessary both to incentivise productivity and to exercise a reasonable balance between the need of the supply chain for creative freedom and the need of client organisations for a reasonable degree of control.

4.3. Internal factors

The most important internal factors affecting productivity are: delays, working hours, size of the labour force, quality and training of the labour force, quality and training of management though it is important to note that some of these may also be influenced by external factors. Unless otherwise stated, the source of the data in this section is “More for Less” (Horner and Duff 2001).

Each of the internal factors are addressed in turn in the following sections.

4.3.1. Delays

Delays may take one of two forms: interruptions, which bring work to a complete standstill and disruptions which slow work down without causing an interruption. The major causes of interruptions are shown in Figure 1.

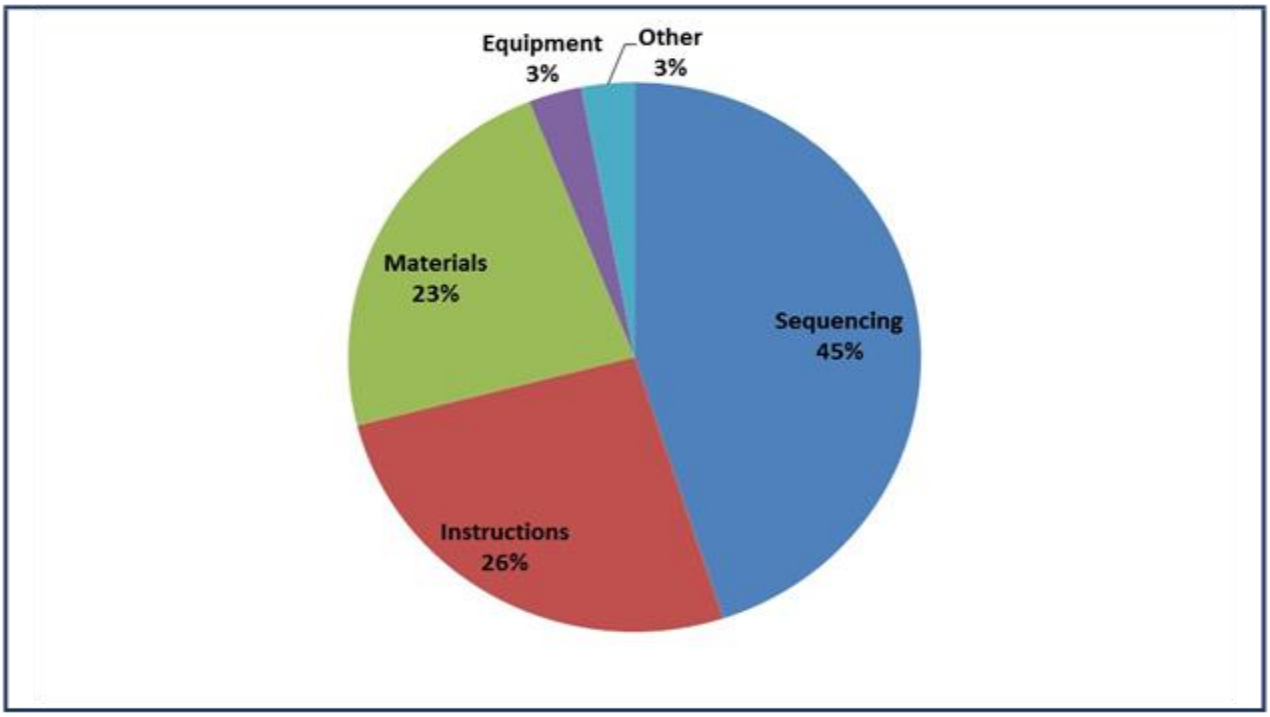

Figure 1: Incidence of interruptions

Research has shown that interruptions lasting less than about 15 minutes and disruptions lasting less than about 4 hours have no effect on a day's output. Interruptions lasting more than half an hour cause an average loss of productivity of close to **30% during the time that the labour force remains at work.** This is thought to be the result of the time taken to wind up to and wind down from peak productivity. The loss of productivity is different for different trades as shown in Figure 2. The reasons for these differences are thought to be differences in the availability of contributing activities, for example, the ability of plasterers to fix edging strips if they run out of plaster. Disruptions cause an average loss of productivity approaching 25%.

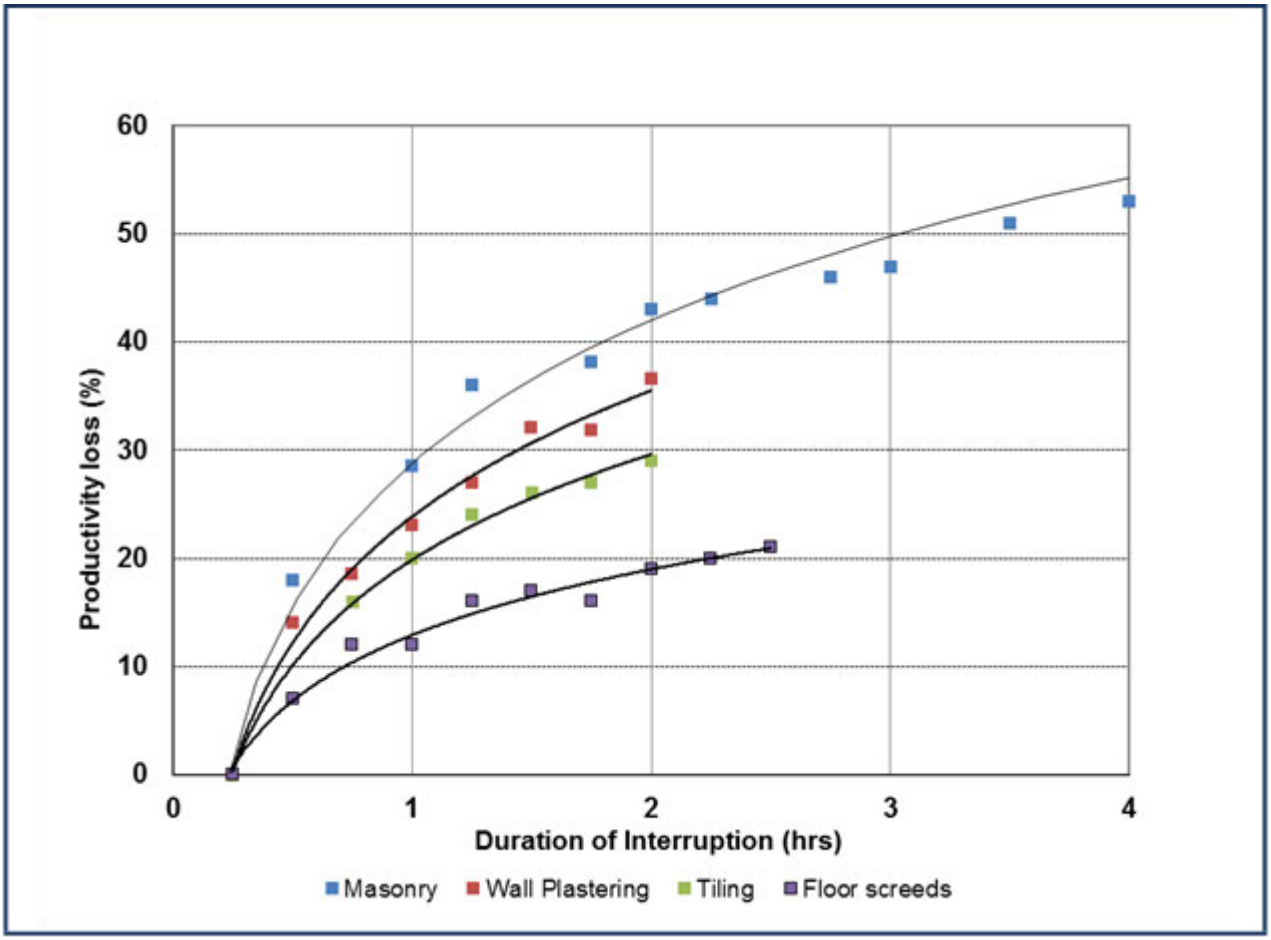

Figure 2: Losses due to interruptions

4.3.2. Working hours

If overtime is worked consistently for more than about three months or so, there is, in round terms, a loss of about 1% in productivity for every hour per week worked above 40 as shown in Figure 3.

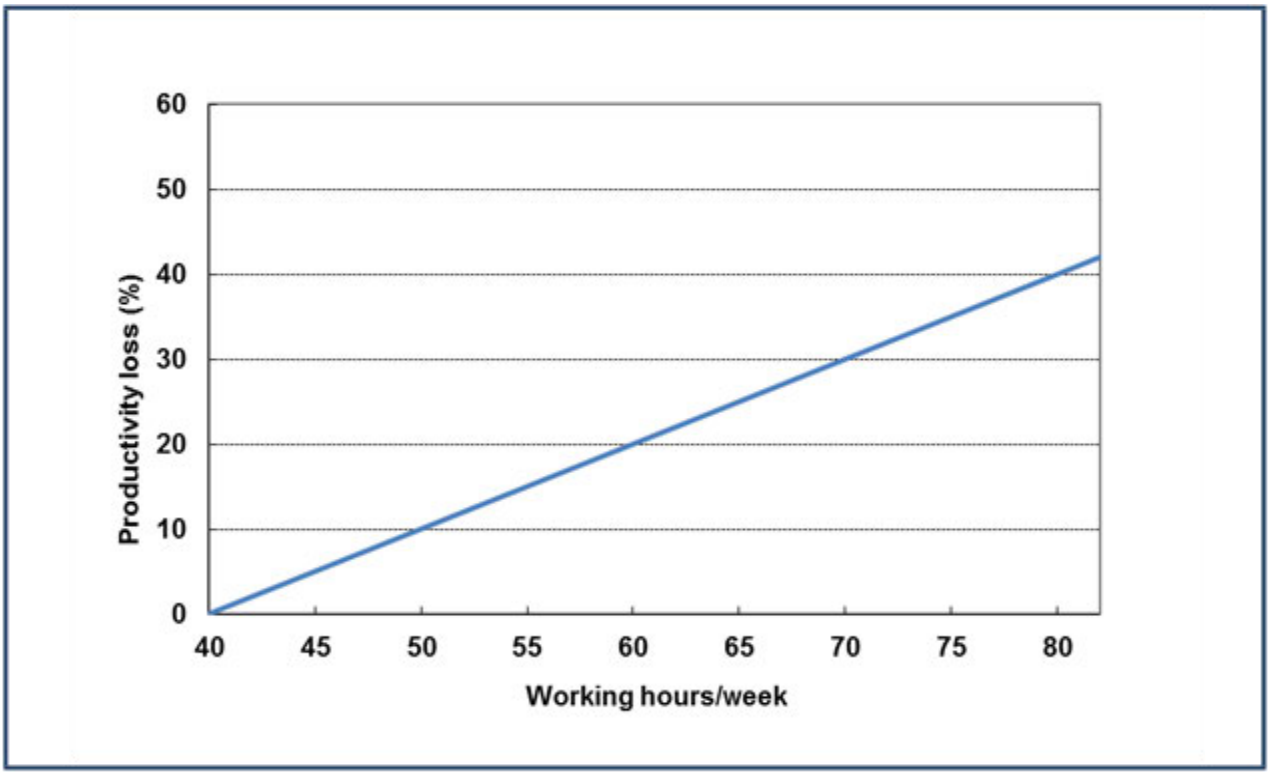

Figure 3: Effect of prolonged overtime working

4.3.3. Size of labour force

The size of the labour force has different impacts on productivity depending on whether any increase was planned or unplanned as shown in Figure 4 and Figure 5.

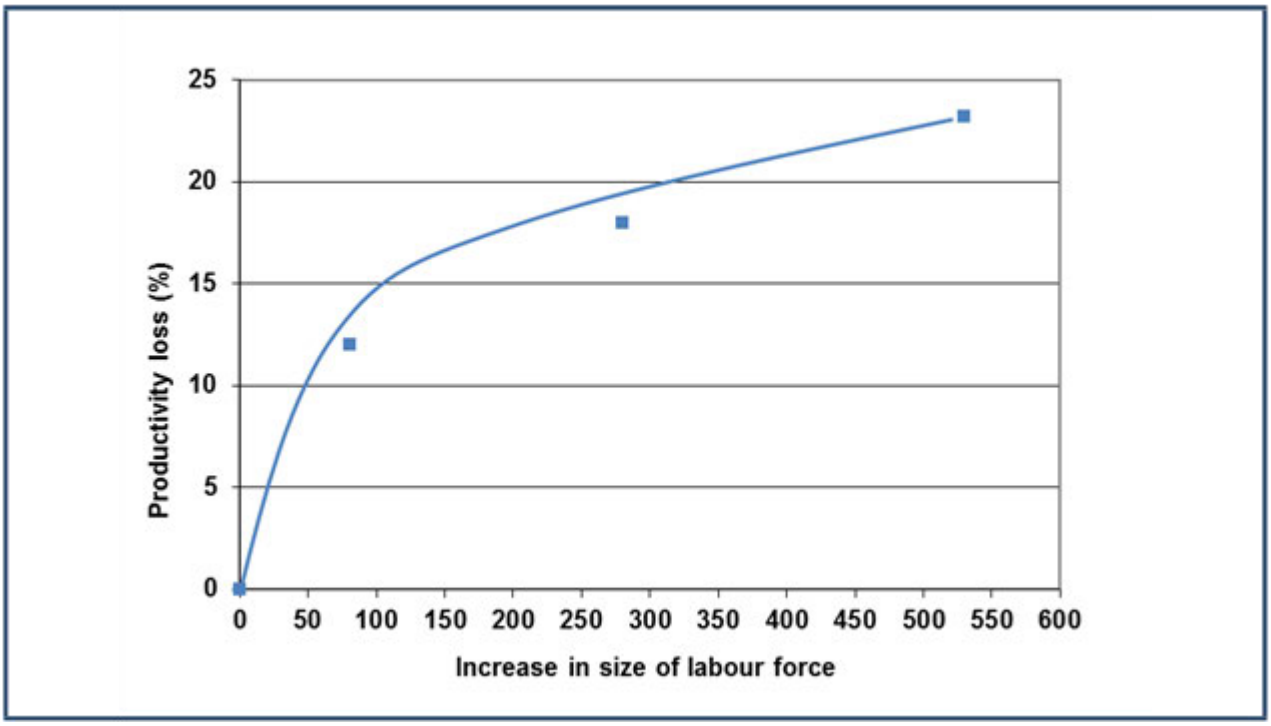

Figure 4: Effect of planned increases in size of workforce

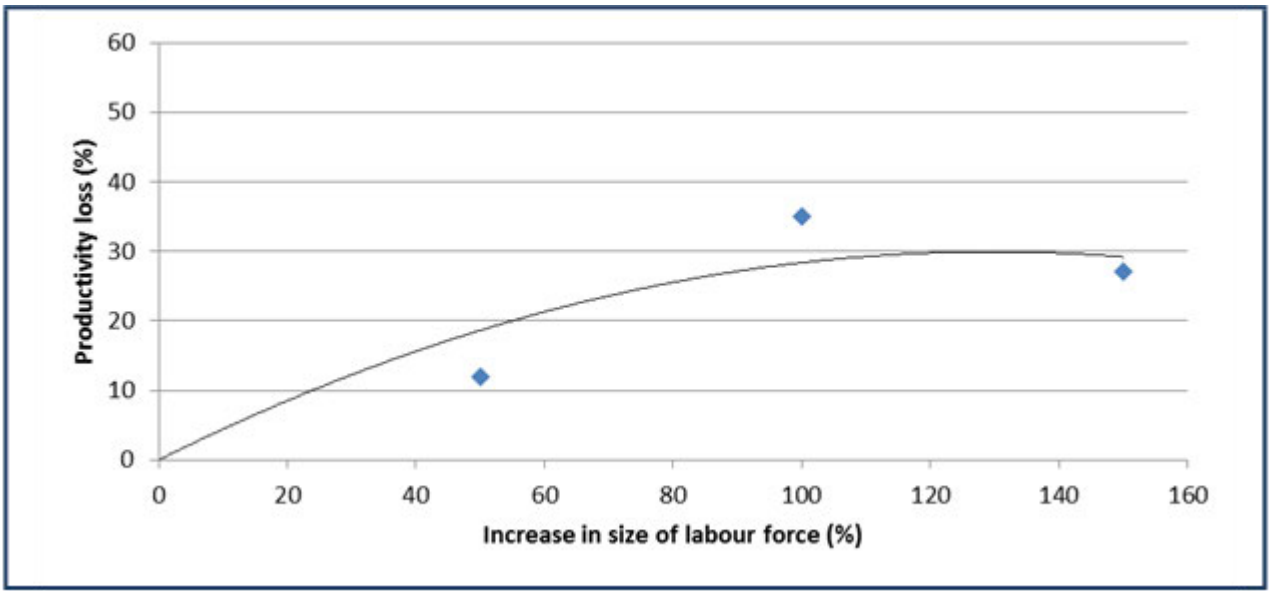

Figure 5: Effect of unplanned increases in size of workforce

Productivity on sites employing 25 people is about 10% higher than on those sites employing 100 people. An unplanned doubling in the size of the workforce causes a loss of productivity of the order of 30%.

4.3.4. Quality and training of the labour force

Figure 6 shows that the average productivity of two gangs on the same site doing identical jobs under identical conditions at the same time can differ by as much as 75%.

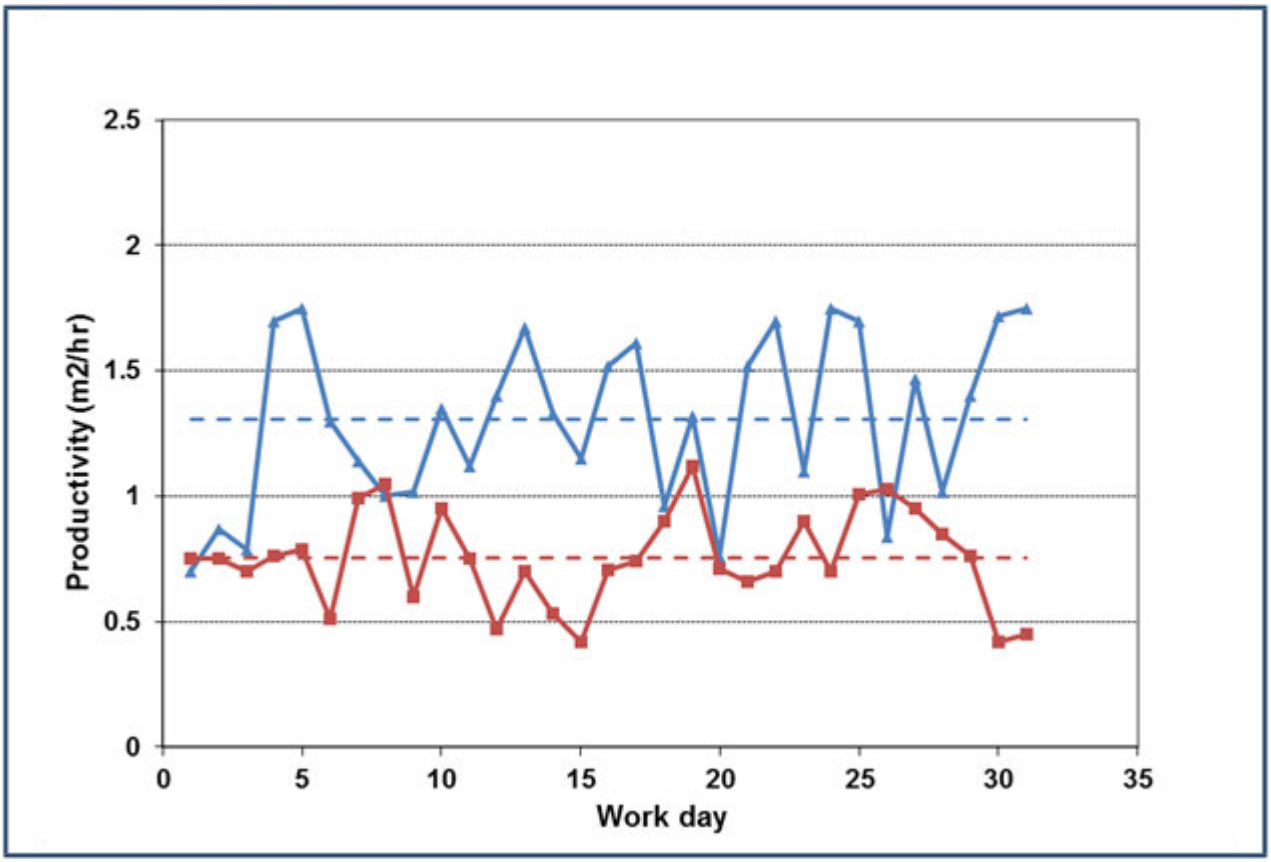

Figure 6: Effect of quality and training of labour force

This suggests that labour should be selected with care and trained appropriately. Abdul-Wahab et al (2008) sought to identify a relationship between training, measured by the number of qualifications attained nationally, and productivity measured in terms of GVA per number employed. They found no correlation between levels of training and productivity between 1996 and 2006. However, training was measured only in terms of standard, existing qualifications rather than that which was focused on productivity. They concluded that work organisation and management practice may have a bigger influence, and that training should be context dependent.

More recently, Mason and Rincon-Aznar (2015, cited in First Joint Special Report of the Business, Innovation and Skills and Education Committees of Session 2015–16) have reported a significant relationship between vocational skills and labour productivity, and a shortage of technicians and tradesmen. They also suggest that if vocational education is to be effective, classroom based training must be reinforced with employment based training.

4.3.5. Quality of management

It can be argued that all of the internal causes of changes in productivity are the result of management actions. Delays can be avoided by good planning. Working hours and the size of the workforce are decided by management. The quality of the labour force is a function of the way in which it is selected and trained: both are the responsibility of management. In 1910, F. W. Taylor determined that the optimum ratio of supervisor to labourers for work in Bethlehem Steel Works was 1 to 7 (Taylor, 1911). In construction, a similar result was found by Horner and Whitehead in 1990 who measured the number of “supervisor equivalents” and productivity at the task level on 12 building sites (Horner and Whitehead, 1986).

4.4. Concluding remarks and recommendations

The principal external factors affecting productivity over which CITB may exert some influence are:

Whilst little data is available to support these largely anecdotal conclusions, we recommend that CITB considers hosting a conference for clients, contractors and their supply chains to increase awareness of the external factors that affect productivity, to identify potential barriers and to promote strategies for minimising their impact.

- the economic cycle (influencing Government to support a stable level of construction activity);
- the regulatory environment and the encouragement of creativity;
- the promotion of partnering and trusting relationships between client and contractor;
- the importance of training within the supply chain.

The principal internal factors affecting productivity are:

- delays
- working hours
- size of the labour force
- selection and training of the labour force
- quality of management

We recommend that CITB enter into discussions with trade associations and training providers to explore the potential for creating a greater emphasis on productivity improvement in labour force training.

Perhaps of even greater importance, we recommend that CITB promotes the development and delivery of training programmes for site based managers of all levels to improve their management skills in general, and to increase their understanding of the factors that affect productivity and the steps that need to be taken to improve it.

5. PRODUCTIVITY TRENDS

5.1. Introduction

This section explores long term productivity trends and seeks to understand the causes of changes in order to provide a comparator for the values implicit in the CSN model and to enrich the predictions from the Labour Forecasting Tool. The figures are derived exclusively from ONS data. It is divided into three further sections. Section 5.2 deals with overall trends in construction productivity and output, Section 5.3 explores changes in productivity at the trade level, whilst Section 5.4 offers some concluding remarks.

5.2. Overall trends

Figure 7 shows total construction output in constant 2005 prices and productivity expressed as output per hour worked, both normalised to the values in 1978, the first year for which consistent statistics are available. In each case a straight regression line has been fitted to the data and the statistics suggest a confidence limit of greater than 99% in the presumed relationship. Thus we can conclude that the compound annual rate of growth in output has been consistently a little over 1% for the past 36 years, whilst the compound annual rate of increase in productivity has been approximately 0.5% over the same period.

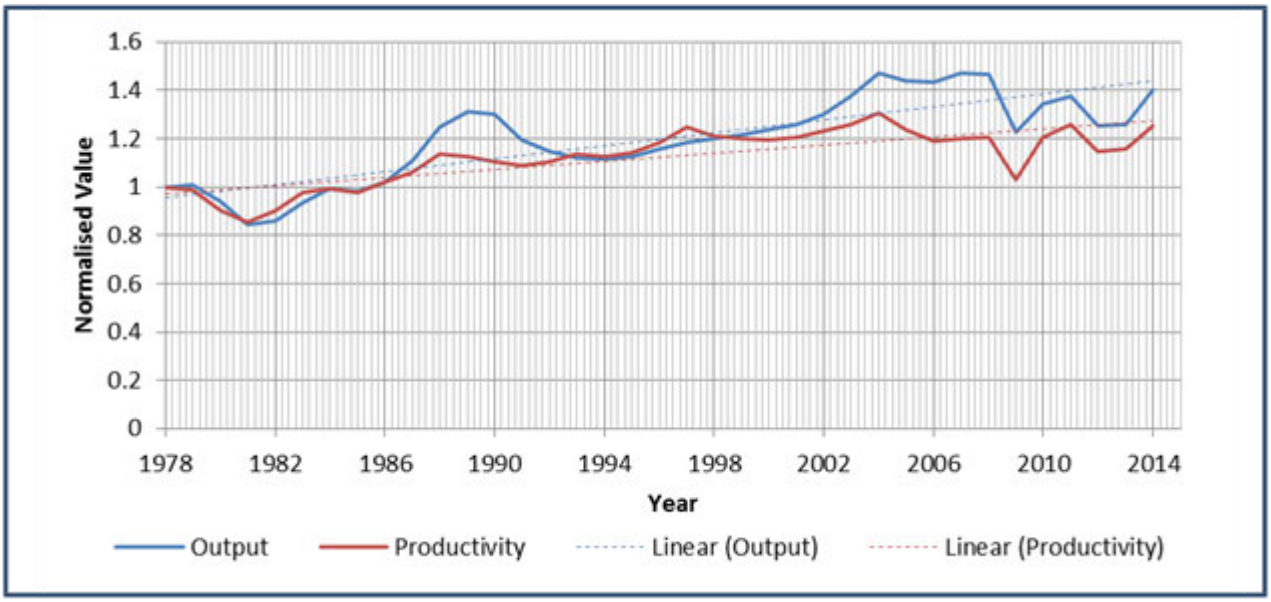

Figure 7: Long term output and productivity trends

Figure 8 shows changes in productivity measured in terms of GVA (at constant 2011 prices) per average number employed during the year for the period 1998 to 2014. The compound rate of growth over this

16 year period is about 1% or roughly twice that measured in terms of total output. This suggests either that there has been a growth in capital investment (mechanisation) or technological progress (innovation) or both. The analysis is limited to the period 1998 to 2014 because GVA prior to 1998 is not available.

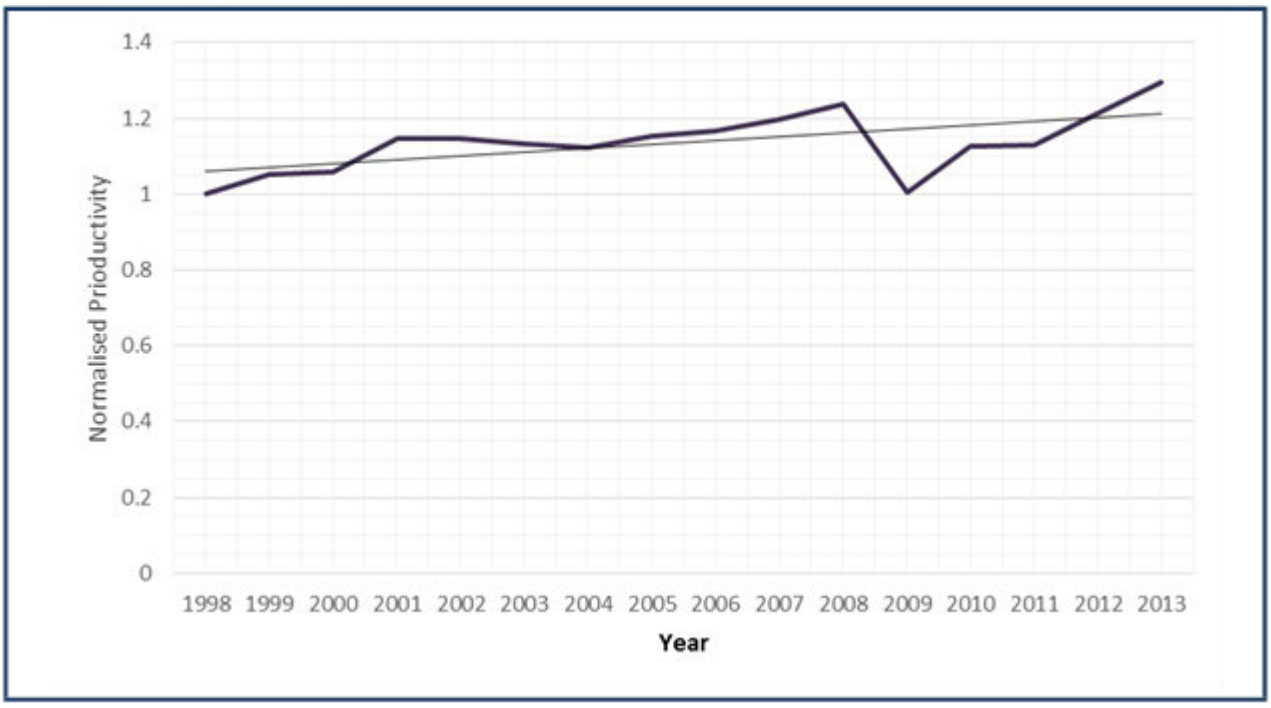

Figure 8: Construction Sector Productivity trend measured in terms of GV per hour worked

Figure 9 shows the relationship between productivity measured in terms of total output per person employed and output for the period 1978 to 2014. The confidence level in the linear regression is greater than 99%.

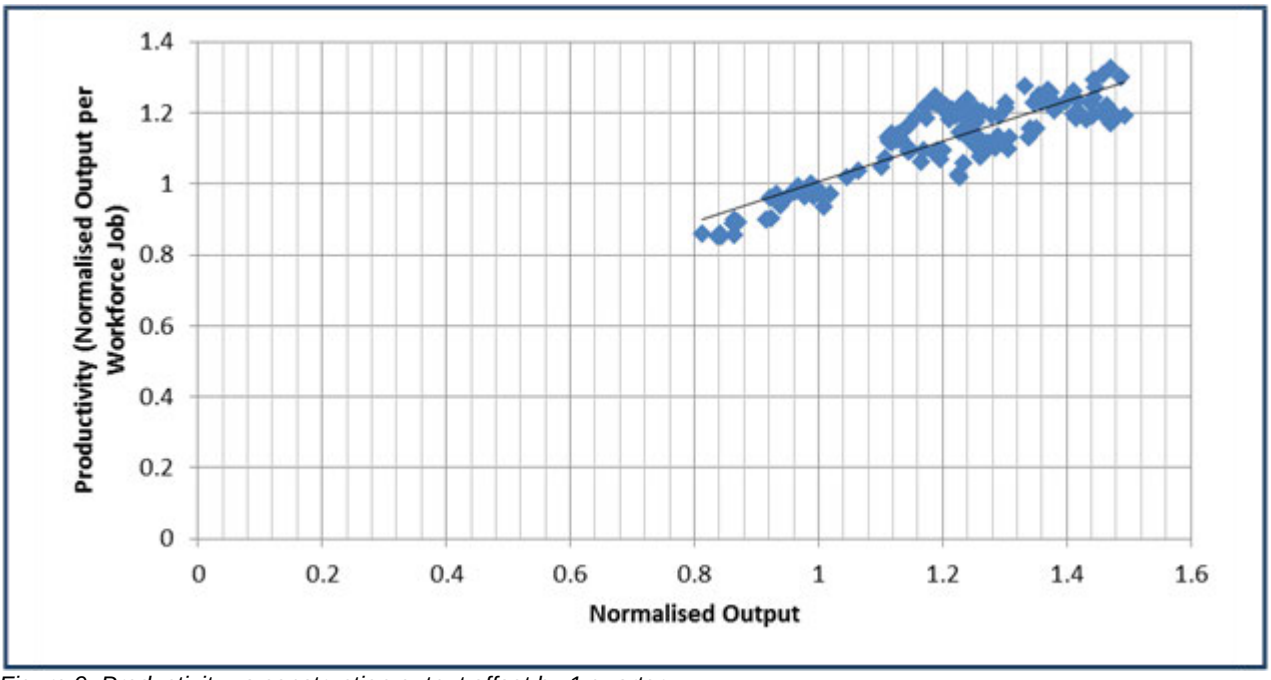

Figure 9: Productivity vs construction output offset by 1 quarter

This very powerful relationship appears to overshadow other factors and suggests that the dominant factor affecting productivity is the level of activity in the construction industry. It could be argued that this is the same phenomenon as that observed at the task and site level. In both cases, when the labour force sees work running out, their productivity reduces.

5.3. Productivity at the trades level

Figure 10, Figure 11, Figure 12, Figure 13 and Figure 14 show changes in productivity measured in terms of GVA per yearly average of number employed for five representative activities: Architectural and Engineering Activities, Construction of Water Projects, Electrical Trades, Plumbing Trades and Roofing Trades respectively. Productivity trends in other activities for which the necessary data is available: Floor and Wall Coverings, Joinery Installation, Painting and Glazing, Plastering, and Test Drilling & Boring are provided in Appendix D.

For consistency, we should use Annual Population Survey data for the numbers employed, but the APS breakdown at this level of detail is available only since 2010. Since we are interested in long term trends, we have therefore been obliged to use BRES/ABI[2] data (as recommended by ONS), but the results should be viewed with caution since there are significant inconsistencies between the two sets of data.

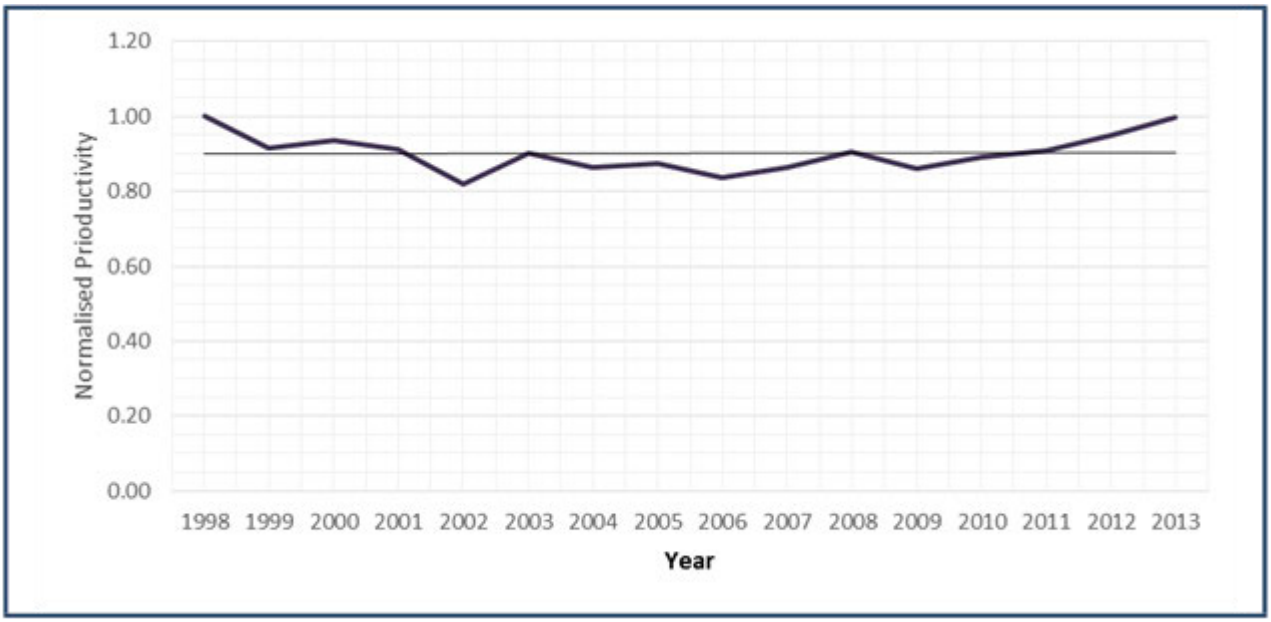

Figure 10: Productivity Trend I Architectural and Engineering activities and related technical consultancy

[2] It is acknowledged that there is a discontinuity between 2008 and 2009 when the ABI was replaced by the ABS and the BRES.

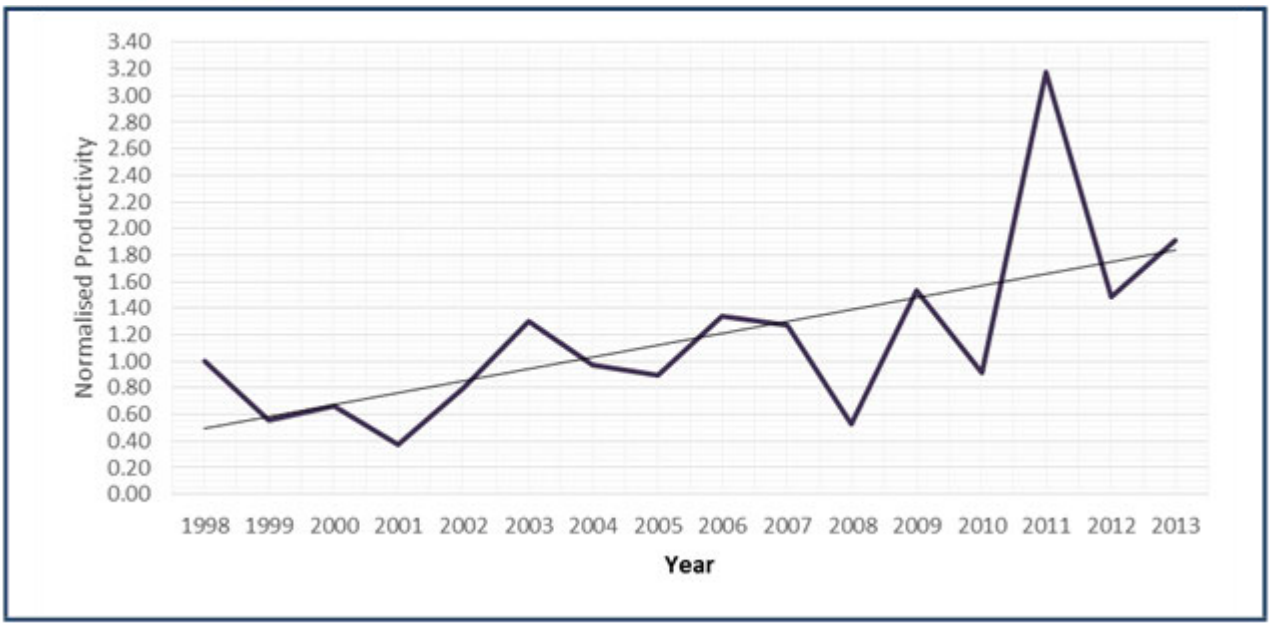

Figure 11: Productivity Trend in Construction Water Projects

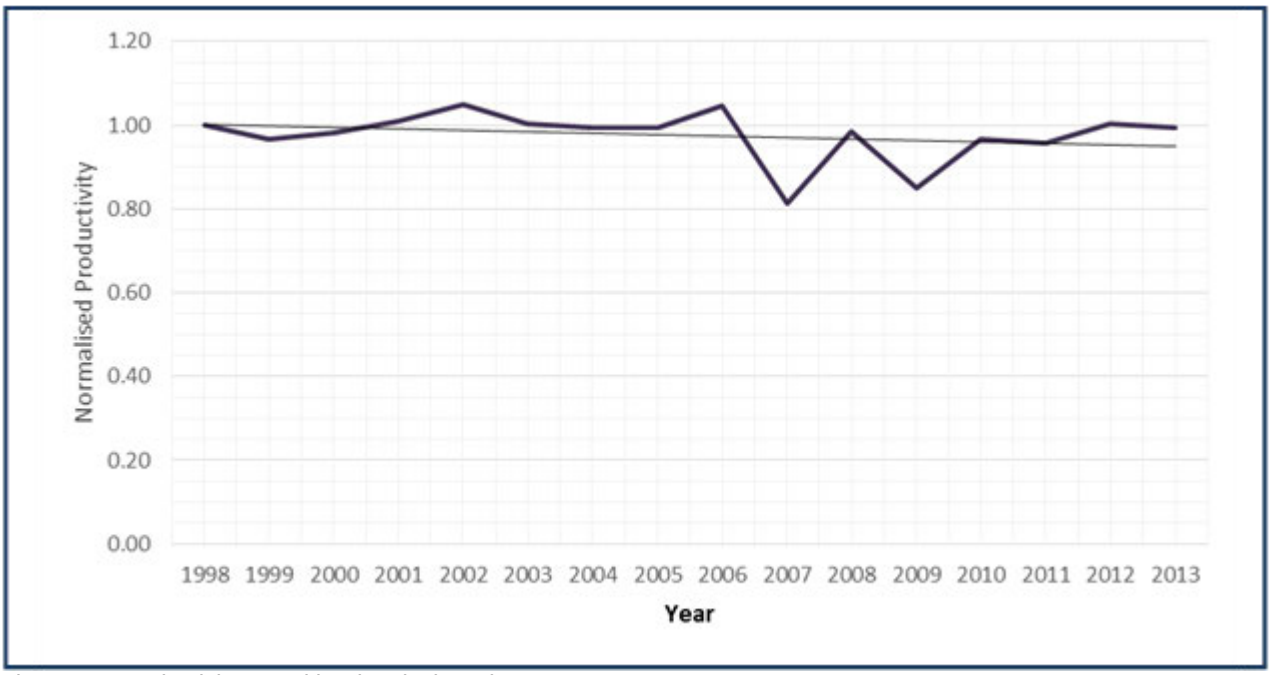

Figure 12: Productivity Trend in Electrical Trades

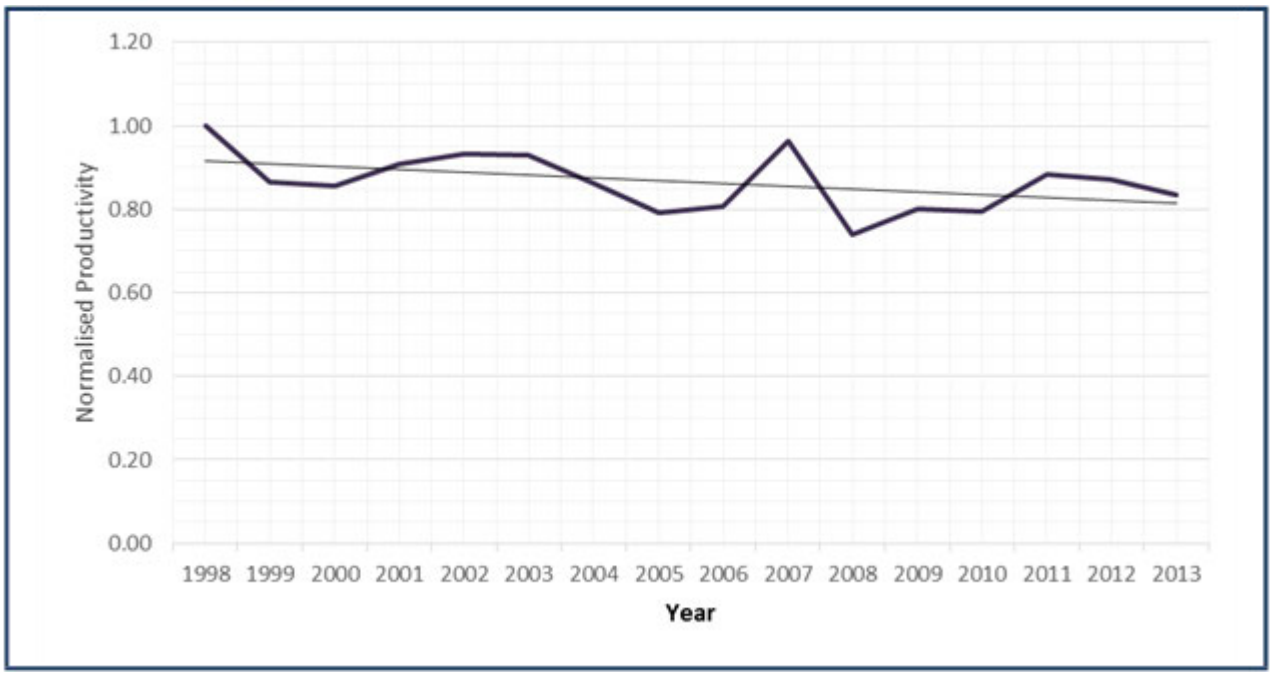

Figure 13 Productivity Trend in Plumbing Trades

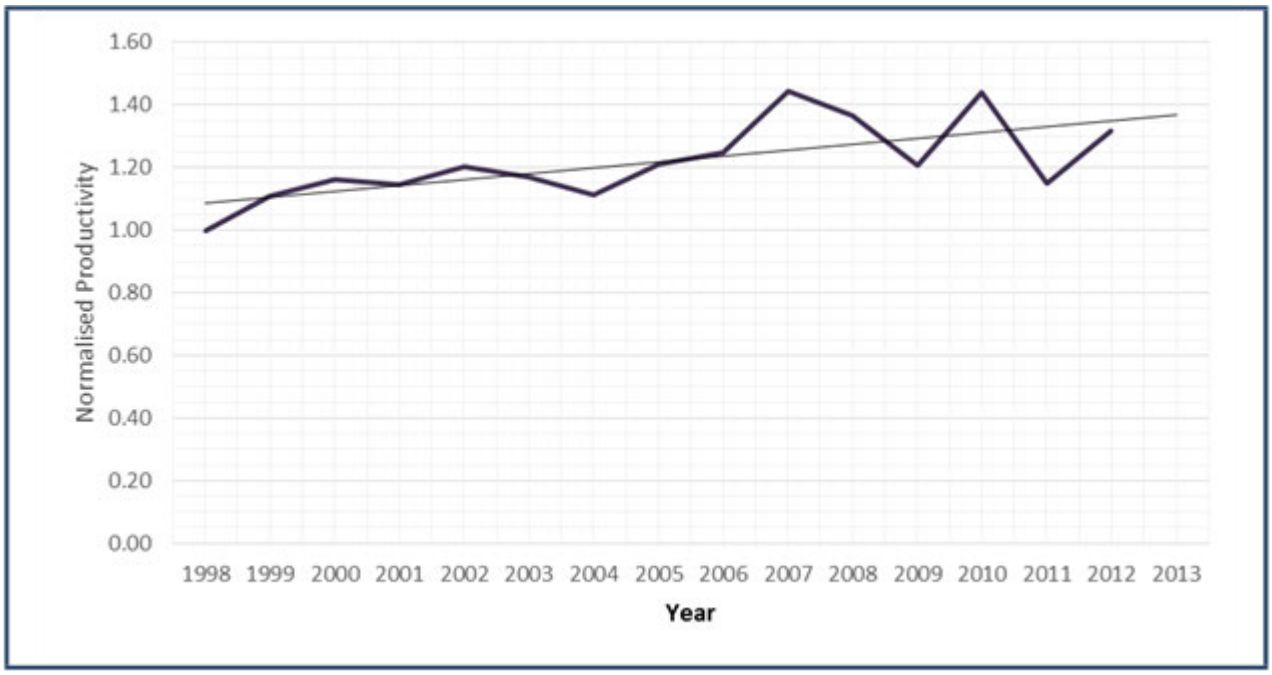

Figure 14: Productivity Trend in Roofing Trades

The absence of significant change in the productivity of the professions is understandable, though it will be interesting to see whether or not the increased use of BIM in future years has an impact. The very significant rise in productivity in the construction of water projects may be a result of the presence of a Regulator, whilst the downward trends in electrical and plumbing trades and the upward trend in the roofing trades are more difficult to rationalise. One possible explanation could be that not all roofers, electrical and plumbing trades are being captured. Since we have disaggregated the BRES data by SIC the employment numbers for roofers for example in Figure 14 are those allocated to SIC 43.91. However, this only includes roofers employed by specialist roofing contractors and not those employed by general builders, who will be in SIC41. This difference is one of the main reasons for the discrepancy between 'roofers', electrical and plumbing trades in the ABS/BRES data and the

LFS: for the last year that data is available in both, ABS/BRES show 26,000 roofers, whereas the LFS shows nearly 45,000.

Generically, the problem is that all building firms classified as ‘general’ will be allocated to SIC41, and these are likely to be employing a whole range of skilled trades. It follows that the trends in individual trades that we have derived in this report should be viewed with the utmost caution.

5.4. Concluding remarks

There is strong evidence to suggest that output in the construction industry has grown at an average rate of 1% pa in real terms over the last 35 years, and that the productivity of the construction industry measured in terms of GVA per hour worked has increased at roughly the same rate since 1998. The cause of this may be an increase in mechanisation or innovation or both. However, the very strong positive correlation between output and productivity suggests that changes in total output may be a dominant factor. We therefore recommend that an annual increase in productivity of 1% pa should be built in to the LFT, and the implications for the CSN model explored.

There is no consistency in the changes in productivity measured at the trades level, and the expert panel could offer no explanation for the trends reported. It is noteworthy that productivity in the construction of water projects shows a very strong growth in productivity, possibly due to the influence of the Regulator, whilst there appears to have been no change in the productivity of the professions during the last 15 years.

6. CONCLUSIONS

6.1. Strategic considerations

1. There is considerable concern about the accuracy of ONS statistics, although they are the most consistent set of historical data available. It was suggested that RIDDOR might provide access to useful data.

2. Productivity improvement on site is not a main priority for major contractors/development managers such as Skanska and Costain, since a) very high percentages of their work are subcontracted and b) there is no financial imperative since clients are more interested in end- to-end productivity in all phases of project development rather than simply construction. However, whilst tier 1 contractors may have no direct interest in improving productivity at the task level, tiers 2 and tier 3 contractors who seek competitive advantage should readily embrace the need to improve productivity.

3. In this context, procurement route and client relationships have a major role to play.

4. Many external factors such as the price of land and the economic cycle are also major influencers.

5. It was suggested that people should think in terms of more than one industry, recognising the differences between housebuilding, non-residential building, infrastructure and repair and maintenance. However, this view was not held unanimously.

6. Off-site manufacture is likely to have a major impact on productivity.

7. Serious consideration should be given to the need to increase the awareness of operatives to the importance of productivity and the factor that affect it, and to the provision of training aimed at improving the productivity of the labour force.

8. The effect of BIM on productivity is as yet unknown.

9. There is an urgent need for better training in leadership and management for those occupying supervisory positions and above.

6.2. Measuring productivity

The choice of measure for labour productivity depends not only on its purpose, but critically on the data available. In order to measure labour productivity trends across the construction industry, gross value added per cost of labour is attractive. At the micro level, the Productivity Index, Earned Hours/Actual Hours should be the preferred option.

The lack of consistent data in the required format is a serious constraint on the analysis and improvement of construction labour productivity.

6.3. Factors affecting productivity

The principal external factors affecting productivity over which CITB may exert some influence are:

- the economic cycle;
- the regulatory environment and the encouragement of creativity;
- the promotion of partnering and trusting relationships between client and contractor;

- the importance of training within the supply chain.

The principal internal factors affecting productivity are:

- delays
- working hours
- size of the labour force
- selection and training of the labour force
- quality of management
- amount of off-site manufacture

6.4. Productivity trends

There is strong evidence to suggest that output in the construction industry has grown at an average annual rate of 1% pa in real terms over the last 35 years, and that the productivity of the construction industry measured in terms of GVA per person employed has increased at roughly the same rate annually since 1998. The cause of this may be an increase in mechanisation or innovation or both. However, the very strong positive correlation between output and productivity suggests that changes in total output may be the dominant factor.

There is no consistency in the changes in productivity measured at the trades level, but productivity in the construction of water projects shows very strong growth, possibly due to the influence of the Regulator.

7. RECOMMENDATIONS

1. The changes in productivity implicit within the CSN model should be compared with the average annual increase of 1% derived in this report.

2. An annual increase in productivity of 1% pa should be built in to the labour coefficients in the LFT.

3. CITB should engage in an industry wide consultation to determine precisely what statistics would be of greatest use and develop a specification for the data that would be of real value to the industry. Depending on the outcome, they should then enter into discussion with the ONS to explore how the recommendations might be implemented.

4. CITB should consider hosting a conference for clients, contractors and their supply chains to increase awareness of the external factors that affect productivity, to identify potential barriers and to promote strategies for minimising their impact.

5. CITB should enter into discussions with trade associations and training providers to explore the potential for creating a greater emphasis on productivity improvement in labour force training.

6. CITB should promote the development and delivery of training programmes for site based managers of all levels to improve their management skills in general, and to increase their understanding of the factors that affect productivity and the steps that need to be taken to improve it.

7. Research is required to quantify the productivity improvement brought about by off-site manufacture.

8. CITB should explore the appetite for the development of a productivity benchmarking tool that could serve both to collect national productivity data based on earned hours and to motivate the industry to improve productivity at the task level.

8. REFERENCES

1. Best, R. and Meikle, J. eds., 2015, *Measuring Construction: prices, output and productivity.*Oxford, UK: Routledge.

2. BRE. *Construction performance measurement & CALIBRE.* [online] available at:<https://www.bre.co.uk/calibre> [Accessed 3 December 2015].

3. Horner, R. M. W. and Talhouni, B., 1995. *Effects of Accelerated Working, Delays and Disruption on Labour Productivity.* London: Chartered Institute of Building.

4. Crawford, P. and Vogl, B., 2006. Measuring productivity in the construction industry. *Building Research and Information,* 34(3), pp.208-219.

5. Briscoe, G., 2006. How useful and reliable are building statistics? *Building Research and Information,* 34(3), pp.220-229.

6. Ruddock, L. and Ruddock, S., 2011. Evaluation of trends in the UK construction industry using growth and productivity accounts. *Construction Management and Economics.* 29(12), pp.1229-1239.

7. AECOM, 2015. *Spon's Architect's and Builders' Price Book 2016.* Oxford: Taylor and Francie.

8. CITB-ConstructionSkills, 2012. *Corporate Business Plan 2012-2014.* [pdf] Accessible at:<https://www.citb.co.uk/documents/about-us/how%20we%20are%20run/citb- constructionskills-business-plan-2012-cskills_tcm17-28848.pdf> [Accessed 2 December 2015].

9. Constructing Excellence, 2015. *Partnering.*[pdf] Accessible at: <http://constructingexcellence.org.uk/wp-content/uploads/2015/03/partnering.pdf> [Accessed 2 December 2015].

10. Bennett, J. and Jayes, S., 1995. *Trusting the Team: The Best Practice Guide to Partnering in Construction*. London: Thomas Telford.

11. Department for Business, Innovation and Skills, 2014. *Innovation Report 2014.* London: HM Government.

12. Infrastructure Client Group, 2014. *Alliancing Best Practice in Infrastructure Delivery.* London: HM Treasury.

13. Hall, B.H., 2011. Innovation and Productivity. *Nordic Economic Policy Conference on Productivity and Competitiveness.* Helsinki, Finland, 29 April 2011.

14. Horner, R. M. W. and Duff, A. R., 2001. More for less - A contractor's guide to improving productivity in construction. London: Construction Industry Research & Information Association CIRIA).

15. Abdul-Wahab, M. S., Dainty, A. R. J., Ison, S.G., Bowen, P., Hazlehurst, G., 2008. Trends of skills and productivity in the UK construction industry. *Engineering Construction and Architectural Management*, 15(4), pp.372-382.

16. Mason, G. and Rincon-Aznar, A., 2015. Skills and Productivity in the UK, US, France and Germany: a Literature Review in *Education, skills and productivity: commissioned research* in *First*

Joint Special Report of the Business, Innovation and Skills and Education Committees of Session 2015–16, London: The Stationery Office Ltd.

17. Thomas, H. R., 1991. Labour Productivity and Work Sampling: The Bottom Line. *ASCE Journal for Construction Engineering and Management,* 117(3), pp.423-444.

18. Page, J. S., 1982. *Estimators' Piping Manual, 4th edition.* Houston, Texas: Gulf Publishing Company.

19. Taylor, F. W., 1911. *Scientific Management.* New York: Harper and Row.

20. Shaddad, M. Y. I. and Pilcher, R., 1984. The Influence of Management on Construction System Productivity - Towards a Conceptual System Causal Model. *Proceedings of 4th CIB W65 International Symposium on Organisation and Management of Construction, Vol 2, pp.613-627.*Waterloo, Canada, July 1984.

21. Horner, R. M. W. and Whitehead, R. C. Labour productivity on construction sites. *Proceedings 2nd Yugoslav Symposium on Construction Management, pp.587-599.* Opatija, Croatia, April 1986.

APPENDIX A

Remit of the Expert Panel

INTRODUCTION

Experian has been awarded a contract by CITB to deliver the most robust and accurate forecasts of construction employment possible at a UK, regional and devolved nation level. To improve the forecasting capability of the Experian model, Whole Life Consultants Ltd (WLC) has been commissioned to analyse productivity trends in the UK construction industry. WLC already have considerable expertise in understanding the causes of low productivity, its importance to the industry and in the strategies needed to improve it. Their work will include a literature review to identify causes of and reported recent changes in productivity and an analysis of ONS data in an attempt to identify historical trends. These trends will be used to:

- enrich an in-depth view of likely industry performance on a rolling five-year basis that will inform the modelling of productivity trends in the CSN model;
- allow CITB to contribute to an informed debate with stakeholders on the likelihood of achieving the targets set out by the *Construction 2025: industrial strategy for Construction;*
- inform the steps that can be taken by CITB to improve labour market productivity and skills.

WLC's work will be guided by a panel of experts, representative of industry and academia, which will meet up to twice a year to review inputs, verify outputs and advise on recent and future developments.

ROLE OF THE EXPERT PANEL

The expert panel will meet twice a year to receive reports from and provide guidance to WLC and Experian. Its remit will be to:

- provide advice on the most appropriate definition of productivity;
- confirm the identification of and prioritise the causes of changes in productivity;
- comment on the methodology proposed by WLC for determining historical trends;
- critically review the outputs produced by WLC and offer observations on their credibility; and
- ensure that WLC's work takes account of the most recent developments in theory and practice.

MEETINGS

We will use the first meeting of the Panel to gather views about the most appropriate definition of productivity, and the direction and cause of productivity trends both during the past 6 months and in the future. At the second meeting, some six months later, we will present our progress on identifying

any trends, exploring their possible causes, and preparing a commentary. Although we have foreseen the possibility of convening and running two meetings of the Expert Panel each year, because trends in productivity are not expected to change rapidly, it may be that the frequency could be reduced to once per year in the fullness of time.

MEMBERSHIP

Productivity in its broadest sense is impacted by procurement, design, construction and arguably maintenance and operations of built assets. The Expert Panel, preferably appointed by CITB, should therefore be drawn from a wide cross section of industry including clients, designers, building services engineers, contractors, sub-contractors, and asset managers as well as academics in the broadest sense, all with expertise in productivity, lean thinking or other relevant areas. It will be necessary to balance the need for a representative, informed cross-section of the industry against the unwieldiness of large numbers, bearing in mind the difficulty in ensuring that all members attend for all meetings. A dozen external members is probably about the optimum. The list below includes some of the people included in our tender, but we would welcome suggestions from Experian and CITB.

Nicola Bates (Head of Business Systems, Shepherd Construction) – Lean thinking

Caroline Blackman (Director, Laing O'Rourke) – Offsite manufacture

Tim Broyd (Professor of Built Environment Foresight, UCL and VP Institution of Civil Engineers) – Construction futures

Alan Hodges (ex BAM –Nuttall) - Productivity

Malcolm Horner (Chairman, WLC Ltd) – Facilitator

Paul Phillips (Director of National Frameworks, Morgan Sindall (Infrastructure) plc) - Client Representatives from CITB, Experian, government agencies, departments and trade federations.

NEXT STEPS

We suggest the following approach.

Experian agree the remit of the Panel and the nature of its membership. Experian, CITB and WLC Ltd propose additional names for agreement by email.

Experian, CITB and WLC Ltd agree the date and of the first meeting of the Panel to be held in London in

March/April.

Experian/WLC issue invitations to potential members of the Panel and to the first meeting.

Prepared by:

Malcolm Horner
27 January 2015

APPENDIX B

Output from Expert Panel workshop 9 September 2015

FACTORS AFFECTING PRODUCTIVITY

- Supply Chain/ Integration/Education
- Uncertainty
- Client Relationships
- Capital/Mechanisation Automation 1 Replacement of kit etc. 2 Innovative novel capital investments)
- Price of land
- Economic Cycle
- Procurement
- Weather
- Ground conditions
- Leadership
- Motivation
- RIDDOR
- Two Industries
- R & M
- Fragmentation
- Site Logistics (Access)
- Supply of materials etc.
- H&S
- Forward programming
- Management process
- Sequencing
- Site Supervision
- Build Quality
- Not one industry
- Skills/ competencies
- Incentivisation
- Triggers for Innovation
- Offsite Manufacture
- Sacks paper
- Planning
- Collaboration
- Design

- Finance
- Business Imperative
- Possessions/ Working windows
- Education in H&S
- HBF Quality measure
- Legalisation
- Contract

MEASURES OF PRODUCTIVITY

- Measuring performance Vs Productivity
- End to end productivity
- Horses for courses
- Business Performance Measures
- Different Industries
- R & M/ Refurb
- People who work in digital process worlds
- Productivity in thinking
- No casualisation
- Improving Data
- Labour numbers and earnings

APPENDIX C

Feedback from Expert Panel workshop

9 September 2015

Figure 15: Feedback from Expert Panel workshop 9 September 2015

Comments on today's Expert Panel meeting:

- Interesting discussion, could do with more representation from operations/contractors and not just main contractors – not sure where this is leading
- Recognition that industry must change
- Air conditioning/access but topic and participants more than made up for it.
- Great contributions from all
- Lot of different views in the room which made for a varied and challenging discussion

Suggestions for future meetings:

- Changing mind set of Architects, Consultants, Engineers
- Future meetings may want to be more formatted around specific elements to avoid a repeat discussion

Would you be interested in attending future meetings of the Expert Panel?

Yes	**No**
9	0

This data is based on 9 feedback forms.

APPENDIX D

Productivity trends

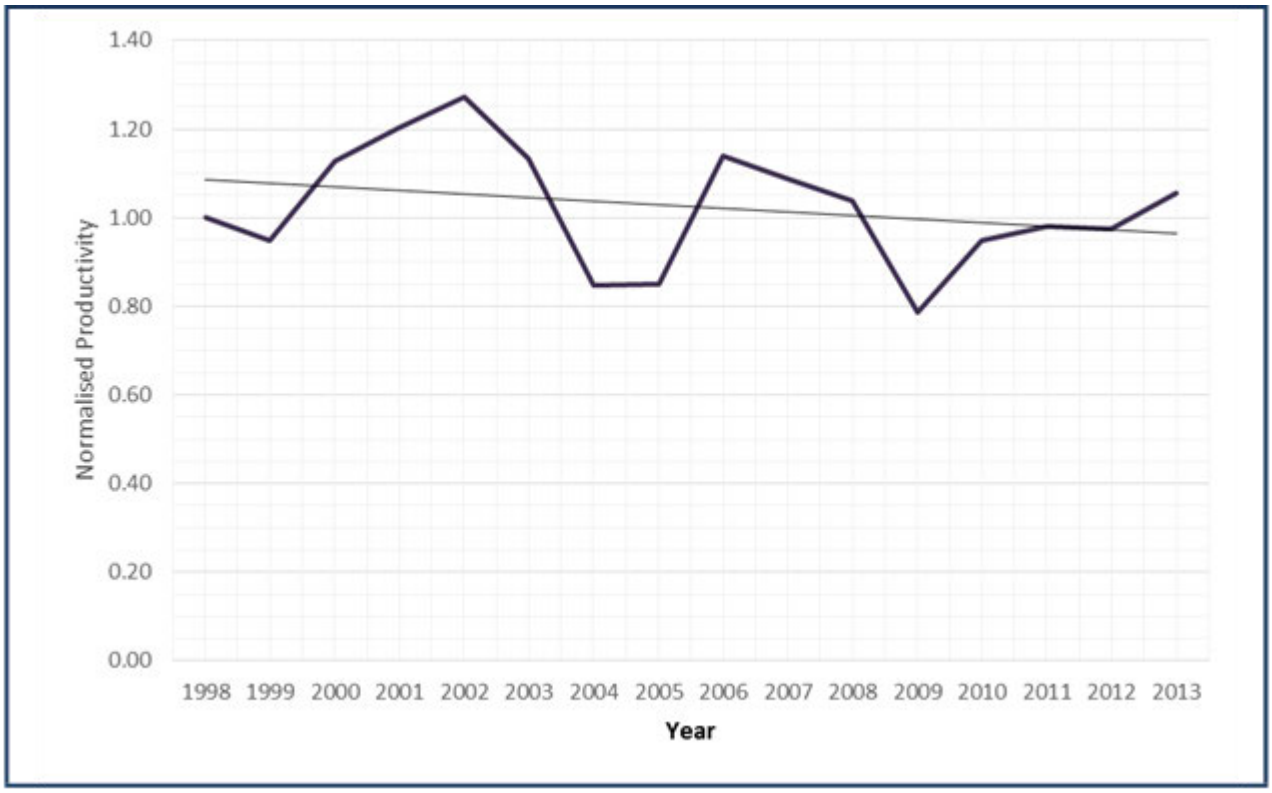

Figure 16: Productivity Trend in Floor & Wall Coverings

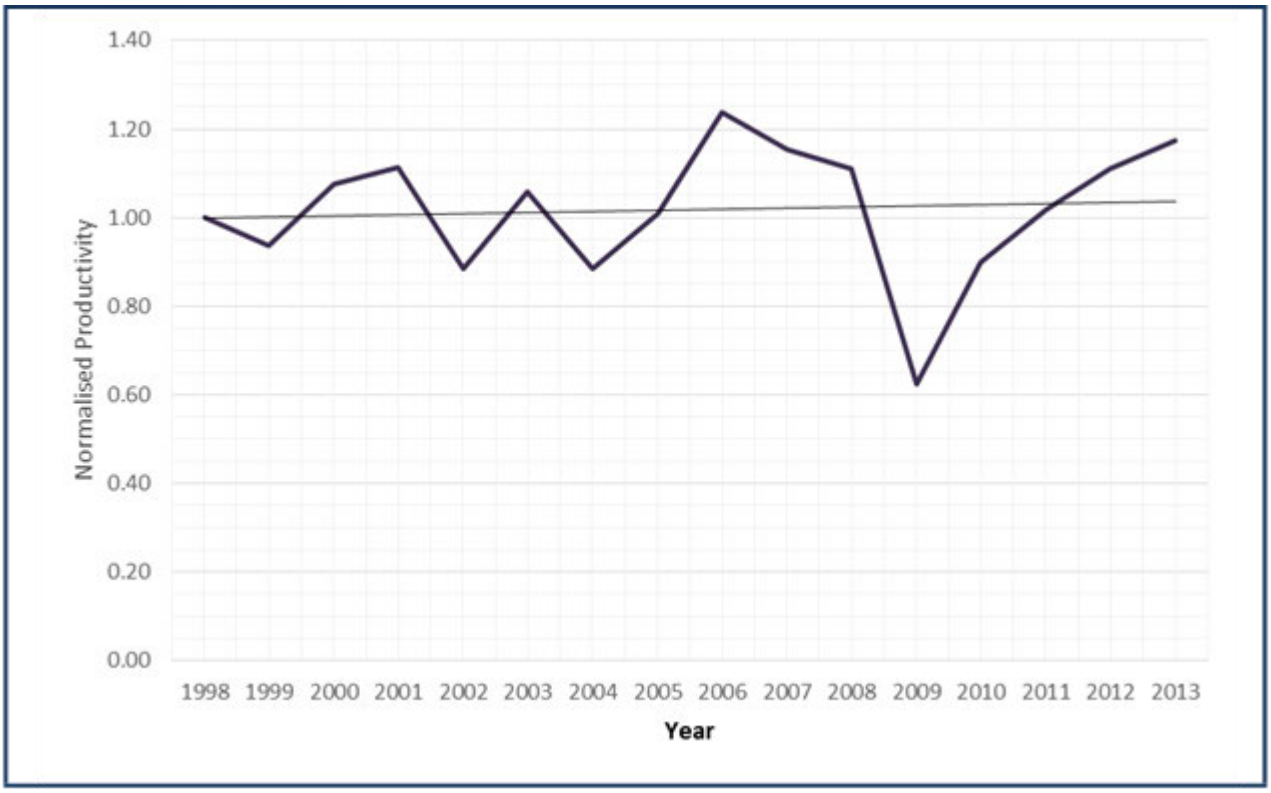

Figure 17: Productivity Trend in Joinery Installation

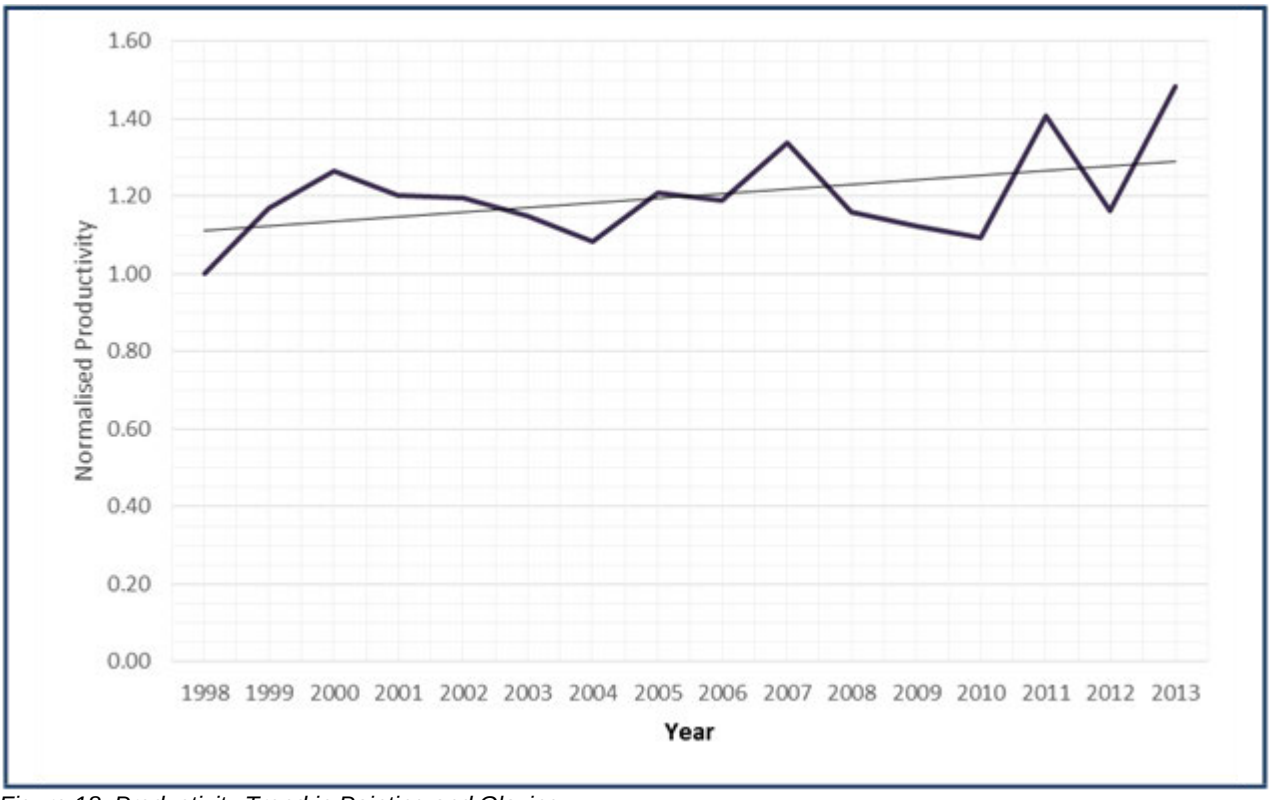

Figure 18: Productivity Trend in Painting and Glazing

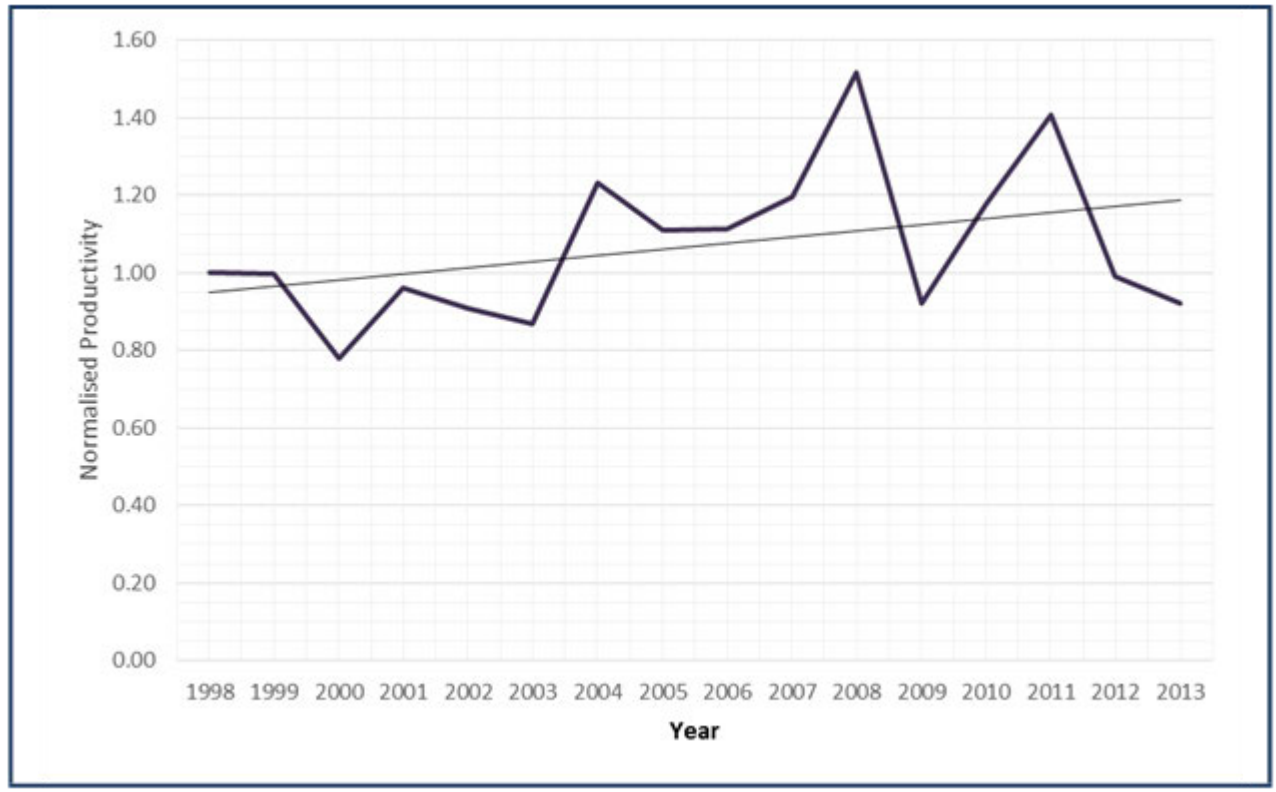

Figure 19: Productivity Trend in Plastering

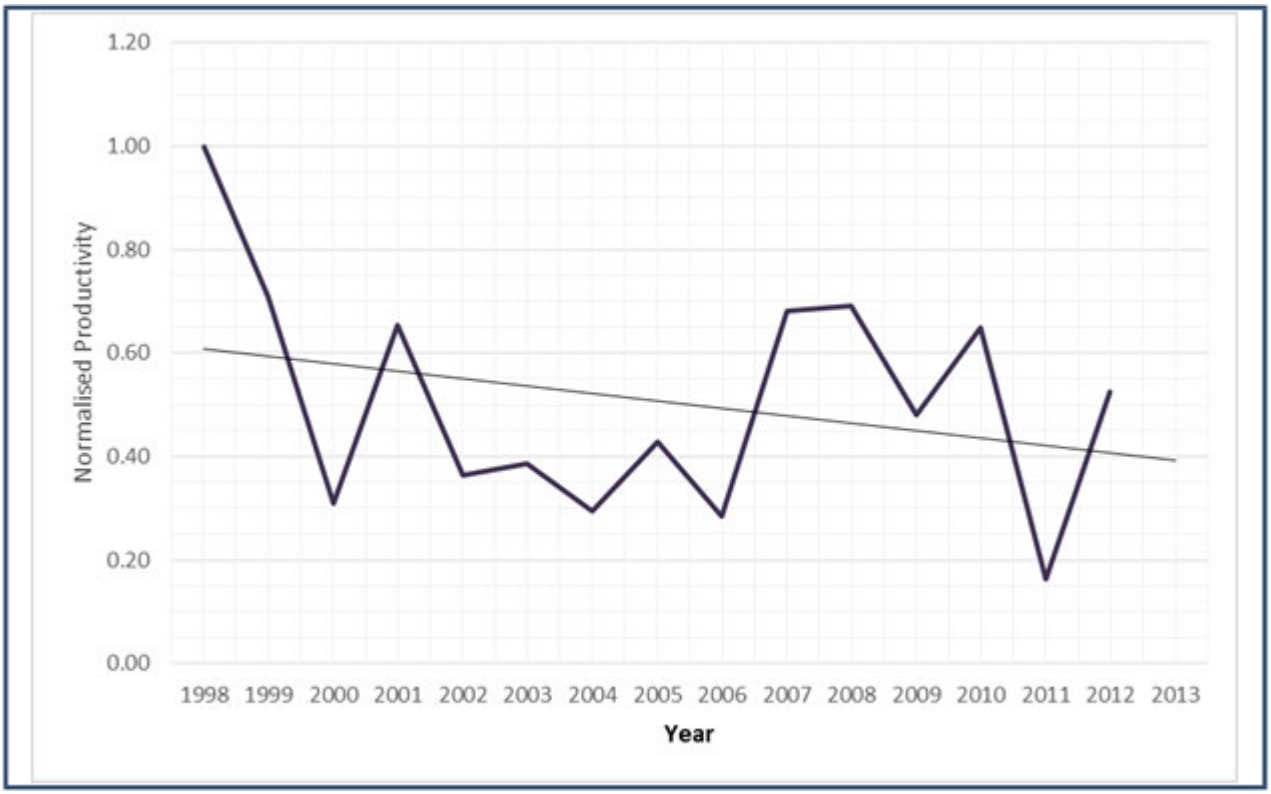

Figure 20: Productivity Trend in Test Drilling and Boring

Study prepared by Whole Life Consultants Ltd from a commission by Experian

Client: Experian

Author: Malcolm Horner Approved by: Mohamed El-Haram Date: 2 December 2015

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