



National Audit Office

Homebuilding: Measuring Construction Performance

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SUMMARY

- 1 This report is about defining Modern Methods of Construction in homebuilding. In particular, it addresses how the Government might move from defining such methods in terms of particular building products and techniques towards a definition in terms of performance and outputs, with the potential to encourage innovation across the whole homebuilding sector, social and private, regardless of construction technique chosen.
- 2 Our research has drawn on expert knowledge contributed by over 70 key stakeholder organisations active in home building. Wherever possible, we have drawn on existing performance indicators to identify the vital few ones which drive behaviour and so affect the construction of housing.
- 3 We have identified a set of performance indicators to form a possible new definition of Modern Methods of Construction which reflect key stakeholder priorities (Figure 1). The indicators cover not only the construction stage but also the performance of the completed property. The detailed definitions underlying these are at Appendix 1.

1 Performance indicators for assessing construction techniques		
	Construction stage	Completed property
Time	<ul style="list-style-type: none"> ■ Duration of Construction – Predictability and Actual 	<ul style="list-style-type: none"> ■ Defect resolution ■ Life span – Predicted
Cost	<ul style="list-style-type: none"> ■ Construction Cost – Predictability and Actual 	<ul style="list-style-type: none"> ■ Whole life costs – Predicted
Quality	<ul style="list-style-type: none"> ■ Number of defects ■ Health and Safety ■ Environmental efficiency 	<ul style="list-style-type: none"> ■ Quality of workmanship ■ Customer satisfaction ■ Environmental impact

Source: National Audit Office

FINDINGS

Homebuilding is a significant part of the national economy

1 Privately owned homes in England were worth over £3 trillion in 2005 and significant amounts of money are spent each year on housing, with large numbers of people employed in the homebuilding sector (**Figure 2**). The private homebuilding firms are among some of the most profitable companies in the construction sector (**Figure 3**).

2 Homebuilding key data

- As at April 2005, there were 21.8 million dwellings in England, of which 15.4 million were owner occupied.
- Privately owned homes in England had a total market value of over £3 trillion in 2005, with an average price of over £200,000.
- In 2005, over £17 billion was spent on the construction of new housing in England, with the majority of this, £15 billion, spent on new private sector housing and £2.6 billion on public sector housing.
- In 2005-06 just over 1 63,000 new homes were completed in England, of which almost 145,000 were privately built.
- The average cost of construction of a new home in 2005 was just over £100,000.
- In 2005, a further £20 billion was spent on maintenance and repair.
- In 2005 roughly 150,000 people were employed in the homebuilding sector.

Source: Department for Communities and Local Government Housing Statistics; Department of Trade and Industry Construction Statistics Annual 2006

3 There were many homebuilders among the 15 most profitable construction companies in 2005

Company	Sales (£ million)	Pre-tax profit (£ million)	Pre-tax profit as a percentage of sales (Per cent)
Henry Boot	101	30	30
ESH Holdings	86	20	23
Persimmon	2,286	495	22
Jelson Holdings	75	15	20
Strata Homes	67	13	20
Morris Homes	148	28	19
Redrow	780	141	18
Wilson Bowden	1,231	216	18
Barratt Developments	2,513	407	16
Bouygues (UK)	100	16	16
George Wimpey	3,003	367	12
Taylor Woodrow	3,477	411	12
Heyrod Construction	68	8	11
Keepmoat	335	33	10
JW Muir	94	9	9

Source: Building Magazine article October 2006, based on an analysis by Plimsoll

NOTE

Homebuilding firms are highlighted in bold.

The Government wants homes to be built more quickly and efficiently

2 High demand for housing, coupled with a lack of supply of new homes, has resulted in problems of affordability in many parts of the country. To address this problem, the Government and its main agencies for delivering new housing, the Housing Corporation and English Partnerships, want to encourage alternative ways of building new homes more efficiently and quickly (Figure 4).

Modern Methods of Construction are currently defined in terms of particular products and methods

3 Modern Methods of Construction have been defined in terms of particular building products and methods which involve various forms of supply chain specifications, prefabrication and off-site assembly, intended to produce better quality homes in less time (Figure 5).

4 The Government has encouraged new ways of building homes

■ The Housing Corporation's Kick-Start Programme (October 2001)

The Housing Corporation allocated £80 million of grant to Registered Social Landlords over 2002-03 and 2003-04 to promote the greater use of Off-Site Manufacture techniques in the new affordable housing they were building. The programme focussed primarily on pre-assembly and Off-Site Manufacture using timber and steel frame and successfully raised the profile of Off-Site Manufacture as an approach with great potential to improve the way that homes are procured.

■ The Housing Corporation's Challenge Fund Programme (2003)

Registered Social Landlords were awarded grant to build 2,600 key worker homes using Modern Methods of Construction.

■ The Housing Corporation's National Affordable Housing Programme 2004-2006

The Housing Corporation sought to meet the Government target that 25 per cent of the affordable housing that it funded should be built using Modern Methods of Construction. Indications are that over 40 per cent will be delivered in this way.

■ English Partnerships

English Partnerships has a target of 25 per cent of homes across all its programmes (both affordable and private housing) being constructed using Modern Methods of Construction, over the two years from April 2005. Where Modern Methods are seen to be most appropriate, a higher target of 50 per cent of homes can apply. Where English Partnerships requires Modern Methods of Construction, it states in its site development brief the specific levels of Modern Methods of Construction to be included, but does not dictate or endorse specific systems or approved suppliers.

■ Barker Review of Housing Supply (March 2004)

The Government commissioned Kate Barker to review the issues underlying the lack of supply and responsiveness of housing in the United Kingdom. In her final report in

March 2004 she confirmed the need for an additional 70,000 –120,000 new private sector homes and 17,000 extra social rent homes each year. She highlighted the need for the homebuilding industry to come up with more innovative ways of building more homes. Recommendation 33 called on the homebuilding industry to develop a strategy to address barriers to Modern Methods of Construction.

■ National Audit Office Report "Using Modern Methods of Construction to build homes more quickly and efficiently" (November 2005)

The Office of the Deputy Prime Minister asked the National Audit Office to investigate the scope for building homes more quickly and efficiently using Modern Methods of Construction. We reported in November 2005 that Modern Methods of Construction can make it possible to build up to four times as many homes with the same amount of on-site labour and reduce on-site construction time by up to half. Building performance can also be at least as good as for homes built using traditional building methods, although the average costs of Modern Methods were higher.

■ Design for Manufacture initiative

To encourage industry to look at how best to construct high quality, well-designed homes more cost-efficiently and to stimulate fresh thinking, English Partnerships, on behalf of the then Office of the Deputy Prime Minister, invited developers in 2005 to submit proposals for the construction of high quality homes for a construction cost of £60,000. Developers were free to use improved ways of employing traditional materials and construction skills, or innovative new methods. The chosen developers would then be given the opportunity to develop homes on 10 sites, 30 per cent of which would be the £60,000 homes and the remainder would be constructed using equivalent processes and cost efficiencies. Between November 2005 and February 2006 developers were selected for all ten sites. The first homes were started on site in Autumn 2006 and will be completed in Spring 2007.

Source: National Audit Office

5 Modern Methods of Construction are currently defined in terms of particular building products and processes

Typical forms of Modern Methods of Construction are:

- **Volumetric construction:** where the whole dwelling is prefabricated off site in modules which are then assembled on site. Modules may be constructed in a variety of forms from a basic structure to fully finished and serviced units.
- **Panelised construction:** where flat panels are produced off-site and assembled on site to produce a three-dimensional structure. The most common approach is to use open panels, consisting of a skeletal structure. More complex, or closed, panels involve more prefabrication typically including lining materials and insulation. Services, windows, doors, internal finishes and external cladding may also be incorporated.
- **Hybrid:** a method also referred to as semi-volumetric that combines both the panelised and volumetric approaches. Typically, volumetric units for highly serviced areas such as kitchens and bathrooms (sometimes referred to as “pods”) are used with the remainder of the dwelling or building constructed using panels.
- **Non-off-site Modern Methods of Construction:** these encompass innovative house building techniques and structural systems typically including technologies such as “TunnelForm” or “Thin Joint Blocks” that fall outside the off-site categories.

Source: National Audit Office

The scope for a new definition of Modern Methods of Construction

4 The demands being placed on the homebuilding sector, in terms of the numbers of new homes it is required to deliver, the quality of these homes and their cost, have increased greatly.

- In December 2005, in its response to the 2004 Barker report, the Government set out its ambition to increase the rate of supply of new housing (both affordable and private) to 200,000 new homes a year by 2016, from 156,000 in 2004-05.
- The environmental standards which new homes are required to meet have increased significantly and will continue to do so. New Building Regulations in April 2006 introduced new standards for energy efficiency in new buildings which represented a 70 per cent increase in energy efficiency requirements since 1990. In December 2006 the Government published the “Code for Sustainable Homes” and “Building a Greener Future: Towards Zero Carbon Development” which proposed a framework for continuing increases in mandatory energy efficiency standards until all

new homes should be zero carbon from 2016. This represents an increase of over 100 per cent over the 2006 standards. Assessments of new homes’ environmental sustainability under the Code started on a voluntary basis in April 2007 and the Government is considering making these assessments mandatory from April 2008.

- In 2004, in response to a report on public sector efficiency by Sir Peter Gershon, the Government set each of its departments a series of efficiency targets to be achieved by March 2008. The Housing Corporation, for example, has to achieve efficiency gains in the amount of grant it gives for the development of new affordable housing of £430 million in real terms between 2005 and 2008 against the baseline year of 2003-04.

5 In response to these higher aspirations, the Government has been working closely with the homebuilding industry on how to improve homebuilding performance and outputs. For example, the Housing Corporation and English Partnerships have been putting greater emphasis on the sector’s performance in delivering the required outputs when allocating grant or choosing development partners, and less on the particular construction methods the sector chooses to deliver improved performance (**Figure 6 overleaf**).

6 The private homebuilding sector has recognised the need for improved performance regardless of the construction method used. In response to Recommendation 33 of the 2004 Barker Report, the Home Builders Federation established the Barker 33 Cross-Industry Group. This Group considered that Modern Methods of Construction should not be defined in terms of particular construction techniques or products but more widely in order to embrace innovation in process, people and product as well as in construction methods and systems. The Group recommended in February 2006 that Modern Methods of Construction could be redefined in terms of the following:

- Greater business efficiency;
- Enhanced design and quality;
- Improved customer satisfaction;
- Enhanced building performance;
- Increased housing supply meeting the aspirations of the market as a whole (open market, social and affordable); and
- Enhanced environmental performance with reduced impact.

6 The Housing Corporation and English Partnerships want to improve homebuilding performance

English Partnerships

- In its Price and Quality Standards for its development partners, which it adopted in September 2005, English Partnerships requires the use of construction techniques that achieve significant efficiencies in terms of delivery and output – whether through Modern Methods of Construction or by other methods, and by building on the lessons learnt in the Design for Manufacture Competition.
- Where English Partnerships does not stipulate Modern Methods of Construction in a development brief, it always requires bidders to otherwise demonstrate construction efficiencies, reduction in waste and clarity on construction supply chains irrespective of the build method or materials used.
- English Partnerships has adopted a working definition of Modern Methods of Construction that is not related to particular construction methods: “the process of deploying efficient project management processes, with a view to providing more product, of better quality, in less time. It may or may not involve the manufacture of components off site; it will certainly involve greater application of processes more akin to manufacturing, for example quality control, component pre-assembly and very good quality supervision.”

Housing Corporation

- In its 2006-2008 National Affordable Housing Programme, the Housing Corporation assessed bids for grant funding in terms of: the bids’ fit with the relevant regional housing strategy; their value for money, in the context of the Housing Corporation’s need for efficiency gains; the quality of the housing proposed; and the deliverability of the proposals. The Housing Corporation expected that there would be very significant use of Modern Methods of Construction because it saw these as a way to deliver the improvement in supply chain management needed to achieve the greater efficiency the Corporation required.

Source: National Audit Office

7 The National Audit Office has published several reports recently on construction and homebuilding

- Improving Public Services through Better Construction (March 2005).
- Report to the Housing Corporation: Value for Grant Comparator (August 2005).
- Using Modern Methods of Construction to build homes more quickly and efficiently (November 2005).
- Building more affordable homes: Improving the delivery of affordable housing in areas of high demand (December 2005).

Source: National Audit Office

How we examined the scope for a new definition

8 We employed Concerto Consulting to carry out the detailed fieldwork for this report. Together we consulted over 70 key stakeholder organisations, through a survey, one-to-one interviews, and a series of workshops. The consulted organisations covered a wide range of stakeholders in the homebuilding process and included many of the largest private homebuilders and Registered Social Landlords. We also carried out desk-based research to identify existing performance measures. More details of our methodology are given at Appendix 2.

9 The aim of our research was to identify a common set of performance indicators for evaluating different construction methods and tracking year on year improvement in a simple and systematic way. We have taken a strategic approach, aiming to identify at the top level only those vital few performance indicators which drive behaviour and therefore affect the construction of housing. We have avoided inventing new indicators and used existing ones, where possible, to ease the adoption of such a set of indicators.

10 We focussed on the outputs of the construction process in terms of deliverables, in addition to the process itself. In doing this we reflected the Government’s overarching objective for housing – delivering the numbers required to the necessary timescale (time), in the right place and of the right quality (quality), at prices people can afford (cost) – through a profitable homebuilding sector.

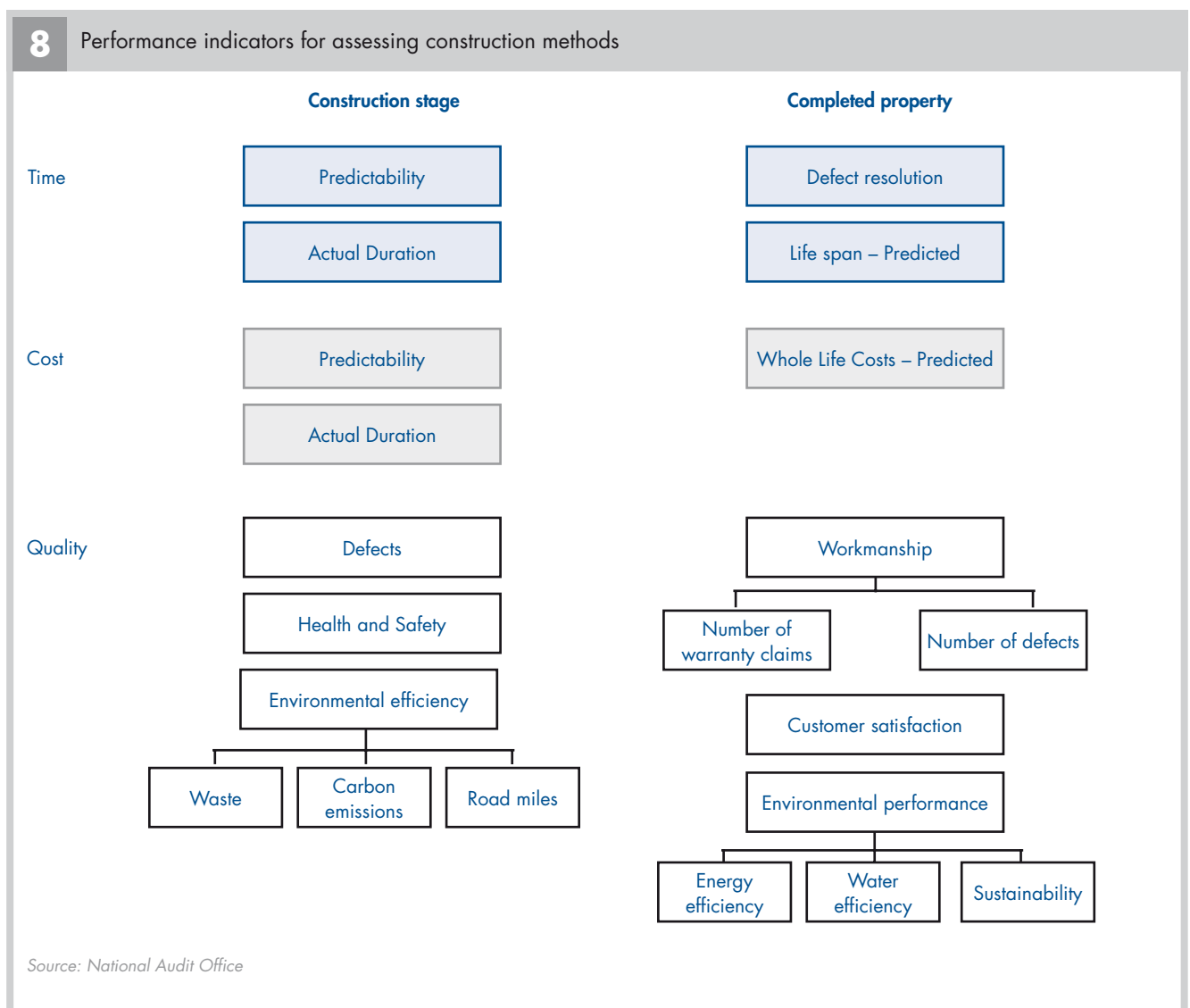
The role of the National Audit Office

7 A new definition of Modern Methods of Construction, which moves from its current definition in terms of particular construction technologies to one based on performance and outputs, has the potential to encourage innovation across the whole homebuilding sector, social and private, regardless of construction technique chosen. The National Audit Office is well placed to examine the scope for such a new definition on behalf of the Department of Trade and Industry, Communities and Local Government, English Partnerships and the Housing Corporation as we are independent of government departments and have considerable experience across the homebuilding and construction sector (**Figure 7**).

We have identified a set of performance indicators which could form a new definition

11 There are many different performance measures used for homebuilding which are a mix of input and output indicators. From these we have identified a comprehensive set of the vital few performance indicators which could provide the basis for a new output-based definition of Modern Methods of Construction (Figure 8). The indicators themselves are output-based and comprehensive in covering both the construction stage and the performance of the home once complete.

12 These indicators are technology-blind in that they can be applied equally to any construction technique. They can therefore be used to compare the performance of different construction methods and track year on year improvements in performance. The detailed definitions underlying these are at Appendix 1.



13 By measuring the performance of different construction techniques, the indicators we have identified could help to inform stakeholders when comparing one technique against another. However, any decision about which technique to use will go beyond the consideration of these indicators alone. Other factors at other stages of the homebuilding process can also impact on the construction stage (**Figure 9**).

The performance indicators are based on existing measures

14 There are currently a number of different schemes for measuring the construction of new homes (**Figure 10**). Each contains many indicators measuring different aspects of performance. We have restricted our performance indicators to those that stakeholders see as the most important.

9 Other factors can influence the choice of construction method

- By identifying the numbers of new homes which local planning authorities will allow in an area and the timescales involved, Regional Housing Strategies and Local Development Plans help provide the certainty which firms need to invest in the production facilities necessary for many innovative construction techniques.
- Obtaining planning consent can be a lengthy and uncertain process, mitigating against the use of modern construction methods where the production of off-site elements has to start well in advance of the actual start of construction on site.
- Planning committees can be reluctant to embrace modern construction methods as they perceive that they produce poor quality homes with a short life span.
- Homebuilders may favour construction methods which are more able to accommodate late design changes in a way that Modern Methods of Construction, with their long lead times, may not.
- Completed homes must be mortgageable and insurable if they are to sell. Homebuilders therefore need be satisfied that any new method of construction will meet these criteria.

Source: National Audit Office

10 We examined six different schemes for assessing homebuilding performance

Homebuilders' Key Performance Indicator Toolkit

This Constructing Excellence scheme measures the following aspects of housing construction and the performance of the completed home:

- Profitability
- Productivity
- Design and construction time – Predictability and actual duration
- Design and construction costs – Predictability and actual outturn
- Defects
- Safety
- Respect for People
- Environmental performance: Product and Process
- Housing quality
- Client and resident satisfaction

EcoHomes

New homes are rated for their environmental performance and energy efficiency. For example, currently all English Partnerships homes are required to have an EcoHomes rating of "Very Good".

Code for Sustainable Homes

The rating covers a number of aspects of environmental performance, including the energy and water efficiency of a new home and the environmental impact of the materials used in its construction.

Lifetime Homes

Completed homes are assessed for the flexibility and adaptability of their design.

Secured by Design

New homes are accredited by the local police service for the extent to which they have been designed with home security in mind.

Building for Life

Under this scheme housing developments are assessed for the quality of design of the housing and its environs. Aspects covered include public spaces, car parking, access to community facilities and transport links.

Source: National Audit Office

15 The proposed performance indicators are consistent with other initiatives that the Government has undertaken to assess and improve the performance of the homebuilding that it funds (Figure 11).

11 The Government has taken a number of steps to improve its homebuilding performance

Housing Corporation

The Housing Corporation uses the Value for Grant Comparator, prepared with the assistance of the National Audit Office, to rank Registered Social Landlords' relative performance in delivering new homes across three weighted indicators:

Economy (weighted at 50 per cent)

- Grant per unit
- Grant per person
- Whole life cost

Quality (weighted at 30 per cent)

- Unit size
- Unit layout
- Accessibility
- Sustainability
- Overall

Timeliness (weighted at 20 per cent)

- Speed of delivery
- Predictability

The Housing Corporation also uses an Operating Cost Index to assess Registered Social Landlords' costs in maintaining and running social housing.

In April 2007 the Housing Corporation published its Design and Quality Strategy and revised Design and Quality Standards to help the providers of affordable housing to respond to new building and design challenges. The Strategy and Standards identify performance standards for three core elements of new housing: the internal environment; the external environment; and sustainability.

Registered Social Landlords

The allocation of grant by the Housing Corporation is dependent on registration under the Construction Client's Charter which requires the use of Constructing Excellence's Homebuilders' KPI Toolkit (Figure 10). Many Registered Social Landlords have formed benchmarking clubs to compare their performance using these indicators.

Source: National Audit Office

English Partnerships

Through its Price and Quality Standards English Partnerships assesses all project submissions against a clear set of standards which must be achieved across the board before it will consider appointing the developer making the submission. The standards cover the following aspects of performance:

- Design statements
- EcoHomes
- Secured by Design
- Building for Life
- Inclusive design
- Lifetime Homes
- Construction efficiency
- Car parking
- Building specifications
- Land remediation
- Fire
- Integrated tenure
- Site-specific design issues
- Deliverability and long-term management
- Community engagement
- Delivery and financial capacity of the proposal

In its Design For Manufacture competition, English Partnerships is assessing the performance of the chosen developers, their housing designs and construction methods across the following performance indicators:

- Cost
- Manufacturing, construction and supply
- Component life, life-cycle costing and performance in use
- Continuous improvement, lean construction and supply chain
- Innovation and risk management
- Health and safety
- Sustainability and environmental impact
- Replicability of processes

The performance indicators reflect key stakeholders' priorities

16 The proposed performance indicators could help the industry to measure its performance in meeting the increasing demands placed on it as listed at paragraph 4:

- The indicators include a measure of the length of time of the construction stage. Speedier construction will help the industry meet the requirement for an increased number of new homes each year.
- There are measures of energy efficiency and environmental impact of both the construction process and the property once completed. Use of these indicators will help the industry to measure its progress in meeting the new standards in these areas.
- Measures of the actual costs of construction and life-cycle costs of the completed property will help the Government achieve its requirement for efficiency savings.

17 The measures cover the aspects of performance that the Barker 33 group recommended should form the new definition of Modern Methods of Construction – business efficiency; quality of the completed building; environmental performance; and customer satisfaction (paragraph 6).

18 The indicators address the interests of the customer, covering many aspects of construction performance that will be important to the customer: the number of defects that arise on a new home and the speed with which the homebuilder resolves these, as well as the costs of running the house.

APPENDIX ONE

Performance Indicators

This Appendix describes in more detail the performance indicators for assessing excellence in housing construction and the completed home which forms the new output-based definition of Modern Methods of Construction.

Construction

TIME

Predictability and Actual Duration

Purpose

To measure the predicted and actual time taken for the factory build and on-site construction of the new home and compare the two.

Definition

Construction Time: Time between Start on Site and Practical Completion stage gates of the process.

Factory Build Time: Time between Contract with Supplier and Start on Site stage gates of the process.

We have included different definitions to reflect the fact that using Modern Methods of Construction often involves placing orders for the offsite manufacture of specialist components with long lead times, before construction starts on site.

Method

Obtain the values of:

- Estimated Factory Build Time
- Actual Factory Build Time
- Estimated Construction Time
- Actual Construction Time

Performance against prediction can then be calculated as:

$$\frac{\text{Actual Time} - \text{Estimated Time}}{\text{Estimated Time}} \times 100\%$$

Estimated Time

COST**Predictability and Actual Cost**

Purpose

To measure the predicted and actual cost of the construction of the new build project and compare the two.

Definition

Costs should include only those costs directly related to the construction of the individual properties, including the cost of components fabricated offsite. Examples of costs to be excluded are the costs of land acquisition, design, site remediation, access work and landscaping.

Method

Obtain the values of the:

- Predicted/Estimated Construction Cost per square metre
- Actual Construction Cost per square metre

Performance against prediction can then be calculated as:

$$\frac{\text{Actual Cost per square metre} - \text{Predicted/Estimated Cost per square metre} \times 100\%}{\text{Estimated Cost per square metre}}$$

QUALITY**Defects**

Purpose

To assess the impact on the Commissioning Client/Purchaser of any defects at the point of handover of the completed new home.

Definition

Condition of the completed new build in respect of defects at the point of handover, using a 0–10 scale, where:

- 10 = Defect free
- 8 = Some defects with no significant impact on the client
- 5 = Some defects with some impact on the client
- 3 = Major defects with major impact on the client
- 1 = Totally defective

This definition is the same as that used by Constructing Excellence.

Method

Survey conducted on completion of the new build project to determine the Commissioning Client's/Purchaser's assessment of the condition of the project with respect to defects using the 0–10 scale.

Health and Safety

Purpose

To identify the number of accidents involved in the construction of new homes.

Definition

Our definition builds on that used by Constructing Excellence but differentiates between on-site and off-site operations to reflect the fact that many Modern Methods of Construction involve off-site manufacture of components:

- Reportable accidents per 100,000 employed per year on-site for the Main Contractor's company including on-site self-employed operatives and on-site sub-contractors.
- Reportable accidents per 100,000 employed per year off-site for the Main Contractor's company including off-site self-employed operatives and off-site sub-contractors.
- Reportable accidents per 100,000 employed per year for the portfolio of new build projects carried out by the Commissioning Client.

Health and Safety *continued*

Method

Details on how these are measured are included in the Constructing Excellence publication "*Constructing Industry Key Performance Indicators: New Build Housing Key Performance Indicators – Methods of Measurement*".

Environmental Efficiency – Waste

Purpose

To assess the environmental impact of the construction process by measuring the amount of waste removed from site during construction process.

Definition

Our definition builds on that used by Constructing Excellence but differentiates between on-site and off-site operations to reflect the fact that many Modern Methods of Construction involve off-site manufacture of components:

- The amount of waste (including extracted material, demolition waste, etc.) in cubic metres removed from site during construction per £100,000 of project value (m³/£100,000). The time period is Start on Site to Construction Completed/Available for Use.
- The amount of waste in cubic metres removed from the factory during completion of order per £100,000 of project value (m³/£100,000).

Method

Details on how the on-site indicator is measured is included in the Constructing Excellence publication "*Constructing Industry Key Performance Indicators: Environment Key Performance Indicators – Methods of Measurement*". Currently, data on the off-site performance is not collected.

Environmental Efficiency – Carbon dioxide emissions

Purpose

To assess the environmental impact of the construction process by measuring the amount of CO₂ emissions caused by the energy consumed during this stage.

Definition

Our definitions builds on one of those used by Constructing Excellence but differentiates between on-site and off-site operations to reflect the use of off-site manufacture in many Modern Methods of Construction:

- The amount of CO₂ emissions caused by the energy used on site during the construction process per £100,000 of project value (kg CO₂/£100,000).
- The amount of CO₂ emissions caused by the energy used during the offsite fabrication process per £100,000 of project value (kg CO₂/£100,000).

Method

Details on how emissions from on-site activity are measured are included in the Constructing Excellence publication "*Constructing Industry Key Performance Indicators: Environment Key Performance Indicators – Methods of Measurement*". The same methodology can be used to assess emissions from off-site activity.

Environmental Efficiency – Road Miles

Purpose

To assess the environmental impact of the construction process by measuring the amount of transportation involved in constructing new homes.

Definition

Our definition builds on one of those used by Constructing Excellence – distance travelled – as being the most appropriate measure of the carbon footprint of the transport impact of the construction process. Our definition differentiates between on-site and off-site operations to reflect the fact that many Modern Methods of Construction involve off-site manufacture of components.

- The number of road-miles travelled by on-site operatives during construction. The time period is Start on Site to Construction Completed /Available for Use.

Environmental Efficiency — Road Miles *continued*

- The number of road-miles travelled by off-site operatives delivering to and from the site during the Deliver New Homes process. The time period is Start on Site to Construction Completed/Available for Use.

Method

Either during construction and/or on completion of the project, ascertain:

- The number of road-miles travelled by on-site operatives during the construction process per £100,000 of project value. The time period is Start on Site to Construction Completed/Available for Use.

$$\frac{\text{Number of Road Miles} \times 100,000}{\text{Project Value (£)}}$$

- The number of road-miles travelled by off-site operatives delivering to and from the site during the construction process per £100,000 of project value. The time period is Start on Site to Construction Completed/Available for Use.

$$\frac{\text{Number of Road Miles} \times 100,000}{\text{Project Value (£)}}$$

Completed home

TIME**Defect Resolution Time**

Purpose

To measure the impact on the Occupier/Commissioning Client of the time taken for contractors to resolve defects identified after handover.

Definition

Customer satisfaction with the contractor's performance in dealing with defects arising during the defects resolution period following the new home's completion, using a 0–10 scale, where:

- 10 = All reported defects resolved in a timely and responsive manner
- 8 = Most reported defects resolved in a timely and responsive manner
- 5 = Some reported defects resolved in a timely and responsive manner
- 3 = Few reported defects resolved in a timely and responsive manner
- 1 = No reported defects resolved in a timely and responsive manner

Method

Survey conducted three months following completion of the new home's defects resolution period to determine the Commissioning Client's/Occupier's assessment of the contractor's response to dealing with any defects arising, using the 0–10 scale.

Lifespan — Predicted

Purpose

To identify the predicted life-spans of a property built using a particular construction method.

Definition

The predicted lifespan of the new homes in years.

Method

Predicted Lifespan: Estimate (in years) supplied by developer/builder at Contract on Site/Commit to Invest stage-gate, as supported by valid assessments of component durability.

While there is much data on the performance of various construction components and technologies, mainly traditional, useful data on the actual life span of some new technologies is not yet available because of the timescales involved.

COST**Whole Life Costs — Predicted**

Purpose

To measure and compare the predicted cost in use of the property over its lifespan.

Definition

The predicted whole-life cost of the new homes.

Method

Obtain the value of Predicted/Estimated Whole Life Cost per square metre at Construction Completed/Available for Use, as supported by valid assessments of component durability.

QUALITY**Number of Defects/Warranty Claims**

Purpose

To measure the quality of the property as built.

Definition

- Number of Defects: Condition of the completed new build in respect of the number of defects arising during the defects resolution period, using a 0–10 scale, where:

10 = Defect free

8 = Some defects with no significant impact on the client

5 = Some defects with some impact on the client

3 = Major defects with major impact on the client

1 = Totally defective

This definition is the same as that used by Constructing Excellence.

- Warranty Claims: Number of warranty claims made during the warranty period (usually the first 10 year's of the property's life).

Method

Surveys conducted of the new home three months after the end of both the defects resolution and warranty periods to determine the Occupier/Commissioning Client's assessment of the defects arising using the 0–10 scale.

Customer Satisfaction

Where customers fall into two discrete categories:

- a) the purchaser/commissioning client of the property;
- b) the occupier of the property.

Purpose

To measure the customers' satisfaction with the completed new build.

Definition

Customer satisfaction with the new build at handover/initial occupation and three months after the defects resolution period.

Customer Satisfaction *continued*

Method

Data could be captured through surveys and/or through interviews/focus groups. It is proposed that a standardised questionnaire is developed, based on existing questionnaires such as that used by the Home Builders Federation, which could be used in both scenarios so as to maintain a consistent approach. It is envisaged that surveys would be the preferred route:

- With the purchaser/commissioning client at handover to the purchaser/commissioning client; and
- With the occupier three months following the end of the defects resolution period.

The number of defects and the contractor's performance in resolving defects could be measured through the same mechanism and at the same time as this measure, incorporated within the same questionnaire.

Environmental Impact – Energy Efficiency

Purpose

To measure the energy efficiency of the property in use. While there are statutory minimum energy efficiency standards for new homes, measurement of performance using this indicator will allow those homebuilders who choose to build to higher standards to gain recognition for this.

Definition

Completed property's energy efficiency rating under the Code for Sustainable Homes.

Method

Rating to be calculated by the homebuilder using the methodology set out under the Code for Sustainable Homes: Technical Guide, published by Communities and Local Government in March 2007.

Environmental Impact – Water Efficiency

Purpose

To measure the water efficiency of the property in use. While there are statutory minimum water efficiency standards for new homes, measurement of performance using this indicator will allow those homebuilders who choose to build to higher standards to gain recognition for this.

Definition

Completed property's water efficiency rating under the Code for Sustainable Homes.

Method

Rating to be calculated by the homebuilder using the methodology set out under the Code for Sustainable Homes: Technical Guide, published by Communities and Local Government in March 2007.

Environmental Impact – Sustainability

Purpose

To measure the environmental impact of the property in use.

Definition

Completed property's overall environmental sustainability rating under the Code for Sustainable Homes.

Method

Rating to be calculated by the homebuilder using the methodology set out under the Code for Sustainable Homes: Technical Guide, published by Communities and Local Government in March 2007.

APPENDIX TWO

Methodology

1 We appointed Concerto Consulting to work alongside us on this project. With their help we carried out desk-based research to identify existing performance measures. We also consulted over 70 organisations involved in homebuilding, via the use of a survey, one-to-one interviews, and a series of five workshops. The consulted organisations covered a wide range of stakeholders in the homebuilding process and included many of the largest private homebuilders and Registered Social Landlords.

Government bodies

- Department of Trade and Industry
- English Partnerships
- Housing Corporation
- Department for Communities and Local Government
- Health and Safety Executive
- Cabinet Office

Registered Social Landlords

- Black Country Housing Group
- Catalyst Housing Group
- Circle Anglia Housing Association
- Family Housing Group
- Genesis Housing Group
- Great Places Housing Group
- Guinness Trust
- London and Quadrant Housing Trust
- Peabody Trust
- Places for People
- Prime Focus Regeneration Group
- Riverside Housing

- Sanctuary Housing Group
- South Somerset Homes
- Southern Housing Group
- Thames Valley Housing Association

Private home builders

- Barratt Developments
- Bellway Homes
- Berkeley Group
- Bovis Homes
- Crest Nicholson
- George Wimpey
- Redrow Homes
- Stewart Milne
- Taylor Woodrow
- United House
- Wates Construction
- Westbury Homes
- Wilmott Dixon

Other industry stakeholders

- Addison and Associates
- Arup Associates
- Association of British Insurers
- Audacity
- Audit Commission
- Brick Development Association
- British Plastics Federation
- Building Cost Information Service

- Building LifePlans
- Building Research Establishment
- Chiltern District Council
- Citigroup
- Commission for Architecture and the Built Environment
- Constructing Excellence
- Construction Products Association
- Council of Mortgage Lenders
- Design for Homes
- Gardiner and Theobald
- Greater London Authority
- HATC Limited
- Home Builders Federation
- Local Authority Building Control
- Mace Business School
- Modern Masonry Alliance
- Morgan Stanley
- National House Building Council
- Oxford City Council
- PRP Architects
- Royal Town Planning Institute
- Steel Construction Institute
- Tarmac Topblock
- Test Valley Borough Council
- The Forge company
- UK Timber Frame Association
- University of Salford
- Williams De Broe