Final Report

24th March 2006

Benchmarking of use of Construction (Costs) Resources in the Member States (Pilot Study)

BWA

CONTENTS

TABLE OF FIGURES

TABLE OF APPENDIXES ETC.

1.0 INTRODUCTION – Backgound to the Study

1.1 Terms of Reference

1.1.1 The detailed terms of reference for the Pilot Study are included at Appendix A, but as an overview the study was required to:

'investigate the factors which influence the relative resource usage and competitiveness in construction industries with particular reference to national framework conditions'

1.1.2 Five specific areas of work were identified in the terms of reference, namely:

- to undertake a review of related construction industry studies carried out over the past 20 years (at both European and national levels);
- to draw conclusions from the studies identified as to the relative efficiency of resource usage between different Member State's construction industries;
- to identify the various factors that affect resource usage in the construction process;
- to draw conclusions as to the impact that these factors have on the efficiency of resource usage;
- to survey a representative sample of public and private construction industry stakeholders to ascertain their views as to the findings of the preceding areas of work.

1.2 Understanding the work to be performed

1.2.1 The research team's understanding of the work involved was demonstrated in detail in para 2.1, of the proposal dated September 2004.

1.2.2 In the course of the study the team identified further specific pieces of work which were required in order to optimise the outcome of the project.

1.2.3 The first involved the classification of the relevant research reports identified (see Section 4.0) in terms of content; it was further deemed desirable to build an Access database and populate it with details of all reports considered – classified to the level of detail appropriate to their relevance.

1.2.4 This work, which was additional to that envisaged when the original proposal was submitted, made the retrieval of relevant data infinitely quicker and also forms a platform for recording and sorting reports identified later in the project and, indeed, post-completion.

1.2.5 This database has been placed in the public domain being freely downloadable from the project web-site (see below).

1.2.6 It was also deemed desirable to create a web-site dedicated to the project. This was to ensure maximum exposure for the research, to provide easy access to the downloadable questionnaires and reports database and also to give password access to information for the scrutiny of the research team's Advisory Group.

1.2.7 With the exception of the above additional activities all the other components of the proposal were carried out as planned.

2.0 THE METHODOLOGY USED

2.1 Original Programme

2.1.1 In accordance with para 2.4 of BWA's original proposal a preliminary Schedule of Activities (subject to confirmation) was presented to the Commission at the first Monitoring and Steering Group (MSG) progress meeting in Brussels on 29 April 2005.

2.1.2 This Schedule (see Appendix B) was amended to indicate the project being completed by the end of December 2005.

2.1.3 At the beginning of June 2005 BWA produced a draft revision to the Schedule of Activities which indicated the revised completion date; it also incorporated the requirements of the Commission with regard to presentation of the progress and final reports and also the various project meeting dates as agreed at the MSG meeting on 29 April 05.

2.2 Revised Programme

2.2.1 By that time, however, it was apparent that the contacts needed for the purposes of starting the key informant interviews had not come into place during the early part of the programme due to the month lost at the outset. This meant that the informant interview process would need to be re-structured so that it continued throughout both the 'first-strike' and 'comparison' study stages.

2.2.2 A further revised schedule was drawn up following the Workshop on 7 July 05; this is included at Appendix B. An extension of the contract programme was granted to embrace the revised completion date.

2.2.3 This programme indicated the 'first-strike' study being completed by mid-September 2005 with the informant interviews continuing through the 4 country 'comparison' stage. This end date coincided with completion of the 'Review of Previous Studies' and initial results from the questionnaire survey responses.

2.2.4 Because the 'first-strike' study was intended as a high level prototype for the second stage study, it was not essential that all the data from the interviews and surveys should be included by the end of that stage - provided there was a reasonable database of information for all 10 countries. Additional and better data could be fed back into the first-strike model as and when available later in the programme which, in fact, made it more robust than it would have been had the original programme been pursued.

2.2.5 Furthermore, because the 4 countries covered in the 'comparison' stage study were also part of the original group of 10 countries this procedure still permitted all data received before the end of the pilot study to be incorporated as part of both the 'first strike' and 'comparison' stage activities.

2.3 Programme as finally executed

2.3.1 Considerable efforts were made by the Research Team to persuade Associations, Companies and individuals to provide information, and to afford the team opportunities to gather information which was needed to carry out the research in accordance with the agreed programme. Nevertheless, it proved to be an extremely

difficult task and the necessary responses and meetings were not achieved to the full extent required until the latter stages of the project period.

2.3.2 Although the above delays did not impinge upon the construction of the benchmarking 'model' it did mean that the final population and calibration of the 'model' was not completed until one month from the end of the project period.

2.3.3 The programme as finally executed is at Appendix B.

2.3.4 Although this delay in the planned sequence of activities was inconvenient to the Research Team it did not in any way prejudice the quality of the outcome of the project.

2.3.5 The project was completed within the extended time-frame. Some revisions requested by the sponsor following the Validation Workshop on 16th January 2006 were added into the Draft Final Report which was finalised by 28th February 2006.

2.3.6 An Addendum incorporating important additional improvements to the work which were carried out, at the Research Team's own instigation, post-completion was submitted to the sponsor shortly following the presentation of this report

2.4 The objectives of each stage

2.4.1 The objectives of each stage were described in the proposal dated September 2004 and are repeated here at Appendix C.

2.4.2 All the objectives were achieved within the rescheduled programme.

2.4.3 Although no commitments were laid down in the Terms of Reference as to the extent of data to be used in the development of the benchmarking model the Research Team wish to place on record that the amount of responses to the questionnaires (see Section 5.5) was disappointing, especially given the efforts made translating them from English into 6 other languages and in disseminating details of their existence and purpose extensively throughout institutions and media in the EU.

2.4.4 Equally, the numbers of companies and personnel who were prepared to give up time to the research team was very limited, in spite of extensive lobbying of nearly all the key official European associations of contractors, producers, and professionals (see Appendix E).

2.4.5 Although the responses were less than hoped for and a disappointing return for the degree of effort involved, sufficient data was able to be gathered from these sources, plus the review of reference material, to indicate the relative efficiency of the countries studied and the most likely reasons therefor.

2.4.6 The Research Team considers that it would be unlikely that a substantial increase in the numbers of responses and interviews achieved would have significantly altered either the structure of the benchmarking model or the general conclusions.

2.5 The Benchmarking Strategy

2.5.1 The definition of 'benchmarking' adopted by the team in the context of this project was:

'the process of comparing a product, service, product - indeed any activity or object – with a view to identifying 'best buy' or 'best practice', and targeting oneself to emulate it' (Bernard Williams – 'Facilities Economics in the EU' and 'An Introduction to Benchmarking' – IFPI Ltd). The process as used in this project is briefly described below

.2.5.2 The process usually comprises two phases:

- 'first strike' benchmarking
- further in-depth studies

2.5.3 In projects of this nature involving comparison of the use of resources it is the Research Team's normal practice to conduct the 'first strike' phase using comparative cost levels to highlight components of the peer group sample which appear to be non-conforming i.e. higher or lower than the peer group norm.

2.5.4 This approach usually entails some adjustment of the cost data to ensure that the scope of works covered in each case is reasonably comparable.

2.5.5 It is also usual at this stage for the sample to contain inconsistencies in terms of levels of quality; however, unless these are already identified it is customary for them to be identified in the 'examination' stage of the 'first strike' benchmarking when preliminary consideration is given to all the possible reasons for any unusually high or low results.

2.5.6 In the Research Team's considerable experience of benchmarking the use of resources the 'first strike' phase nearly always results in the identification of best and poorest performers. Furthermore, those people or organisations whose data is included in the sample are usually well able to explain the anomalies from their own knowledge of the processes involved.

2.5.7 When carrying out 'external' benchmarking i.e. comparing data from different organisations (or, as in this case, different countries) it is always expected that the costs or other data will not be directly comparable. It is therefore important to make every effort to identify the differences and make a sensible - usually pragmatic - adjustment where necessary.

2.5.8 **It cannot be stressed too highly that absolute accuracy is neither necessary nor even desirable in the 'first strike' stage.** The most important issue is the highlighting of any obvious anomalies which may provide a clue as to where best performance might be found.

2.5.9 In this study the principal problems of comparison were no different in terms of complexity than in any other; the issue of 'scope' of content had to be addressed in the data as did the comparative levels of resource costs, **and** possibly construction purchasing power, within each of the national construction industries.

2.5.10 The issue of 'scope' was addressed as described in para 8.3.13.

2.5.11 Regarding 'purchasing power' it was considered that the use of Construction Purchasing Power Parity Indices was not appropriate as a primary source of data regularisation (see para 8.2.11). Indeed, since nearly all the countries in the sample had the Euro as a currency the question as to whether purchasing power parity adjustment was either necessary or appropriate required further consideration.

2.5.12 In many cases the differences observed in **rates of pay** and employment on-costs for site workers bore little correlation to the relative general labour market conditions in each country - see Fig. A.

FigureA: Average construction industry site labour costs compared to general manacturing industry

Average all-in cost in € per hour		
	Construction	Manufacturing
Country	Spons 1999	Cologne Institute 1999*
Belgium		
Average	27.71	21.84
Netherlands		
average	25.18	20.36
Germany		
average	27.61	20.45
Spain		
average	12.02	13.77
Finland		
average	15.11	21.72
Italy		
average	18.30	15.39
France		
average	17.81	18.50
Ireland		
average	15.57	14.27
United Kingdom		
average	16.57	18.62
Denmark		
average	27.81	23.75
Norway		
average	26.75	26.35
Sweden		
average	23.28	20.65
Czech Republic		
average	2.21	3.26

Source: Cologne Institute and BWA

They were found to be dictated more by the demands of the culture of the construction industries with regard to processes adopted, levels of skill and training and the demands placed upon the site operatives and their managers. Employment benefits and on-costs were comparable across most industries in each country though quite variable as between the countries; nevertheless these differences were much less significant than the variations in internal rates of pay and National PPP would not assist in regularising overall costs of employment as between countries – even if that were appropriate. However, as the rates of pay for site labour were found to be linked in with the efficiency of the processes it was concluded that it would in any case be inappropriate to regularise them for purposes of comparing efficiency

.

2.5.13 With regards to raw materials and components there were differences in the prices paid in the various countries – quite marked in one or two instances such as Spain, Italy and the Czech Republic. Nevertheless, in those countries where cheap basic materials were extensively used the processes were generally more traditional and the cost of materials was not more than 30%-40% of the total outturn price. As such, even savings of up to 10% in material prices overall would only affect the project totals by 3%-4% which is not considered a significant variation for purposes of 'first strike' benchmarking comparisons.

2.5.14 In those countries where there is a high degree of off-site prefabrication the cost of components was found to be as much affected by the sophistication of the production process and economies of scale (e.g. export opportunities- see 8.3.25 - 26) as by comparative rates of pay in the factories. For this reason again, the use of purchasing power parity as a primary tool for component cost comparison was considered inappropriate to this study. Nevertheless, a methodology was developed late in the study to regularise this comparison – see 2.5.21-22.

2.5.15 Furthermore, and even more importantly, efficiency of material/component production is one of the factors in the overall consideration of efficiency of the use of resources. Consequently **it was not a factor to be adjusted out but one to be left in as an efficiency indicator for examination.**

2.5.16 For the reasons given above the use of the hourly rate/cost per sq.m index was selected as the most appropriate method of 'first strike' cost comparison given the decision to use project costs as the peer group data (see para 8.1.7).

2.5.17 At this point reference must be made to certain reservations which developed in the Research Team's thinking during the latter stages of the project concerning the extension of the hourly rate/cost per sq.m index for use in the benchmarking model.

2.5.18 The catalyst for this concern was the gradual appreciation of the full significance of the effects of the various construction cultures on the proportions of on-site to off-site production resources. The reasons for, and consequences of, higher rates of pay for on-site workers in certain countries only became fully apparent to the team in the later stages of the project when the index had been built and incorporated in the model.

2.5.19 Although the index as constructed proved to be a valid indicator, not only of relative efficiency but also of the probable reasons therefor, the team was aware that it did not properly reflect the **actual** mathematical relationship between the efficiency ranking positions of each country. This was because in the more industrialised cultures time on site was discovered to be in some cases half of that in the traditional cultures, so excluding a large part of the project cost from the index calculation.

2.5.20 This failure to differentiate between the ratios of on-site to off-site production was emphasized when the use of Construction Purchasing Power Parity (CPPP) was being further considered in the latter stage report writing at the specific request of the project sponsor; the outcome of that extended review is referred to above and in Appendix N. The failure of CPPP to address the consequences of these cultural differences which the Research Team had identified, was also recognised as a weakness of the hourly rate/cost per sq.m index, see paras 8.2.13 – 14, although the latter was considered to have greater validity and usefulness in cross-border benchmarking of construction efficiency.

2.5.21 In the final event the Research Team was able to develop a methodology which generated a cost-based index incorporating the variations in on-site/off-site production proportions and which overcame their reservations about the hourly rate/cost per sq.m Resource Consumption Efficiency index developed in the main body of this Report.

2.5.22 For logistical reasons it was decided, with the agreement of the project sponsor, to incorporate this index, a description of its construction and a suitably reconstructed Benchmarking Model in an Addendum to this Report – see 'Addendum 1'- 'Further development tof the benchmarking model post-Validation Workshop'

2.5.23 The **comparative quality** of the specification included in project costs was undoubtedly an important variable. However, the base data separated out buildings having different performance requirements e.g. 'offices for letting, 5-10 storeys, non air-conditioned' and 'prestige/headquarters office, 5-10 storeys, air-conditioned'. Better classification of quality than this was not available and it was considered that, again, for the purposes of 'first-strike' benchmarking the issue of comparative quality could be considered to have been adequately addressed, particularly as the differences between most of the 60+ building types analysed would not even be as variable as those in the examples given above (see further details at 8.3.13-15). Nevertheless, a methodology for adjusting for quality of specification and construction quality is also included at Addendum 1.

2.5.24 The second part of the 'first-strike' benchmarking process was the comparison of the efficiency with which each country handled the resource drivers – see Section 7.0.

2.5.25 The two parts of the 'first-strike' study were conducted in tandem and in the event the issues highlighted in the comparative cost analysis (see Section 8.0) were ratified by the findings of the resource driver comparison (see Section 7.0).

2.5.26 It was expected that there would be a strong correlation between the results of the two indices emanating from this stage and this was in fact the case. However, by this stage it had been recognised that it would be desirable to adjust the cost-based index to reflect the cultural differences identified in the study (see 2.5.22 and Section 9.0).

2.5.27 **Again it cannot be stressed enough that the study was a 'snapshot' of the average performance of the industry in each country.** Inevitably there are some organisations which out-perform or under-perform their own internal peer group and this was not reflected in the outcome (see example at 5.3.10). Nevertheless, the Research team's experience is that it is not only systems but people that have a large contribution to make in terms of efficiency; a good system with a poor workforce in one country will not beat a good system with a good workforce in another even though the former's best performers may bridge a part of the gap.

2.5.28 Several examples of apparently good practice such as Bouwteam working, decennial insurance indemnity, better training, increased R and D and management improvements were referred to in the literature review and the Key Informant Interviews but these were exceptional to the general rule and would not, of themselves, be identified directly by reference to the core data used, which reflects typical cost levels in each country.

2.5.29 The study was tasked with identifying and weighting the resource drivers and creating a model which could verify these findings, which it has done. In the process examples of best practice such as those given above were identified – not directly from the benchmarking itself but from the process by which it has been carried out.

These important by-products of the process have been captured in the Report alongside the directly obtained conclusions. There will, of course, be other important factors which will be uncovered in the course of any further in-depth benchmarking studies in this field of research.

2.5.30 The original intention was to restrict the sample to 10 countries and narrow that down to 4 or 5 for more detailed appraisal. In the event, data was available from 13 countries and the detailed model was built using data with regard to all of them (see Section 9.0).

2.5.31 Fundamental differences in the cultures of the construction industries in each country were identified and their apparent influence upon the efficiency of resource-usage stated. Therefore as a result of this study it is already possible for countries to consider where they stand in relation to the apparent best performers in the peer group. The decision to investigate further the causes and methods of redressing any perceived inadequacies is, of course, a matter for each country's industry, or individual organisations within any of the countries.

2.6 Quality assurance measures

2.6.1 The Research Team followed strictly the procedures laid down in the proposal dated September 2004 (para 2.6.3).

2.6.2 In particular, the project director and project co-ordinator covered each other's activities throughout the project and were in full communication on every aspect of every activity in the programme at all **stages**.

2.6.3 All communications were by e-mail and have been filed electronically within the system headings listed at Appendix D.

2.6.4 All electronic documents (other than e-mail messages) were held on the BWA network.

2.6.5 All data held on the company's server was backed-up on a daily basis.

2.6.6 A full audit trail through the project including all external communications is therefore available in electronic format.

2.7 Consultations and contacts

2.7.1 Consultations took place with the following groups. associations, companies and individuals:

- The project Advisory Group (see 2.7.0)
- Associations – see Appendix E
- Companies/individuals – see Appendix E
- Press and other media – see Appendix E

2.7.2 In most cases the Associations consulted promised to notify their members of the existence and importance of the project and, far as is known, they did so.

2.7.3 In the event it proved to be more fruitful to rely upon direct contact with individuals within companies than to rely upon the trade associations to encourage their members' participation.

2.7.4 A few contacts within the UK press agreed to promote the project to their readers; known published features are included at Appendix F.

2.7.5 Others eg: 'Building' and 'Construction Europe' expressed considerable enthusiasm for reporting the findings of the study.

2.7.6 Not one of the journals contacted outside of the UK contacted the Research Team for further information. There have been no reports of any published features other than those in the UK-based press (Appendix F).

2.8 The Research Team's own Advisory Group

2.8.1 In accordance with para 2.3.12 of the original proposal dated September 2004 the Research Team approached a number of acknowledged experts in the affairs of the EU construction industry to invite them to become members of the project's own Advisory Group.

2.8.2 A list of individuals who agreed to assist in this way is included at Appendix G. A number of them attended Workshop meetings held in London during the course of the project. Others agreed to comment on the proposals for implementing the project and the draft final report.

2.8.3 Workshop meetings were held in London on 7 July 2005 and 15 November 2005. Minutes of those meetings are included at Appendix G.

2.8.4 The Workshops proved to be a beneficial source of guidance to the project team; in particular, the second workshop yielded valuable output in terms of the Group members' views of the significance of the various resource drivers used in the questionnaires.

3.0 THE EXECUTION OF THE PROJECT

3.1 The principal activities

3.1.1 The principal activities were:

- The literature review
- Development of the questionnaire
- Distribution of the questionnaire
- Key informant interviews
- Analysis of the data
- Development of the benchmarking 'model'
- Conclusions and suggestions for further initiatives
- Production of Addendum 1.

3.1.2 These activities are described in detail in the following sections.

4.0 LITERATURE REVIEW

4.1 Purpose of the review

4.1.1 The objective of the review was to gather as much information as possible at both European and national levels in respect of:

- how such comparisons should be undertaken and how they should not;
- first indications of whether there are apparent differences between countries in the efficiency and effectiveness with which they use resources;
- first list of the main factors – at international, national, regional, industry and project levels – that contribute to national differences;
- indications of which factors are most significant – and whether and how these change over time;
- views on how construction might usefully be disaggregated in the context of physical, functional and financial performance;
- any indications of how the selected countries (see Item 4.1.3) might benchmark against each other – and how this might change over time;
- other important messages.

4.1.2 In the event this review provided data which was used extensively to supplement the information gathered from questionnaire and key informant interviews to form the body of information used in addressing the above issues as well as contributing data for use in developing the benchmarking model.

4.1.3 A further significant contribution of the review was to be the provision of information as to the extent of relevant data available for each EU country in the 'short list' drawn up at the MSG meeting on 29 April 2005 in Brussels ie: France, Spain, Italy, Germany, UK, Ireland, Belgium, Netherlands, Finland, Denmark, Czech Republic, Poland and Hungary

4.1.4 From this list 10 countries were to be selected (including at least one from Eastern Europe) for the 'First Strike' Benchmarking Study at the next stage of the project. Final choice would depend largely on the extent of good data available in respect of each country; such data would be gleaned from this review and the key informant interview/questionnaire exercise described elsewhere.

4.1.5: In the final event Norway and Sweden were also reviewed by the Research Team and included in the study; this was on the basis that good information was found to be available in respect of each.

4.2 International construction comparisons - options and issues - a general overview

4.2.1 From the outset of the project it was recognised that international comparisons fall into two categories:

- qualitative;
- quantitative.

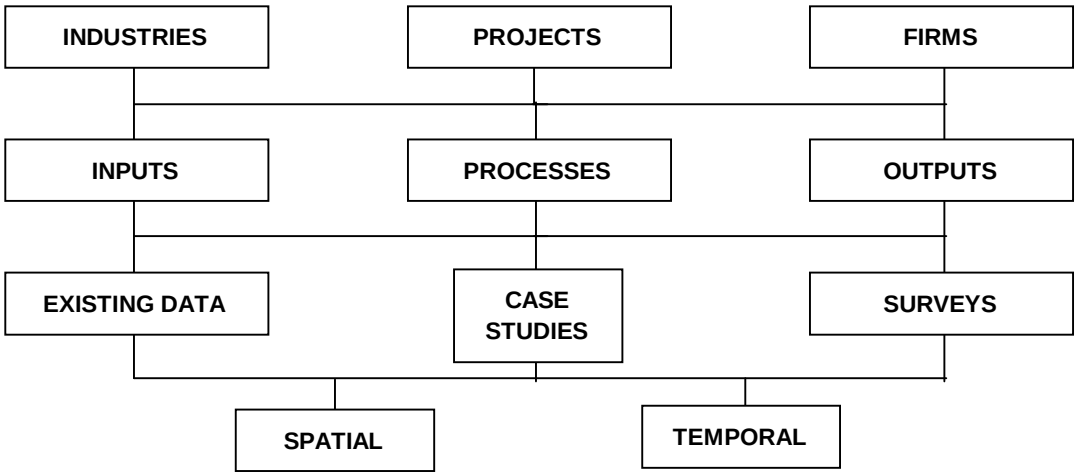
4.2.2 **Qualitative comparisons** rely largely on narrative description to draw out key differences between items being compared.

4.2.3 **Quantitative comparisons** are based on numerical data.

4.2.4 In construction industry research a further sub-category ie: '**representivity**' comes into play. The latter requires that the items being compared are as typical as possible for the country being studied. Eg: when considering the construction of warehouses between countries the projects or data being compared need to be as typical as possible of warehouse construction in each country. The success of such studies depends largely on how well these elements are dealt with.

4.2.5 The construction comparison studies can be of industries, projects or firms. Figure B shows a framework within which such studies can be classified; this review uses this classification in whole or in part with respect to each piece of work studied in detail.

Figure 'B' - The principal options for international comparisons



Source: J. Meikle

4.2.6 The following paragraphs outline the main features of each option and indicate advantages and disadvantages of each.

4.2.7 **Comparisons of industries** – or industry sub sectors (e.g. housing or civil engineering) or regional industries - are representative of countries but they are snapshots at points in time and can be distorted, for example, by the existence (or absence) of major projects. They are also usually highly aggregated – they represent the activities of lots of firms and the outputs of lots of projects and, therefore, conceal as much as they reveal.

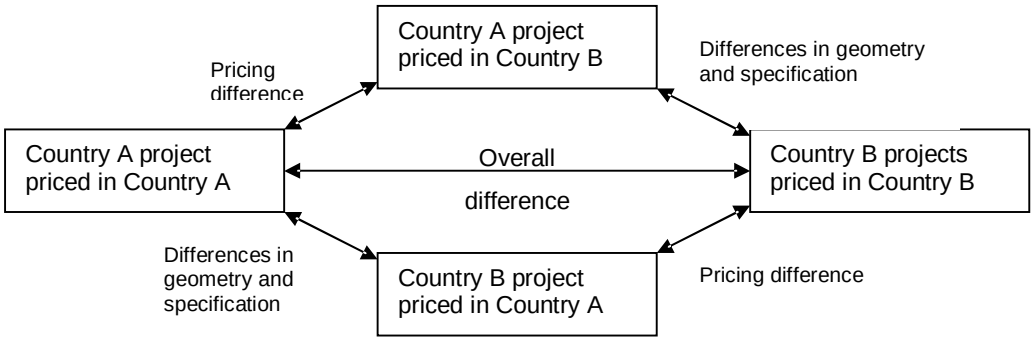
4.2.8 **Comparisons of projects** - are problematic in execution; they embody the comparability/ representivity conundrum. Ideally they involve identical projects built in different countries at the same time. In practice there are inevitable compromises in one or more aspects. Project comparisons can be of physically or functionally identical projects. Physically identical projects are unusual. Occasionally the same client will construct the same project in two or more countries at the same time (an international supermarket chain or an international manufacturing company, for

example) but, even then, sites will be different, ground conditions and climatic conditions will be different and the works will be undertaken in different ways under different regulatory frameworks by different types of firms. The advantage of 'identical' comparisons is that the projects being compared are – more or less – strictly comparable. A disadvantage is that, by being identical, they are relatively unusual and not necessarily representative of either country's construction industry.

4.2.9 Functionally identical projects are projects that respond to the same customer accommodation need but do so in ways that match local social, economic, environmental and regulatory norms. Eg: a family home (for a particular family size and social/income group) can be very different from one country to another in terms of size, accommodation, built form, construction, etc. The advantage of 'functional' comparisons is that they are representative of each country's construction and can be useful in comparing costs and values but it can be difficult (in the absence of assistance from competent and experienced building economists) demonstrating that functionally identical projects are genuinely comparable.

4.2.10 It is possible to disaggregate the physical differences between functionally comparable projects. The diagram below illustrates how this can be done for an international pricing comparison.

Figure 'C' - Disaggregating national difference



Source: J.Meikle

4.2.11 By separating out and evaluating the factors which are different in each member of the sample of projects being analysed it is possible both to compare that which is directly comparable and to learn about the resource drivers pervading the sample as a whole.

4.2.12 The approach requires a great deal of collaborative time and effort in gathering and analysing information about each country's construction and pricing. Nevertheless the process of disaggregation was undertaken at a high level (i.e. with regard to the scope of works included in the cost data) in the course of the benchmarking studies carried out in this project.

4.2.13 **Comparisons of firms** also present a range of problems. As with projects it is extremely difficult to find identical firms in different countries and, unless this is done, it is difficult to understand the detailed effects of different structures, operations, regulatory environments, etc. It is, however, possible and useful to compare aggregated firm characteristics and performance. The size and structure of the industry – nationally, sectorally, regionally – can be informative, as can average firm

characteristics, e.g., employment, turnover, profit, etc. The reliability of these comparisons depends very much on the reporting requirements for firms and the use of common concepts across countries. Generally speaking, requirements and concepts are more common and constant for large firms which makes comparison at that level more valid than for the smaller firms who make up the majority of construction enterprises.

4.2.14 Construction is of course a most diverse operation involving many sectors and sub-sectors. It is therefore very important to ensure that any comparison within and between industries addresses the respective balance of the sub-sectors and keeps comparisons at the sub-sector level in the first instance.

4.2.15 In most benchmarking studies in most industries there is a tendency to measure what is most easy to measure and then to comment on these measures in an analytical way. Construction cost, quantities and time – or some combination thereof – are often the subject of benchmarking studies. Typical metrics include:

- project cost or cost/m²;
- project duration;
- productivity in terms of cost or volume of construction per unit of time;
- production or build rate in terms of m²/day;
- spend rate in terms of €/day or month
- ratio of hourly labour cost to total cost/m² of construction.

Such metrics can be a useful guide to potential differences in performance as between one subject of research and another; insofar as good data of this kind has been available to this project it has been used as both a first indication of comparative performance and a testing ground for the validity of the emerging findings.

4.2.16 **Inputs, processes or outputs** - whether studies are of industries, projects or firms, what is compared will be inputs, processes or outputs. Figure D below sets out examples of these.

Figure D: Examples of content for different comparison studies

	Industries	**Projects**	**Firms**
Inputs	Employment Materials	Labour Materials Equipment Finance Management	Labour Purchases Management
Processes	Standards Legislation Data collection Registration	Procurement Contracts Supervision Management	Contracting Sub-contracting Purchasing Recruitment
Outputs	Output Value added	Cost m^2 or m^3(volume) Euro/£ (value)	Turnover Profit

Source: J.Meikle

The table illustrates the differences and the similarities between different types of study. Inputs and outputs tend to be similar regardless of whether studies are of industries, projects or firms; processes, on the other hand, tend to be quite different. This study has focussed on Projects because of the availability of good data and the skills-base of the Research Team.

4.2.17 **Existing data, case studies or surveys** - generally speaking, data or information for comparison studies will come from three sources:

- existing data or information;
- case studies;
- surveys.

4.2.18 Examples of **existing data** or information include national or industry statistics, corporate data or project data. It will normally, but not always, be based on survey or census data and is often aggregated. The main advantage of existing information is that it is readily available and can be well documented; its statistical reliability, for example, can be tested. Disadvantages include that it can be dated and it may not meet specific requirements. Existing data or information is often most useful for contextual material rather than for direct application as input data.

4.2.19 However, in the Research Team's experience, gathering of data on costs of complex activities (e.g. construction and facilities services) is often unreliable where it is collated at source by people without the necessary financial management skills relevant to the activities in question. Accounting codes are often too coarse to capture the data at the level of accuracy required for benchmarking and the conclusions drawn from inaccurate or imprecise data can be misleading.

4.2.20 Wherever possible data should be used which has been analysed by experts in financial management of the subject matter. Eg: the Building Cost Information Service (BCIS) in UK provides cost analyses of construction projects produced by firms of construction cost consultants/quantity surveyors. [In this research project the data used was compiled by a leading international firm of Chartered Quantity Surveyors].

4.2.21 **Case studies** are usually focused on specific firms or projects. They may involve quantitative data but are often qualitative in nature. The main advantage of case studies is their detail. The main disadvantage is that they are sometimes too specific; it is often difficult to draw generalised conclusions from case study material. Case studies are most useful when they are set in a context of a broad sample of data or survey material where they can be used to illustrate points raised by the wider-ranging analysis.

4.2.22 **Surveys** involve some kind of questionnaire completed by a selection of respondents. The questions asked and the number and selection of respondents will be key determinants of the value of survey results. The more specific the questions and the more representative the survey sample, usually, the better the results; however, as stated above, the questions should not address matters which are likely to be outside of the ability of the respondent to answer them correctly.

4.2.23 The main advantage of well designed surveys is that they elicit responses from a wide range of respondents and can be taken to provide a reliable overview of that sample's overall view on a particular subject. The main disadvantage is that they do not always go into sufficient detail to identify clear cause and effect. Surveys are useful in answering 'what' and 'how much' questions but less so with 'why' and 'how'

questions. [The questionnaires produced by the Research Team for purposes of this project address 'what' and 'how much' in specific terms. The detail incorporated is unquestionably within the knowledge-base of the intended recipients]

4.2.24 **Spatial and temporal comparisons** - international comparisons can either look at 'levels' or 'trends' in the things being compared. Levels or spatial comparisons involve studies at a point in time. Examples include:

- Ÿ the cost of housing;
- Ÿ the volume of construction output;
- Ÿ profitability of joinery firms.

4.2.25 Trends or **temporal comparisons** involve studies of changes over time. They include things like growth rates expressed in percentages per annum. Examples include:

- Ÿ the trend in the consumer price index;
- Ÿ the average annual growth rate in GDP;
- Ÿ changes in productivity.

all over a period of time.

4.2.26 Spatial comparisons are 'snapshots' at a point in time while comparisons of trends over time are a kind of longitudinal study.

4.2.27 The literature reviewed contained examples from each generic source and of each type of comparison.

4.3 Modus operandi

4.3.1 The review was carried out in the following stages:

- Ÿ Stage 1 - prior to the project being awarded the proposers pooled their knowledge of existing research in the field and collected together copies of each relevant document.

- Ÿ Stage 2 - once the project had commenced the reports were first reviewed specifically for the purpose of tracing material identified in the references. This 'snowball' process generated a very large number of 'leads' which, yet produced only a limited amount of directly relevant material.

- Ÿ Stage 3 - the list of reports, etc thus collected was initially set up using an Excel spreadsheet program for ease of reference.

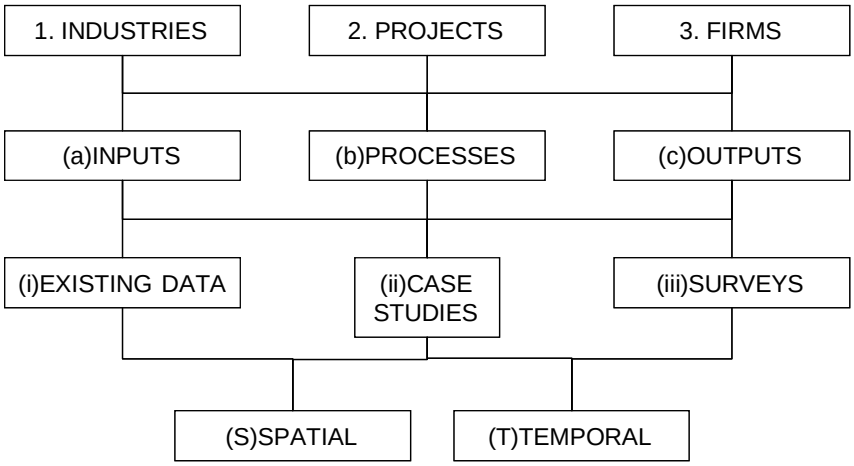
- Ÿ Stage 4 - at the first meeting of the Monitoring and Steering Group on 29 April 2005 attendees were requested to advise the researchers of any relevant projects being carried out in their own countries. This produced references to some significant recent, ongoing and proposed research projects and those available for public consumption were added in to the 'snowball' list.

- Ÿ Stage 5 - a Press Notice was sent out to the majority of relevant Associations and journals in the EU countries under review (Appendix E) and also posted on the project's web-site at www.bwassoc.co.uk/eucon

A later version of this notice (Appendix F) drew attention to the availability of the classified list of reports as a fully downloadable database (see also 4.5).

Ÿ Stage 6 - a system of classifying reports and papers received was then developed using the framework given at Table 1. with an alpha-numerical reference system applied as Figure E.

Figure 'E' - The principal options for international comparisons – alpha-numerical classifications



Source: J.Meikle/BWA

In addition a further classification was introduced:

'4'. Research Procedures and Processes'.

This was designed to embrace material which might be of value to the research team in approaching various aspects of the project and, in particular, data analysis and interpretation.

Ÿ Stage 7 - having assembled and classified the material the next stage was to distil from the material the following information:

- Ÿ names and contact details of researchers who might be able to assist the project in some way;
- Ÿ complete identification of content of relevant reports and papers under the headings given at Figure E above (see also Item 4.6);
- Ÿ initial assessment of the quantity and quality of information available from the material in respect of each of the 'short-listed' countries;
- Ÿ initial analysis of material in the context of its potential use within the Benchmarking Study.

4.3.2 Although the review was essential as a precursor to the rest of the study it was always recognised by the Research Team that the material gathered was more likely to be supportive and complementary to data gathered directly from key informants.

4.3.3 Work on the review continued throughout the project with the final version being produced in a separate document as part of this final report (see Annex 1). Relevant extracts from the review are included at Appendix I and Annex 3.

4.4 Material discovered

4.4.1 As described above the review commenced with a thorough assessment of the research material identified by the research team and their advisors prior to award of the contract.

4.4.2 Details of those studies still considered to be relevant were entered into an Excel spreadsheet and referenced in terms of:

A. Date, title and author(s)
B. Data, title and author(s) of apparently relevant cross-referenced works ('snowball procedure')
C. Availability of material to research team at time of entry
D. Brief description of subject material

A sample page from the 'snowball' spreadsheet is at Appendix H; there were 1,492 entries in the 'snowball' reference list. Much of this material could not at the time be accessed by the team; collaborating members of the project were asked to help in both accessing such material and advising on its value/appropriateness to the project. In the final analysis all directly relevant material was added into the Access database (see Item 4.5 below).

4.4.3 In addition to the 'snowballing' further research material was identified/made available from various sources following commencement of the study; sources included attendees at the MSG meetings, internet searches by the research team by subject matter and attendees at the Advisory Group Workshop meetings on 7 July 2005 and 15 November 2005.

4.5 Information Database

4.5.1 Because of the volume of material uncovered it was considered appropriate to construct a database using Microsoft Access.

4.5.2 It was further considered desirable to use the classification system described at Item 4.3.1 Stage (6) but extended to accommodate the 'content' headings previously given at Figure D in Item 4.2.16.

4.5.3 The final draft classification system consists of a hybrid of the two systems ie: Figure D (subsequently referred to as **Table 1**) and Figure E. This classification system is illustrated in Appendix H – tbl Report Class: Table – which is an extract from the Access database.

4.5.4 The classification strictly in accordance with Figure E (Item 4.3.1 - Stage 6) is given an ID Class prefix 'Fig'; Fig 01 to Fig 10 are the database codes for the alpha-numeric classifications in Figure E.

4.5.5 However, in view of the difficulties encountered in incorporating the contents of Table 1 within the alpha-numeric framework at Figure E it was decided to create a separate classification identity coding system linked exclusively to Table 1 but embracing the first two levels of the Figure E classification system eg:

1. INDUSTRIES
(a) INPUTS, etc

These were given a consecutive ID Class reference using the prefix 'Tab'. Primary Classification of the subject material was based on the highest level of classification in the order used in Table 1 – ie:

Ÿ industries
Ÿ projects
Ÿ firms

Within each of these primary headings the secondary headings ie:

Ÿ inputs
Ÿ processes
Ÿ outputs

were used in turn to prefix the content of the reports.

4.5.6 At Appendix H it can be seen that ID Class Tab 01 relates to:

Ÿ industries (level 1)
Ÿ inputs (level 2)
Ÿ employment (contents – first item)

Tab 02 deals with Industries-Inputs-Materials and Tab 03 then commences the coding for subject material contents within the 'Industries-Processes' subject headings. The classifications for the Tab-prefixed ID Classes use the abbreviations Ind, Pro and Fir as an easily identifiable classification reference for Industries, Processes and Firms for technical purposes. In practice this latter classification does not particularly assist in the interrogation of the database since the actual contents are always displayed in full on the screen eg: in Tab 13 – 'Projects, Inputs, Management' is more user-friendly than merely Pro 05.

4.5.7 The classifications and codings developed for the system have only been applied to a few of the key reports.

4.5.8 Because the development of this system is not an intrinsic part of the Terms of Reference the Research Team were not able to justify further investment of time in classifying material and populating the database beyond the immediately key reference works identified for incorporation in the final stages of the research. However, to demonstrate the way the system works a 'dummy' set of data was created comprising 19 entries with Report IDs from 1500—1519 (inc). At Appendix H the format of the basic Table of Reports is demonstrated; the headings for the Table are self-explanatory.

4.5.9 Each report was also classified in accordance with the countries to which it referred.;. by clicking on any box containing a 'tick' the program will summon up all the reports in the database referring to that country. E.g. Appendix H shows an extract from the list of all the Reports in the database referring to Germany; note that most of these also contain references to other countries as well.

4.5.10 If the researcher wishes to find the content of Report ID No. 1501 the program will take him or her to a screen such as that reproduced in Appendix H; here will be

found details of all the contents classified in accordance with the methodology described in Item 4.5.6.

4.5.11 The researcher interested in finding reports dealing with a particular topic range eg: Firms-output-turnover, would go to the screen demonstrated at Appendix H and, finding it to be ID Class Tab 27, would then be able to access a list of all of the reports in the database having reference to that topic range – see Appendix H.

4.5.12 Other facilities include a search by name of author, reports in possession, dates of reports, key words, titles, and so on.

4.6 Immediate use of the reference material for this project

4.6.1 A general overview of the reference material considered for use in this project can be summarised as follows:

- most material was either too general or too specific (in terms of topic) to be of **direct** use in the early stages of the research
- some of the material provided reinforcement of information, data and conclusions arising out of other activities in the project
- a few of the references proved to be extremely helpful in providing data both for use directly in the benchmarking component of the study and in providing important background information for interpretation of the results
- some reference material did not have an English translation; resources were not available to the project for undertaking extensive translation of material in some languages which, in a few instances, would probably have been beneficial
- none of the material comprehensively addressed the subject matter of this report
- some of the research being carried out in certain EU countries could have been both substantially foreshortened and improved if skilled building economists had been involved or consulted in the process

4.6.2 In the final event it was decided that the best use of the reference material would be:

- to provide evidence as to the generic weight of importance and the relevant achievements of a country's construction industry with regard to any one or more of the 'resource drivers' identified during the project and incorporated in the questionnaires
- to provide background information relating to the levels of, and possible reasons for, efficiency or inefficiency in respect of the use of resources affected by any resource drivers.

4.6.3 The subject matter of the relevant material extracted from the literature was classified and summarised at Appendix 1; this data has subsequently been merged with the data in Appendix M (Details of key informant interviews) at Annex 3 of the electronic version of the Final Report.

4.7 Conclusions from literature review

- The material found was generally not suitable as a first point of reference for detailed analysis
- Spons European Handbook 2000 provided an extremely comprehensive source of data and general information
- 'Building' Survey of International Costs 2005 was also very useful though much less detailed than the Spons Handbook.
- Apart from the above two sources, studies by BWA, EC (Secteur), Business Round Table (all early 1990s) proved to be the only other **comprehensive** sources of relevant data
- A handful of studies provided useful inter-country comparisons – but limited in terms of number of countries, topic, category of development etc
- There are many excellent and useful macro-economic and econometric references
- Future classification of research reports using the one developed here or a similar system would benefit both authors and readers
- Further development/population of the database would be highly beneficial to future research in this and related fields
- Very little of the literature contained material which was in serious conflict with the Research Team's findings, although some attempts to compare efficiency using macro-economic indicators such as' value-added' did not conform for reasons elaborated upon in the text.
- There was evidence of a widespread lack of awareness amongst researchers concerning the discipline and application of building economics as developed and pioneered by the UK quantity surveying profession since the 1960's. This is now to be observed in practice in isolated pockets worldwide. However, an educational syllabus for the discipline of 'European construction economists' drawn up by the EU in 1989 (see database ref.1760) appears never to have been implemented. [The apparent anomaly between the important UK-driven development of the discipline of 'building economics' and the poor performance of the UK construction industry identified in this and other studies is worthy of further study in its own right]

5.0 DEVELOPING THE PROTOTYPE 'EFFICIENCY INDEX' MODEL

5.1 The objectives of the model

5.1.1 The objectives of the model were threefold:

- to identify the relative efficiency of each country in the use of construction resources.
- to identify the factors which influence the level of efficiency in each country.
- to enable countries to establish their own level of performance by comparison with others and identify areas where improvements could be made.

5.2 Efficiency versus effectiveness

5.2.1 The project was specifically concerned with the **efficient** use of construction industry resources in the process of delivering the building to the building employer's stated requirements. Within the context of the discipline of **value management** there is a possibly more significant issue to be addressed i.e. the **effectiveness** or usefulness of the building as delivered to the building owner.

5.2.2 A common measure of such effectiveness is the **return on investment** in the facility. The Research Team's view on the correct way to assess the added value of increased building performance is that any resources consumed by a project over and above a '**zero-base**' has to deliver a return on investment as good as, or better than, the employer's criterion rate of return. 'Zero-base' is defined as 'the least performance which could legally meet the employer's basic functional requirements without any optional extras'. E.g. a simple non-air-conditioned office building might meet the employer's basic needs in respect of space and facilities; a better elevational appearance and internal environment would only be justified if the quantified additional benefit gave an adequate return on the additional 'above-zero-base' expenditure.

5.2.3 The **effectiveness** of a building is generated in the briefing phase when the building employer, who is often inexperienced in building matters, depends upon his design team to help him to decide on the shape, size and specification most appropriate to his needs.

5.2.4 In a macro-economic context it is this **effectiveness** aspect of value management which is the most critical; not only does it impact upon the **actual level of resources used** (including finance) but also it will have a significant impact on the commercial or social efficiency of the activities it accommodates.

5.2.5 Errors in the value management process can take the form of:

Ÿ 'over-design'
Ÿ 'under-design'

'Over-design' means the generation of requirements for consumption of resources greater than needed to meet the brief, and 'under-design' is the opposite. Both these errors stem from an inadequate value management regime. Whether or not they trace back to faulty briefing or misinterpretation (possibly carelessness) in the design development phase these deficiencies in the design process always impact upon the **effectiveness** of the output.

5.2.6 Some of the experts consulted during the study used the term 'non-quality' to describe that part of the resource consumption of a project which does not add value to the output. The Research Team prefer to use the term which they have developed for use in connection with their formal approach to value management ie: '**redundant performance**'

5.2.7 In the context of the construction process 'redundant performance' may be described as 'that part of a product or process which generates consumption of resources which are not beneficial to the output'.

5.2.8 The term 'beneficial to the output' can be applied in the context of both **efficiency** and **effectiveness**.

5.2.9 In the case of **effectiveness** 'redundant performance' relates to generation of (costs) resource consumption in the provision of features of a product not needed to support the (user) business requirement.

5.2.10 In the case of **efficiency** 'redundant performance' relates specifically to resources which are consumed in the construction **process** which do not contribute to the achievement of the intended performance of the product; here the required functional performance is not at issue – merely the performance of the manufacturers in delivering the product.

5.2.11 Another term used to indicate 'redundant performance' is '**non-contributory resource input**'.

5.2.12 Value management as a discipline requires the elimination of **all** redundant performance. This means that it must address and eliminate 'non-contributory resource input' both in terms of the **effectiveness** of the product as per the brief and the **efficiency** of the production process.

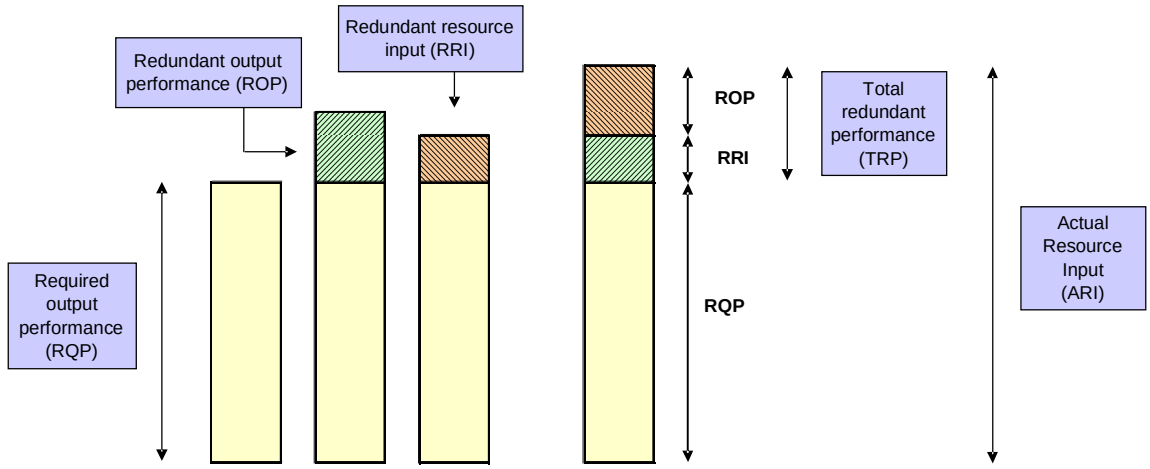
5.2.13 Two examples illustrating the subtle differences in these definitions are as follows:

5.2.14 In the first example an architect and his client may agree that a particular design feature (eg: decorative brickwork) would improve the 'image' of the occupier. The additional resource input would need to be justified in value management terms by calculating the extra cost and setting it against the likely benefits to be derived. Even if the feature results in an increased consumption of construction resources the extra resource input may be justified by the value of the output to the user.

5.2.15 In the second example the decorative brickwork is designed in such a variegated pattern that there is little opportunity to develop a 'learning curve' in the process. If an equally beneficial output could have been achieved with less variegation and better 'buildability' then the extra resources consumed over and above the basic decorative solution would be 'non-contributory resource input' in respect of the production process.

5.2.16 Insofar as this research project was concerned with the influence of design on the **efficient** use of resources the Research Team had to draw a theoretical line between the two scenarios painted above and focus specifically on the impact of the latter type of inefficiency and its prevalence, or otherwise, in each country.

Figure 'F' - The implications of design and production on the consumption of resources



Source: Bernard Williams Associates

5.2.17 Figure F illustrates the effects of the above scenario on creation of redundant performance. In the first case the designer (or the briefing party – or both) has over-provided in terms of functional performance. In the second case, the production process has over-provided the use of input resource relative to the requirements of the product as designed and specified. The Figure further demonstrates the combined effects of over-provision of resources which has occurred in meeting both functional and production requirements.

5.2.18 The focus of this project was, however, on the **efficient** use of construction resources. As such, it has not dwelt upon this wider application of value management; rather it has concentrated exclusively on the activities that extend from the briefing stage insofar as they impact upon the **efficiency** of the construction process i.e. the first case discussed at 5.2.15 above and illustrated as RRI in Figure F.

5.2.19 Just to further complicate an already complex theoretical distinction it must also be recognised that an **efficient** use of input resources can still result in an **ineffective** or inadequate building whilst, at the same time, **inefficient** usage of resources in production may yet deliver an **effective** output.

5.2.20 The impact that design has upon the output must also of course be investigated in depth, but in this research project only from the point of view of how it influences the **efficiency** of the use of resources during the construction process not the **effectiveness** of their output.

[N.B. Para 2.2.1 (Concentrating the Research) of BWA's proposal dated September 2004 specifically refers to the above interpretation of the brief for this project].

5.3 The resources

5.3.1 The research team used their own extensive knowledge of the construction industry to generate the list of generic headings for 'resources' under which to study the efficiency of usage of resources.

5.3.2 It was considered appropriate to extend the primary classification into sub-categories related to their deployment within the industry. The result of the findings is summarised in Figure 'G'

Figure 'G' - Scope of Resources

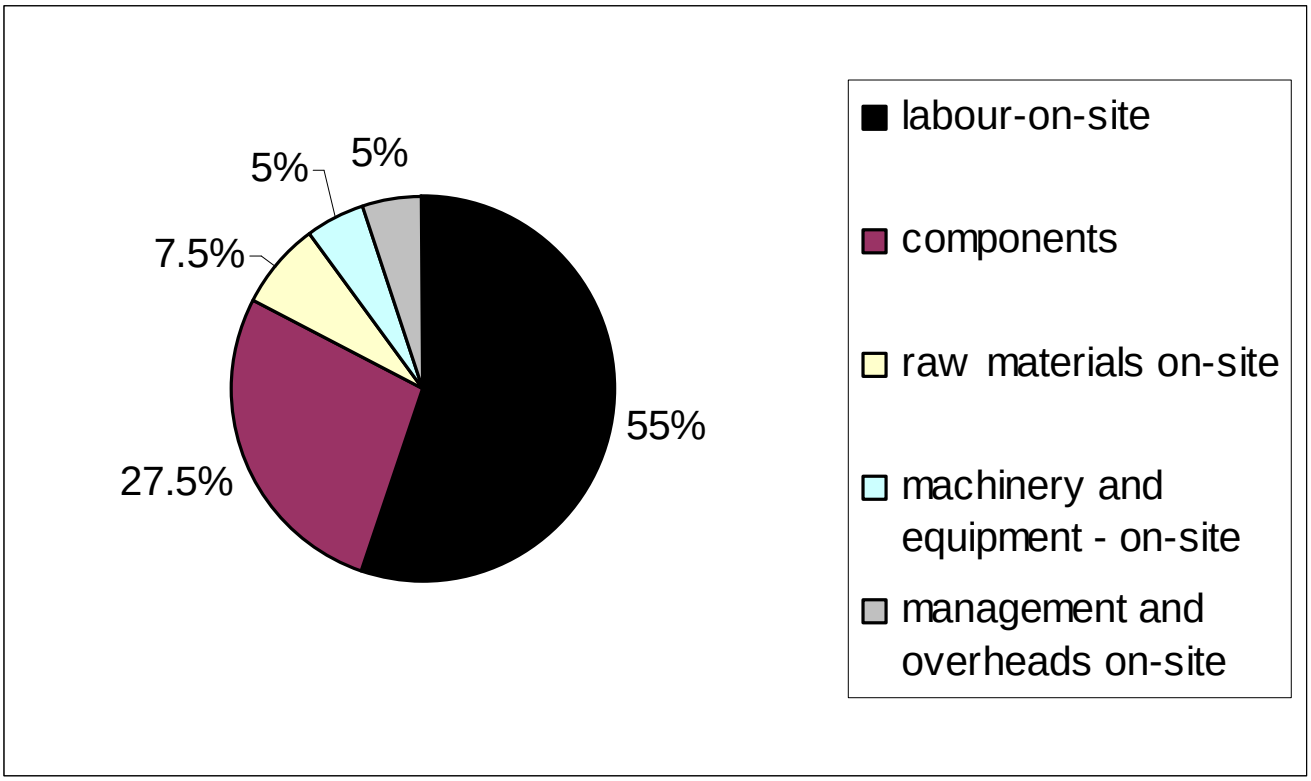
Resource	Place of deployment				
	Design Office	**On-site**	**Factory**	**To and from site**	**To and from factory**
Manpower	P	P	P	P	P
Raw materials		P	P		
Components		P	P		
Manufacturing plant			P		
Site plant and vehicles		P			
Transport vehicles				P	P

Source: Bernard Williams Associates

5.3.3 In developing the model of the use of resources it was necessary to use some basic assumptions about the deployment of resources in a project.

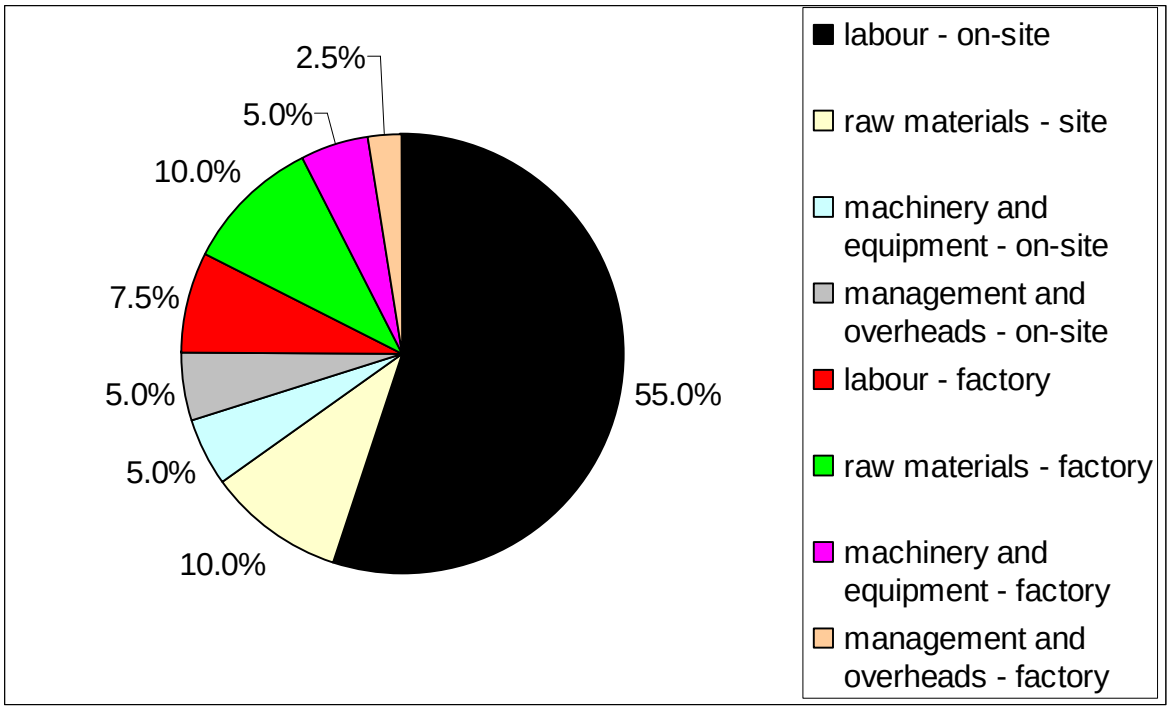
5.3.4 An initial empirical assessment of the proportion of the value of construction resources absorbed by each category and sub-category in the traditional construction cultures such as UK, Ireland and Spain is given in Figures H and J. This is based on well-established ratios in conventional construction projects which were also confirmed in some of the literature reviewed. [NB this is re- assessed statistically for each country in a later stage of the research – see Addendum 1]. From the analysis it can be seen that nearly two-thirds of the resources required are manpower (65%) and that most of that figure (55%) is normally consumed on site.

Figure 'H' - Analysis of typical resource consumption by project cost: traditional process



Source: Bernard Williams Associates

Figure 'J' - Analysis of typical resource consumption : site/factory cost split - traditional process



	Site costs %	Component costs %
Labour	55%	10%
Raw materials	7.5%	10%
Plant/vehicles	5%	5%
Management and overheads	5%	2.5%
total	72.5%	27.5%

Source: Bernard Williams Associates

5.3.5 Construction economics is very much influenced by the extent of **off-site fabrication**, its cost and the way site management accommodates it. As a general rule, off-site production and component assembly labour is no more expensive than its on-site equivalent (lower in countries where site labour rates are comparatively high – see Figure A) although it does incur the overhead of facilities costs in accommodating and servicing manufacturing plant, material storage and the administrative function. However, site production is very much at the mercy of

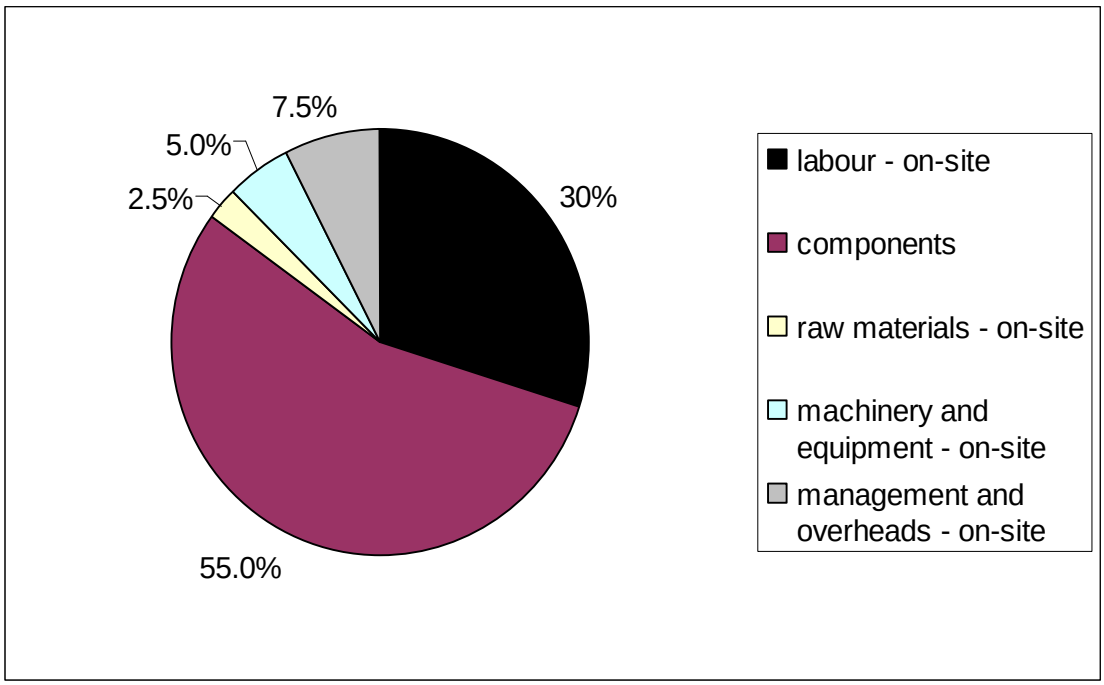
management and the weather, both of which are, in some countries, fairly unpredictable.

5.3.6 A typical analysis of the cost of resources in the more industrialised construction cultures is shown at Figures. K and L.

5.3.7 Apart from the issues of quality control, supply chain management and transportation costs, the break-even point in the on-site/off-site fabrication decision generally hinges on the cost, quality and availability of the on-site labour and its management and also, in some countries like Finland, the prevailing weather conditions.

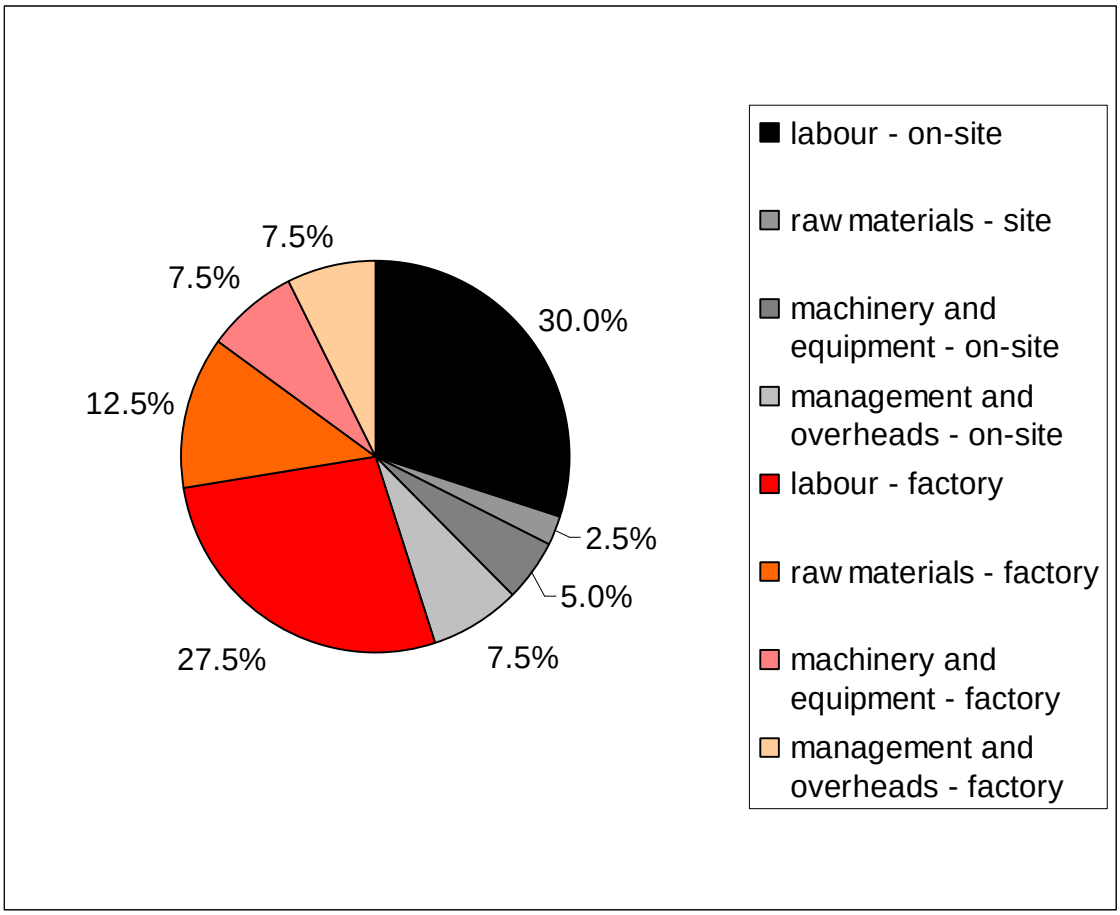
5.3.8 In countries such as Belgium where site labour costs are relatively high, off-site pre-fabrication is extensive; earlier studies (e.g. Building and Development Economics in the EU - BWA 1994) have already indicated that not only does Belgium find that this approach works best for them but it also appears to give them a competitive edge over most of the other EU Member Countries, especially for higher performance purpose-designed buildings.

Figure K – Analysis of typical resource consumption by project cost :industrialised process



Source: Bernard Williams Associates

Figure L. Analysis of typical resource consumption by project cost : site/factory cost split – industrialised process



	Site costs %	Component costs %
Labour	30%	27.5%
Raw materials	2.5%	12.5%
Plant/vehicles	5%	7.5%
Management and overheads	7.5%	7.5%
total	45%	55%

Source: Bernard Williams Associates

5.3.9 The UK embarked upon a major shift to 'industrialisation' of house-building in the early 1980's. This was in response to demanding Government housebuilding targets where speed was the driver rather than the inherent on/off-site fabrication economics. However, the movement was short-lived as poor aesthetic results and quality of construction in proprietary systems (many imported) were considered to be too high a price to pay for the speed required. Several building collapses also turned opinion against the movement. Nevertheless, timber-framed low- rise housing did

gain a permanent foothold in the aftermath as did a hybrid approach known as 'rationalised traditional' construction.

5.3.10 Again, in the 1990's some major commercial developments in the UK were built using off-site fabrication of components and toilet pods; this had the effect of halving the 30% difference in cost identified at the time between the UK and Europe's most cost efficient builder of high quality international standard office buildings, i.e. Belgium (see 5.3.8 above).

5.3.11 Elsewhere in the EU the German, Dutch and the Nordic countries' construction industries have increased their proportions of off-site fabrication in the past 30 years; their relatively higher on-site labour rates seem to have been a driver for this - compare the Southern European countries where site wages are low and on-site assembly is still the norm – although the industrialised processes of themselves generate a demand for better trained, more competent and thus higher-paid site labour. In the colder and wetter climates of Northern Europe the need to minimise on-site production time has also been a catalyst for increasing industrialisation.

5.3.12 Since the Research Team had no **conclusive** evidence at the outset of the research upon which to determine whether off-site fabrication was more efficient than on-site assembly (and if so why) it was considered sensible to start building the model to reflect traditional proportions of resource usage.

5.3.13 Therefore the basis adopted was the more traditional analysis (as shown in Figures H and J). It was appreciated that this would vary from country to country and from building type to building type. Nevertheless the research team were well aware of where these differences lay and the changes in the proportions which accompanied them. The researchers therefore had regard to these 'differences' when comparing results of the research into each Member Country's usage of resources. In the final event there proved to be a strong correlation between off-site fabrication and efficient use of resources and this was picked up, analysed and incorporated in the model's program (see 8.2.13 – 14 and 9.2.4)

5.3.14 The minor components of the construction cost – ie: other than construction labour and materials – comprise:

- on-site plant/vehicles
- design

5.3.15 The extent of on-site plant and vehicles should reduce where there is extensive off-site fabrication. Although this factor is very significant with regard to the efficiency of the rest of the resources consumed overall in such regimes, it is much less so in terms of cost and consumption of resources in its own implementation; it has therefore been acknowledged as a significant issue but not one which needs to be explored in depth for the purposes of this research.

5.3.16 Similarly, for the purposes of this research the cost of building design has been excluded when calculating the labour resource deployed in projects; however the 'design' content of off-site fabrication is acknowledged and would need to be addressed in any further more detailed research into this subject.

5.3.17 The basic resources ie: people, materials and equipment are deployed in a variety of ways in the design and construction process. Eg: design can be a function of materials and systems manufacture, management personnel and manual labour

occur in the extraction of raw materials, in the manufacture of components and systems and in on-site manufacture and assembly.The same applies to equipment.

5.3.18 In the same way that there are options about delegating the process of manufacturing components to external suppliers there are similar options about delegation of parts of the on-site assembly to sub-contractors. The latter, who are usually classified as SME's (small/medium enterprises), also have the option of self-supply or importation of systems and components.

5.3.19 Each act of delegation to an external provider shifts the location of production and management (and sometimes design) away from the principal agents of (design and) construction; this alters the cost ratios as between fully traditionally managed resources and fully industrialised resources – and all the intermediate regimes.

5.3.20 Apart from the shift of balance of cost from site production costs to component costs there is also a redistribution of the overhead, profit (and risk). The latter is potentially a source of increased cost of production - or at least price to the customer – but the Research Team gathered evidence that the shift towards pre-fabrication may actually result in cost savings (see Appendices I, M and Q).

5.3.21 Projects which involve extensive sub-contracting have been found to be more expensive than those involving directly employed labour. The problem appears to be to do with remote management plus the doubling-up of overheads, profit and risk.

5.3.22 The Research Team took the view that any construction regime which generates an out-turn price for a project (after adjustment for economic variables), greater than that for a similar project in another, is responsible for an inefficient use of resources.

5.5.23 This view proved to be justified by the appraisal of the out-turn costs - and resource-usage efficiency ratios derived from them - in a number of the countries included in this study.

5.4 The resource drivers

5.4.1 A resource driver is any action or omission that influences the usage of resources. Common examples include design, specification, site management, legislation and the weather.

5.4.2 Design and specification are generally within the control of the employer and his design team (although sometimes heavily directed by external factors such as ground conditions) and similarly site management is within the constructor's field of influence. On the other hand the legislation in place and the weather are outside of the immediate control of the employer or any other member of the sector's workforce.

5.4.3 The influence of a resource driver is at its greatest when the part(s) of the work it influences is at its most '**resource-sensitive'** i.e. it features highly in terms of quantity, quality or both. E.g. if the elevational treatment of the outside wall requires the use of expensive materials then the external walls will be '**resource-sensitive'** and the shape and size of the building will become significant 'resource drivers' - because they will influence the wall-to-floor ratio and hence the quantity of resources needed to construct the cost-sensitive element.

5.4.4 As stated above, the agent of the design and specification resource drivers is the **building employer though his design team**. Within the value management process 'value engineering' should take place under their direction. 'Value

engineering' is defined ('Facilities Economics in the EU' - Bernard Williams : IFPI Ltd. 2000) as 'the process whereby products and services are provided to the required performance for the least cost (use of resources); it requires the elimination of any*redundant performance*' (see paras 5.2.6 etc above). The corollary to this (extracted from the same source) is that '[the value engineer] should not permit the design or specification of a product or service to generate costs (resources) in respect of performance criteria which are not necessary to support the business requirement' (see also Section 5.2 above).

5.4.5 However, also as stated above (See para 5.2.20), this study was specifically **not** addressing the influence of design on the choice of shape and size of buildings and specification of materials insofar as they may, or may not, provide **effective** usage of resources. **Where this study began was therefore at the point in the design process where the design team takes decisions which will impact on the efficiency of the construction process itself.**

5.4.6 The research team addressed the matter of identification of the resource drivers from two different directions and in the order as given:

- in-depth analysis of all activities taking place on a project from inception to completion together with associated/concurrent non-profit activities and events
- study of the relevant reference material – see Section 4.0

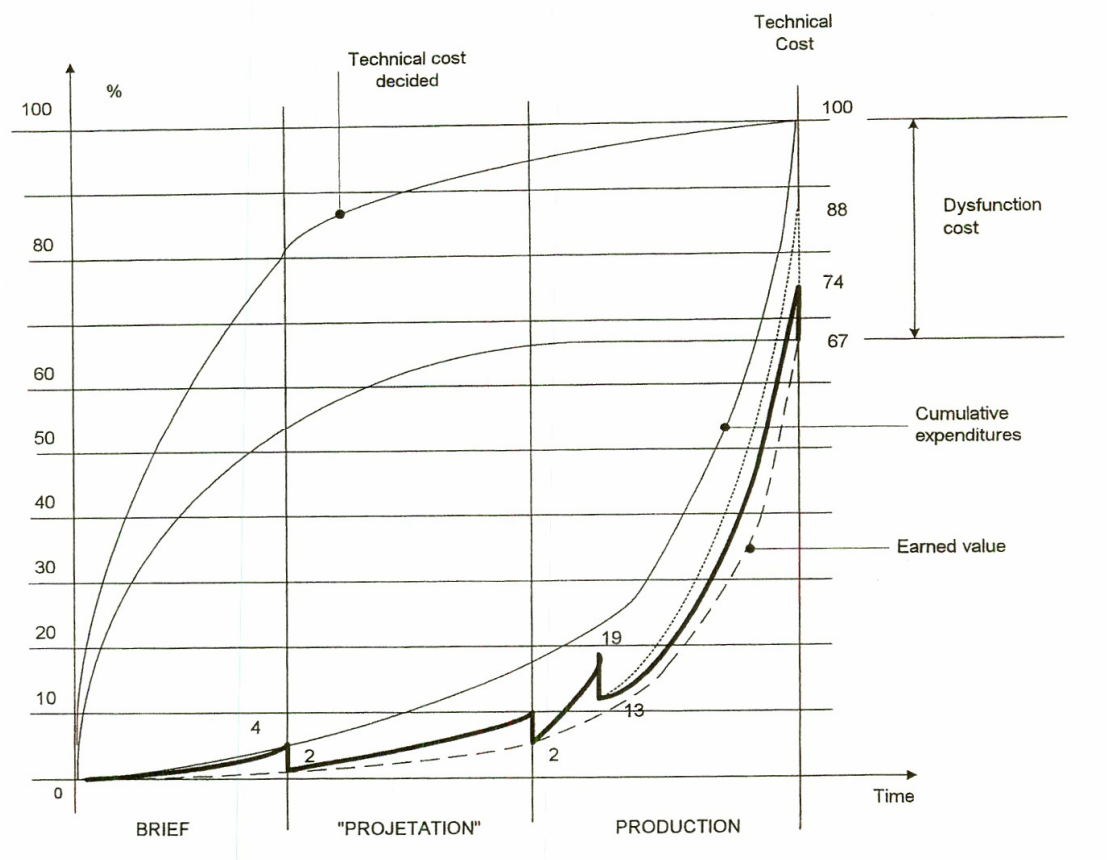
5.4.7 The activities and events identified at the pre-construction, construction and post-construction phases plus the external factors are scheduled at Appendix J. This list was the catalyst for a facilitated workshop within the research team at which the activities and events were explored in great detail; the outcome was the list of resource drivers given in Figure N below.

5.4.8 Great care was taken during the development of the list to avoid specifically connecting any of the resource drivers to a particular process, regime, culture or category of stakeholder, although in most cases the connection was obvious and indisputable. This was because it was deemed necessary to avoid drawing informants into a 'role-protective' or 'patriotic' mode.

5.4.9 At item 5.4.2 above the distinction was drawn between those resource drivers within the control of the building employer and the design team and those which are not.

5.4.10 The **controllable** resource drivers are the responsibility of the various stakeholders at different stages in the design/construction process. It is generally acknowledged that the output from the pre-construction design stage has the biggest influence on the effectiveness/efficiency or otherwise of the use of resources. Figure M illustrates how the technical cost (resource consumption) is essentially generated at the briefing stage, modified in the 'projetation' stage and scarcely influenced at all during the production stage,

Figure 'M' - The value analysis of a project



Source: Ing. M. Gobin GTM Construction

5.4.11 Generally speaking the construction team is charged with making the best they can of what is handed to them to build. In some countries, notably France, it is common practice for contractors to offer alternative proposals for meeting the design criteria; such proposals normally offer a cost saving resulting from a rationalised (or value-engineered, 'buildable') approach to the given performance requirements. Although the latter approach is beneficial to the building owner it can indicate a potential waste of resources (by the original design team) if the building has already been fully designed and specified; in a properly value-managed design process the need for such 'variant' proposals should have been eliminated unless the bid document is performance-based.

5.4.12 The **uncontrollable** resource drivers fall into two categories:

Ÿ naturally occurring

Ÿ man-made

Those naturally occurring include the weather and the 'innate quality' of the labour force. Those which are 'man-made' include 'legislation' and 'communications systems'.

5.4.13 The list of **controllable** factors at Figure N was derived mainly from an analysis, in chronological order, of the various activities of:

- briefing
- design
- construction
- post-completion

The **uncontrollable** factors do not have any definitive chronological pattern.

5.4.14 In the event the relevant literature review material did not identify any resource drivers over and above those in Figure N; in fact many of these resource drivers were not referred to at all in any of the literature reviewed.

5.4.15 A future model should be able to accept weight-of-importance values for each of the categories and sub-categories listed in Appendix J. However, for purposes of this pilot study the list of resource drivers was reduced by aggregating the sub-categories within categories and also by grouping some categories. The reason for this was twofold:

- to reduce the amount of data needed to be collected at interviews and in questionnaire responses
- to reduce the possibility of redundant analysis should the system turn out not to work as planned

5.4.16 Even after distillation the list of resource drivers needing to be explored came to 24, as shown in Figure N below:

Figure N - Schedule of high-level resource driver categories

Resource Drivers	
Controllable	Uncontrollable
1 Buildability	1 H&SaW legislation
2 Communications	2 EU Competition legislation
3 Change	3 Building regulations
4 Labour – skills & incentive	4 Hazardous substances regulation
5 Management skills & incentives	5 Minimum wage regulations
6 Repetition of processes	6 Maximum working week regulations
7 Selection of components	7 Weather - adverse
8 Materials handling	8 Non-availability of labour
9 Site security	9 Non-availability of materials
	10 Non-availability of plant
	11 Adverse site conditions
	12 Adverse site access
	13 Poor innate calibre
	14 Poor quality of indigenous materials
	15 Poor quality of indigenous plant

Source: Bernard Williams Associates

5.4.17 Having finalised the list of categories the Research Team needed to determine:

- Ÿ how significant each category can potentially be
- Ÿ how each country addresses the potential challenges/benefits that each category presents.

5.4.18 The views of both the Research Team and the informants on both counts are discussed in detail in appendix L.

5.5 The Questionnaire

5.5.1 A survey form was developed incorporating the list of resource drivers in Figure N and addressing both the 'weight of importance' of the resource drivers and their significance/management in each country.

5.5.2 It was designed to be used in one-on-one interviews and also as a widely distributed questionnaire. The survey form is included at Appendix K.

5.5.3 Experience teaches that different stakeholders tend to have different views on what is good and bad about their industry, each one generally criticising every other stakeholder group except the one to which they belong. The questionnaire therefore required stakeholders to identify their role and status within the industry; this was intended to help the research team to eliminate any such bias (by statistical analysis) in the final model.

5.5.4 Earlier work (e.g. Building and Development Economics in the EU – BWA: FT Management Reports 1994) identified that there were apparent differences in the efficient usage of resources between different building types in different countries. For this reason the questionnaire required separate responses for individual building categories.

5.5.5 In the case of the **controllable** resource drivers it was not only necessary to establish their comparative potential influence but also how well each country, in general, addresses the challenges/benefits that each resource driver potentially provides. The survey form therefore asked two distinct questions about each one, i.e.

- Ÿ how important is it? (weight of importance)
- Ÿ how well is it addressed ? (level of achievement)

5.5.6 The 'importance' question was specifically required to be answered in theory **without** reference to the chosen Building type. The 'level of achievement', on the other hand, had to be answered in respect of the **building type and country specified**. The questionnaire gave an example (Part 7A) of how answers to the two questions are to be tackled. A **helptext** provided definitions of the resource driver categories listed.

5.5.7 Scores for both considerations were out of 5. The use of the results in developing the model is explained below (See para 2.5.11).

5.5.8 In the case of **uncontrollable** resource drivers - the questions posed were:

- Ÿ how important is it? (weight of importance)
- Ÿ what is the actual degree of influence ?

5.5.9 The key to the ratings out of 5 for the 'how important?' set of questions were the same as for 'weight of importance' of the **controllable** drivers. However, in the case of the 'degree of influence' the ratings related to the impact which each category of resource driver typically had in the country specified. For example, bad 'weather' can have a very significant effect on a building site anywhere; however, it will be more of a problem in one country than another, e.g. compare Finland with Spain where the potential problem is the same but the typical impact is generally quite opposite. Again a **helptext** provided definitions of the resource drivers listed.

5.5.10 The ratings for 'level of significance' in each country were reversed in order of incidence in the uncontrollable resource drivers. This is because the resource drivers in Part B are all negative in their impact; consequently a high score needed to denote the **least** impact if the values of the weighted scores (see below) were to be complementary in level of benefit to those derived from 'A'.

5.5.11 It was considered necessary to assess the 'weight of importance' of all resource drivers in respect of labour, materials and plant. For this reason the prototype survey form (see Appendix K) originally required respondents to score the drivers out of 5 in respect of all three primary categories of resources ie: labour. materials and plant. However, it was decided that this would complicate the form unnecessarily. The research team had good data as to which resource category each resource driver impacted upon and drew upon this in finalising its assessment – see below and Appendix L.

5.5.12 The Research Team conducted its own workshop on the comparative weights of importance of all the resource drivers and their findings were similarly confirmed or revised following the interviews, Advisory Group Workshops and analysis of the questionnaires.

5.5.13 Serious departures from the research team's initial assessment of weight of importance were pursued at the key informant interviews and the final considered views of the Research Team in respect of both the weight of importance and levels of achievement in respect of each resource driver are given in detail in Appendix L.

5.5.14 The more important information from the surveys is in the 'country-specific' answers to 'level of achievement' and 'degree of influence' (in Parts 7A and 7B respectively).

5.6 Format of survey form

5.6.1 The survey form was produced in an Excel spreadsheet to facilitate interactive completion and analysis.

5.6.2 It was translated from the English original into French, German, Spanish, Italian and Dutch at the Research Team's expense. A further translation into the Czech language was effected by the representative of the Czech Republic on the Advisory Group (Ing. Jan Blahonovsky, who later also became a member of the Monitoring and Steering Group).

5.6.3 A multi-country version of the form was also produced to enable experts with cross-country experience to score levels of achievement on a country-comparison basis – see Appendix K.

5.6.4 The form was presented to the first MSG meeting and was also sent to the members of the Advisory Group for their individual completion and comments. Their helpful comments were addressed and changes made in the presentation to overcome the minor problems identified.

5.6.5 Further feedback from respondents plus information emerging from the 'review of previous studies' (see Section 4.0) was taken into consideration and the survey form further amended as necessary from time to time during the currency of the project.

5.7 Distribution of survey form

5.7.1 The distribution of the survey form was as follows:

- via EU Associations (FIEC, ECCREDI, ACE, etc)
- via the project web-site: www.bwassoc.co.uk/eucon
- linked to the project web-site via the EC's web-site
- to the relevant media in each country
- directly to key informants

5.7.2 Comprehensive listings of all those contacted are give in Appendix E.

5.8 Results of returned survey forms

5.8.1 Responses to research questionnaires are notoriously poor and this was no exception. With hindsight a much higher level of information sought might have generated a larger response, but such is the extent of 'survey overload' in the industry that this could not have been guaranteed. Also, the value of such data would have been very limited.

5.8.2 In the event around 100 survey forms were returned from a potential roll of over 1m qualified to respond from the countries surveyed. The responses were not, on their own, statistically significant, nor were they ever expected to be. Nevertheless, the opportunity was available, and accessed, to discuss individual responses with their authors and also to compare consensus results with the conclusions reached by the Research Team from their desk research and key informant interviews.

5.8.3 The survey form was also used to score and weight individual resource drivers following the review of each document in the literature review and each key informant interview.

5.8.4 The cross-country survey form was used by the Research Team to summarise the results of their findings prior to populating the model.

5.8.9 A complete summary and analysis of the results from all the completed survey forms is included at Appendix L.

6.0 KEY INFORMANT INTERVIEWS

6.1 Identification of interviewees

6.1.1 Suitable organisations, and individuals within organisations, were identified following contact with the various Associations representing the stakeholders in the industry. Contacts were also made with personal contacts of the Research Team and members of the Advisory Group and the MSG.

6.1.2 Considerable difficulty was encountered in persuading companies to participate in the interviews in spite of strenuous efforts by FIEC, its member organisations and other enabling bodies. In the event it was necessary to use very direct methods of persuasion to elicit the necessary response from certain countries.

6.1.3 Although the ensuing reactions produced an adequate range of interviews the majority of interviews were the result of individual initiatives from within the Research Team and the FIEC Secretariat.

6.1.4 Formal interviews were held in:

- UK
- Belgium
- France
- Germany

6.1.5 A considerable number of communications with key informants concerning these and most of the other countries in the set took place over the telephone and by e-mail.

6.1.6 Details of the key informant interviews and communications and classified notes of the key issues discussed are included at Appendix M; this data has subsequently been merged with the data in Appendix I (Reference material used in the research indicating relevant output) at Annex 3 of the electronic version of the Final Report.

6.1.7 The overall effect of the delays in holding the interviews was that the complete data for compiling the final model was not available until the very late stages of the project. [In some cases confirmatory interviews were held after the formal submission of the Draft Final Report (but before the Validation Workshop) and details incorporated in this document].

7.0 DEVELOPING THE RESOURCE USAGE EFFICIENCY INDEX – STAGE 1 ANALYSING THE RESOURCE DRIVER EFFICIENCIES

7.1 The methodology - principles

7.1.1 The construction of the index was the result of multiplying the weights of importance of each controllable resource driver by the 'level of achievement' in each country. The resultant aggregated weighted score of all the resource drivers for each country was converted into an index relative to a best performance score of 100. This process is illustrated in principle in Figure L.

Figure 'O' – Illustration of a (hypothetical) scored and weighted analysis of resource drivers to calculate an index of comparative efficiency

Resource drivers	Weight of importance	Level of achievement and total efficiency score					
		Country A		Country B		Country C	
		Rating	Total Score	Rating	Total Score	Rating	Total Score
1	4	3	12	2	8	2	8
2	2	4	8	3	6	3	6
3	3	4	12	3	9	4	1
4	5	2	10	3	15	2	1
5	1	3	3	2	2	2	2
			45		40		38
Efficiency rating – average score ÷5 (No. of resource drivers)			9		8		7
Efficiency rating – indexed to best score			100		89		85

Source: Bernard Williams Associates

7.1.2 It can be seen that Country 'A' has the highest weighted average score at 9; using this as the base index of efficiency to = 100, Countries B and C have indices of 89 and 85 respectively.

7.2 The methodology in practice

7.2.1 The assessment of the weightings and scores used in the creation of the final index was carried out by the Research Team drawing from all the information gathered in the course of the study, including:

- literature review
- questionnaire responses
- key informant interviews

7.2.2 In the event the numbers of questionnaire responses received was too small to provide, on their own, reliable statistical data on the **levels of achievement** in each country; indeed, even an inordinately greater volume of replies would not, of itself, have done other than provide further background information for testing the Research Team's own findings.

7.2.3 For the same reasons the further analysis of the small sample of results by building type and stakeholder classification (see Appendix K) was of primarily academic interest.

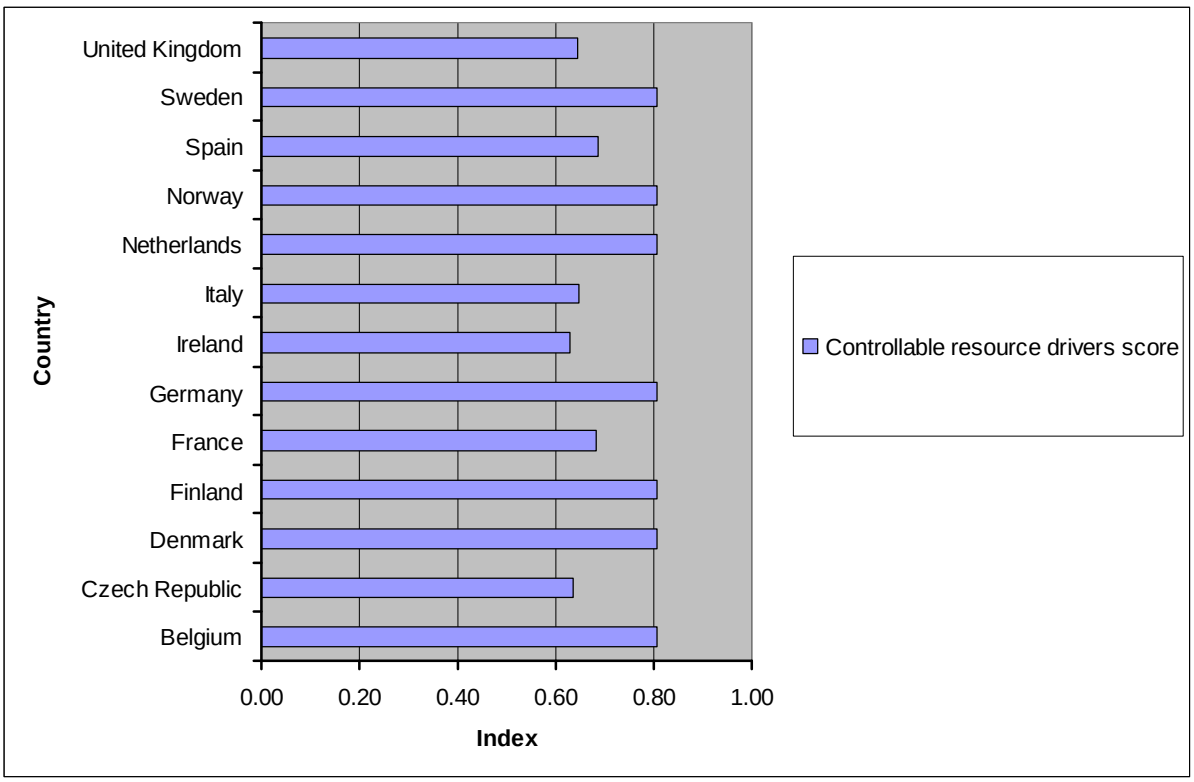
7.2.4 Nevertheless, the 'universal' analysis of the 'weights of importance' of the resource drivers did prove to be consistent within the set both between stakeholders and by comparison with the Research Team's own assessment. After eliminating the few obviously non-conforming ratings the cross-country average for **'weight of importance'** of the resource drivers was adopted as the primary basis of assessment.

7.2.5 The key issues forming the basis for the final assessment of weightings and ratings for each resource driver are given and discussed in Appendix L.

7.3 The results

7.3.1 The final index of efficiency based on the analysis of the resource drivers is given at Fig. P.

Figure 'P' - Index of efficiency of resource usage based on analysis of the resource drivers (Resource Driver Efficiency Index)



Source: Bernard Williams Associates

7.3.2 The above table is derived solely from the 'controllable' resource drivers.

7.3.3 The 'uncontrollable' resource drivers are not an indicator of efficiency as such; they are merely an indicator of adjustments which may be necessary to the index of efficiency to take into account any major disparities between the countries in respect

of these uncontrollable resource drivers. In the event such adjustment was not found to be necessary in development of the prototype benchmarking model for the reasons given in Appendix L. Nevertheless, any further development of the model would need to address these factors if significant variations were identified in any country or countries.

8.0 DEVELOPING THE RESOURCE-USAGE EFFICIENCY INDEX – STAGE 2: ANALYSING THE COMPARATIVE CONSUMPTION OF RESOURCES

8.1 The methodology – options

8.1.1 Para 4.2.15 describes some of the many key performance indicators (KPI's) in respect of cost, quantities and time by which international construction efficiency comparisons can be attempted

8.1.2 Para 4.2.16 describes the typical contents for comparison of inputs, processes and outputs when comparing industries, projects and firms.

8.1.3 Para 4.2.17 lists the sources of information as existing data or information, case studies and surveys.

8.1.4 Para 4.2.18 lists national or industry statistics, corporate or project data as examples of existing data.

8.1.5 A key feature of this project was the attempt to produce a benchmarking model which combined the theoretical assessment of resource usage efficiency (the resource driver based index) and the outturn resource usage efficiency as measured by comparing the ratio of the hourly cost of site labour to the total cost of construction (the resource consumption based index)

8.1.6 However, as stated in 2.5 it should be noted that at a late stage of completion of this Report a methodology was devised for creating an index that could also accommodate the productivity of the off-site manufacturing process – see Section 9.0 and Addendum 1 for further details of this late development.

8.1.7 The Research Team's view was that **project-based** comparisons would be more beneficial to the benchmarking process than methods using macro-economic statistics. Examples of the latter are:

- Labour productivity relative to-
  - estimates of gross output
  - value added per person employed
- Total factor productivity-
  - combining value added and the value of the capital stock in relation to the numbers of persons employed.

- Key Performance Indicators (KPI's)

8.1.8 When it became apparent that there was a sufficient volume of good quality data available on project outturn costs in all the countries to be included in the study (see 8.3) the decision was made to proceed along this route rather than to rely upon the macro-economic statistics. In view of the research team's skill-base being set primarily in the micro-economic analysis and evaluation of construction projects it was considered that a successful application of this process would be feasible .

8.1.9 Where appropriate selected macro-economic statistics were used to test the conclusions of the study. However, the drawbacks to reliance upon this data for making international comparisons of construction efficiency were considered to be many and significant. These issues are briefly discussed in Appendix N.

8.2 The selected methodology - principles

8.2.1 Three ways of assessing comparative resource consumption on projects were considered:

- Ÿ analysis of first-hand data on individual projects
- Ÿ reviewing data contained in published analyses of individual projects
- Ÿ analysing published high-level data on project costs

8.2.2 Analysis of data on individual projects from any source does not give a definitive overview of cross-country performance. However, studies on performance on similar projects identified in the literature review provided useful pointers to possible differences between the respective countries' efficiency which proved to be helpful when testing the findings derived from the method adopted.

8.2.3 The Research Team could find no published data covering details of resource consumption in all major building types that was common to all (or even a few of) the countries studied.

8.2.4 There were however several sources of published data on typical out-turn prices for a wide range of building types in all the countries studied.

8.2.5 The Research Team therefore decided to use the latter for comparing out-turn prices for buildings (always having regard to known variables such as specification, tender dates, potential cost over-runs, price of labour, materials and equipment, etc) as a basis for assessing the actual consumption of resources.

8.2.6 As previously stated the core members of the Research Team are all experienced and highly qualified construction cost consultants which made this choice of process viable. The Team had the knowledge and ability to understand the merits and demerits of each source of published data and how to use it validly (adjusted where appropriate) and without fear of the overall findings being discredited by failure of the researchers to be aware of, and to address, the potential pitfalls.

8.2.7 A due diligence test on the out-turn price data used, and the indices derived from it, was applied by the Research Team as described in Appendix O.

8.2.8 The Research Team decided that the efficiency of resource-usage should be concerned only with what it was possible to achieve in each country at the time the research was being conducted. This meant that, although data for most countries in the set was in Euros, consideration needed to be given to the principle of adjusting for the purchasing power differences between the actual prime costs of resources supplied in each country when analysing the out-turn prices for purposes of identifying comparative efficiency

8.2.9 The Research Team considered the various methods available for removing these differences when comparing the out-turn prices of buildings in different countries:

- Ÿ National purchasing power parity (NPPP)
- Ÿ Construction purchasing power parity (CPPP)

- Ratio of labour price to out-turn cost per unit of parameter

8.2.10 The literature review confirmed the Research Team's view that **National PPP** is only appropriate for comparing macroeconomic indicators such as GDP.

8.2.11 The accuracy of **Construction PPP** has been queried in several recent research reports. The Research Team's own criticism of this methodology has been expounded in 2.5.11-15. It was therefore deemed to be an inappropriate basis of first analysis. However, the problems highlighted were stated to be less serious for the developed countries so its applicability as a second, supporting, comparative tool was examined in the context of the findings of the study based on site labour per sq.m. – see Figure V below and Appendix P).

8.2.12 In the event the Team elected to use as the primary index the Resource Consumption Efficiency index based on the **ratio of site labour hourly rates to out-turn price per m²** having compared the robustness of the results against a range of alternative methods including CPPP(see above), alternative data sources, and macro-economic statistics (see below). They also undertook an assessment of the effect of the proportion of material costs to total costs on the integrity of the indices created – (see Appendix Q) and expanded this in depth in Addendum 1.

8.2.13 A full dissertation on the validity and use of this Index is at Appendix Q. Such an index gives an **absolute** comparison only when comparing similar processes e.g. traditional with traditional; when comparing different processes, e.g. traditional with industrialised, the indices can only be directly used as indicators i.e. by setting the hourly rates against the respective outturn costs However, it has been possible to adjust this index to reflect the on-site/off-site cultures in each country and this has been used in a further development of the model – see section 9.0. and Addendum 1.

8.2.14 In its unadjusted form the index has an exaggerating effect upon the differentials which is to some extent redressed in the Benchmarking Model by the merger with the comparable 'Resource Driver Efficiency iIndex' (see para9.1.1). The adjusted index in Addendum 1 however, falls much more closely into line with the 'resource driver based index'.

8.3 Sources of price data for use in the study and the indices derived

8.3.1 The Team sought data that would be comparable across the countries in the set, particularly with regard to:

- measurement of floor area (eg: gross internal, gross external, net internal etc)
- scope of contents (eg: for letting, for owner occupation etc)
- reliability and any shortcomings of data, expertise and qualifications of data providers

8.3.2 It was recognised that there were cultural differences with respect to the design and specification of some types of buildings. The research team therefore compiled a schedule of comparative specifications for the main building categories in each country – see Appendix R. In the final event this data was only used as a point of reference ; its use and application will be of greater relevance in any further in-depth studies in this field.

8.3.3 The alternative sources used in testing the potential validity of this form of efficiency index were:

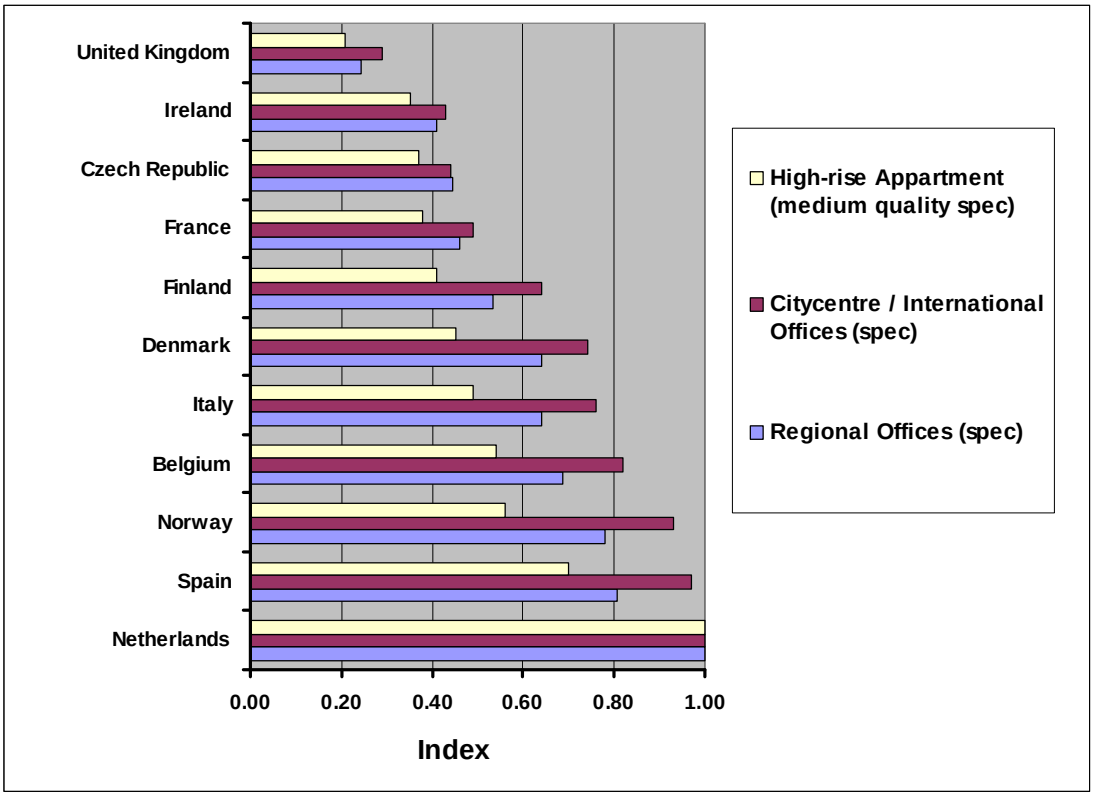
- The 'Building' Survey of International Building Prices – 2005 – see Appendix S
- Spons European Handbook 2000 – edited by Davis Langdon & Everest – see Appendix S
- Laxtons European Price Book 1996 – edited by Tweeds
- Building and Development Economics in the EU (Financial Times Management Reports 1994 – edited by Bernard Williams Associates)

8.3.4 The latter two sources were indexed to 2005 but were only used as an additional due diligence check on the data arising from the first two sources. There were in fact no contradictions between these latter two sources and the former two which suggested that there had been little change in countries' performance over the period. However, due to the unreliability of indexing construction costs over a significant period this comparison has not been included in this Report.

8.3.5 The Building 2005 survey was used for the initial test since it was the most up-to-date and included hourly rates of pay for workers and costs per m² of floor area for the main building categories. It covered all countries in the set except for Germany. The editors are a highly respected international firm of Chartered Quantity Surveyors who have gathered this data from their own projects and those of associated firms in each country.

8.3.6 Inevitably in a wide-ranging survey of this kind there were some anomalies within the data provided. Therefore in one or two instances it was necessary for the Research Team to make carefully considered alterations based on their reading of the rest of the data before carrying out the hourly rate/price per m² ratio analysis for each building type in each country. However, overall the data was totally appropriate for such an exploratory analysis and the results were not sensitive to regulatory adjustments made by the team to parts of the data. The results of the analysis are shown at Fig. Q.

Figure 'Q' - Resource Consumption Efficiency index based on 'Building' 2005 Survey



Source: Bernard Williams Associates

8.3.7 The calculations underlying this index are given in detail at Appendix T. It is important to note that in producing the index the Research Team has adopted a policy of always using the hourly rates and prices per m² from the same source if available (but see 8.3.28 re adjustments for UK hourly rates).

8.3.8 As shown in Appendix T there was a very strong correlation between these results and the updated results of BWA's previous research in 1992/93. This encouraged the Research Team to pursue this methodology by looking at all other available sources of similar data.

8.3.9 The Spons European Handbook 2000 edited by Davis Langdon Everest contained similar data to that available in 'Building' 2005 except that:

- it contained a considerably greater variety of building categories and performance classifications within each sector
- it was 5 years out of date

8.3.10 Bearing in mind that the hourly rates and costs/m² were both reflective of the economic conditions prevailing in each country at the time, it was considered appropriate to test the Building 2005–based index at Figure Q using the Spons data in a similar fashion. The costs/m² used for this preliminary test were from the high level summary at the end of the Spons European handbook, but even this was much more detailed and comprehensive than the data in the 'Building' 2005 Survey. [This

is not in any way a criticism of the latter which was prepared as a general feature in a construction journal whereas the former was a commercially published technical book.]

8.3.11 The results indicated a very similar pattern to that obtained from the Building 2005 Survey as shown at Fig. Q above.

8.3.12 Although the Spons European Handbook data is 5 years old the Research Team considered that it was consistent at the date of collection, and that no **fundamental** changes had taken place affecting **the whole industry** in each country since that date.

8.3.13 In the light of the high degree of conformity shown between the indices derived from this data source and that in the 'Building' 2005 survey and BWA's 1992/93 research (see Appendix T) it was decided to do a further, more detailed, analysis based on a very much more detailed set of data also provided in the Spons European Handbook 2000. This handbook lists costs/m² on a strictly comparable basis of scope from over 50 categories of buildings in the following sectors:

- Industrial
- Administrative and Commercial
- Residential
- Health & Education
- Recreation and Arts
- Other

8.3.14 Sample pages for 2 countries showing the nature, extent and strict comparability of the data are also given at Appendix S.

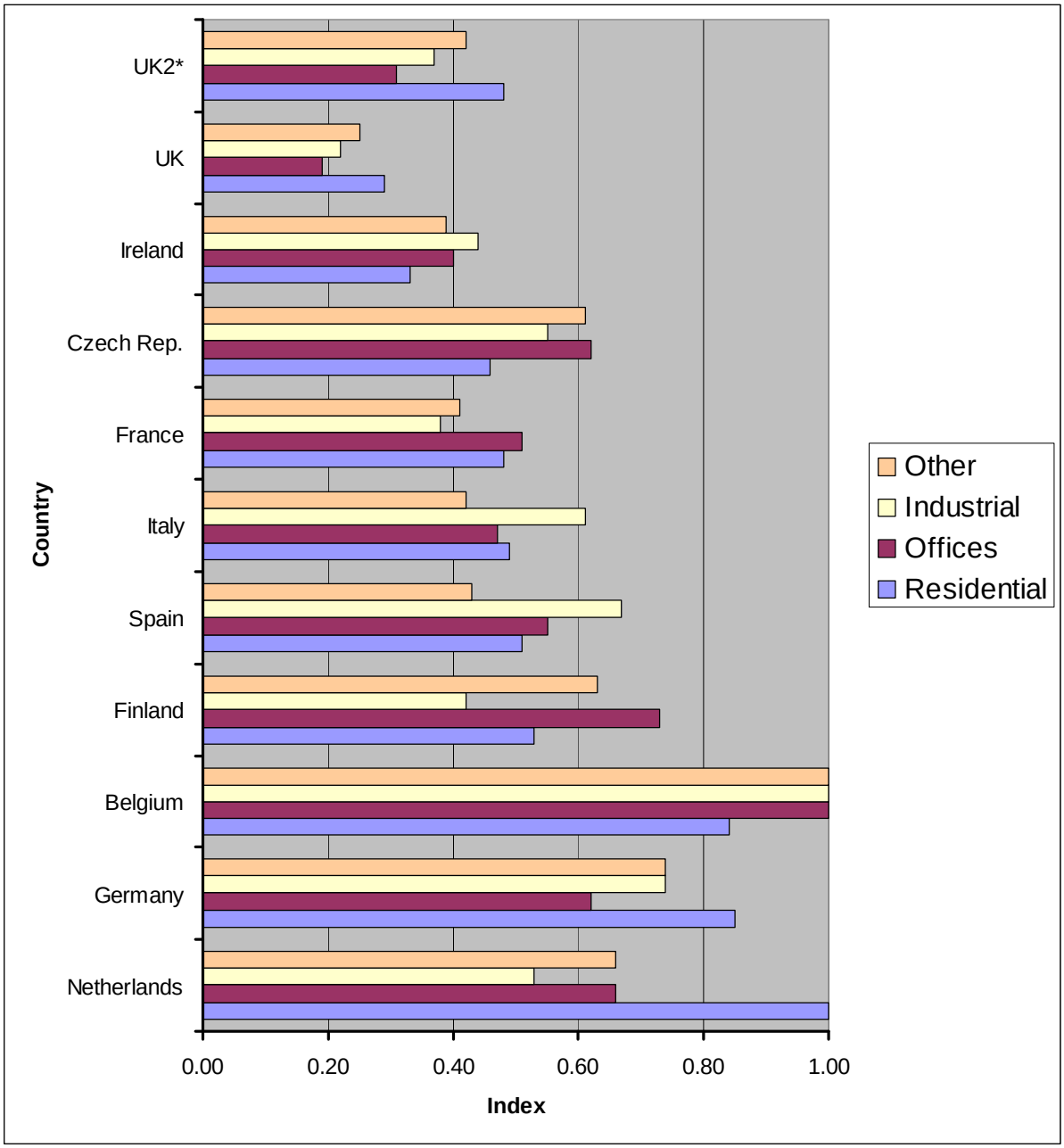
8.3.15 This variety of data afforded the possibility of comparing the indices across the construction sectors as well as further validating the overall indices through use of a further, much more extensive yet comparable database of different building categories.

8.3.16 The original proposal was for a 'first strike' benchmarking study of 10 countries, and a further in-depth study of five countries ie Germany, France, Italy, Spain and UK. In the event, in view of the lack of responses from Spain and Italy to the Research Team's attempts to gather first-hand information and data, the Research Team decided that it would be more appropriate to deal with all the countries at this second more detailed level rather than attempt to do further in-depth studies of the 5 major countries, especially as (with the possible exception of Germany) none of them turned out to be best performers to use as exemplars .

8.3.17 The detail for Italy and Spain was based almost entirely on the Desk Research although the Research Team had no reason to believe that the results for the latter two countries were significantly less reliable than the others. This was due to the quality of the source data used in creation of the basic indices and quality of evidence from the literature review.

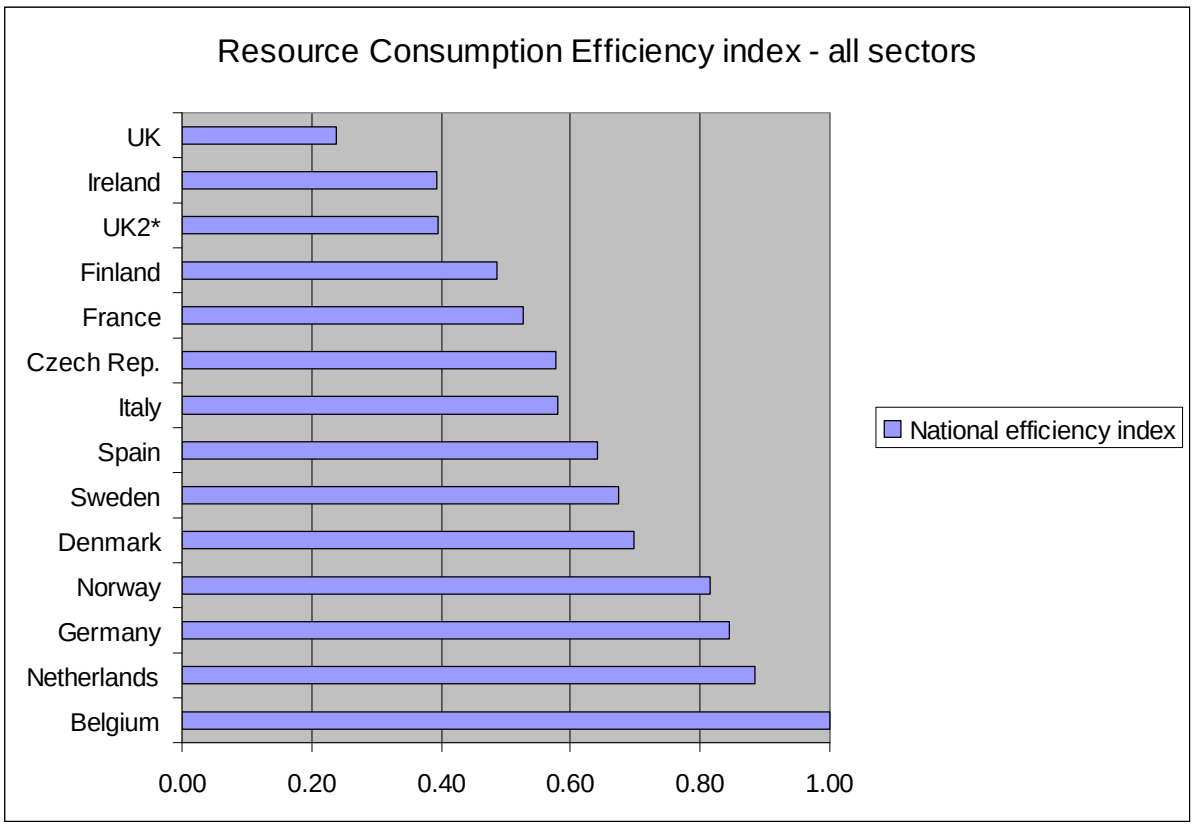
8.3.18 The individual sector indices thereby derived are given at Figure R and the effect of the sectoral distribution on the overall index for each country (after re-allocation by reference to the breakdown of construction GDP at the period) is at Figure S.

Figure 'R' - Resource Consumption Efficiency index based on Spons European Handbook 2000 – sectoral distribution



Source: Bernard Williams Associates

Figure 'S' - Resource Consumption Efficiency index based on Spons European Handbook 2000 –weighted analysis over all sectors



Source: Bernard Williams Associates

8.3.19 The calculations underlying the construction of the above indices are also included at Appendix T.

8.3.20 Adjustments were necessarily made to minor components of the above data with regard to:

- Ÿ apparent anomalies
- Ÿ importation of data from other sources for countries not included in the Spons data
- Ÿ information gleaned from interviews with key informants updating isolated components of the data used.

8.3.21 In particular the data was reviewed in respect of the impact of 'declared' and 'undeclared' migrant workers on the average hourly wage rates (see literature review and various comments given by key informants at Appendix M). It was not always clear from the literature whether the migrant workforce referred to comprised both declared and undeclared workers. However, it was apparent that in some countries at least the hourly rate was suppressed to the minimum for migrant workers whatever their legal status. Although the extent of this phenomenon could not be assessed in detail the evidence was that the use of a migrant workforce was common to most if not all of countries in the set

8.3.22 The proportion of migrant, low paid workers to the total workforce was suggested to be as high as 30% in Germany, although they had since 'capped' the level of

'declared' migrant workers to 15% of the total workforce (see Key Informant Interview No. 6). The research team had no evidence that a higher level existed in any of the countries in the set.

8.3.23 In practice the ratio of skilled to unskilled site workers is usually more like 4 or 5:1 in the industrialised cultures and 3:1 in the traditional cultures. However, in the construction of the hourly rate/sq.m index the hourly rate was taken universally as the straight average of the rate of skilled and unskilled workers. This calculation had the effect of depressing all of the hourly rates by a small measure which was deemed to make due, if not totally accurate, acknowledgement of the likely impact of the lower rates paid to migrant workers on the productivity indices derived.

8.3.24 The Research Team does not believe that the overall index as constructed is significantly sensitive to the issue of variations in the proportions of the low-paid migrant workforce as between countries in the set. Nevertheless, any further development of the Benchmarking Model would need to take into account any more accurate data available in this connection.

8.3.25 Further consideration was also given to the incidence of 'material' efficiency and its effect upon the index. The following key issues were identified:

- ready access to materials and components at a reasonable price
- export opportunities for prefabricated components
- the variable ratio of site labour to materials where extensive off-site pre-fabrication is prevalent
- the effect of wastage of materials on site.

8.3.26 The Research Team concluded that the implications of all these factors would not generally affect the overall index for the following reasons (and stated exceptions):

- **ready access to materials** – this was mainly a problem for the UK and Ireland where the cost of imported materials raised the total cost of materials on projects by as much as 10%; this slightly exaggerated the relatively poor level of their respective indices although it also served to justify the economic case for greater industrialisation in these countries
- **export opportunities** – this was an important feature of the economics of construction in countries such as Finland where the industrialised process developed avoided the problems of internal recession through the facility of also manufacturing components for export. The feature did not directly affect the indices
- **the** variable **ratio of labour/materials** – is a feature of the difference between those industry cultures dependent upon extensive prefabrication of components and systems and those which are not. At its extremes the labour:materials ratio changes from 55% : 35% in traditional regimes to 30% : 55% in fully industrialised regimes.(See Section 5.0) However, since all buildings constructed under these industrialised regimes are inherently less expensive overall the higher proportion of materials costs/m² does not in fact represent a significantly higher total cost of materials. The overall effect is therefore that material cost differentials are relatively insignificant and were

originally ignored for the purposes of the development of the model in this scoping study – but see 8.2.13 and Addendum 1.

- **waste** – is a common phenomenon but the Research Team could only find numeric references to this in relation to UK sites, where figures as high as 20% were recorded. The Research Team took the view, supported by references in the literature review, that there would be less waste on sites where components were prefabricated, further justifying the opinion that materials on such sites would not be significantly more expensive than in the more traditional processes.

8.3.27 It was noted, however, that in some countries such as UK, Ireland and Germany the quality of materials specified was rather higher in some categories of buildings. No adjustment was made for this in this 'scoping study' but it should be noted that any adjustment would cause a slight improvement in these countries' respective performance indices. Obviously any further more detailed benchmarking studies would need to have due regard to the effects of quality of materials specified.

8.3.28 The team had recognised from the outset that the hourly rates given for the UK in all sources (see 8.3.3) did not take into account the higher costs of the extensive amount of self-employed labour or 'premium' bonuses paid to employees to overcome labour shortages. They were however used in the first instance for the sake of unequivocal consistency. The index results for UK using these original rates were patently unrealistic; it was therefore decided to make a further calculation for UK based an hourly rate data from key informant interviews and other sources. This is given as UK 2 in the above indexes. Although the team considered that the situation in the UK was unique among the set, it was nevertheless decided to compare all of the hourly rates with data from other sources; no further adjustment was deemed to be necessary as a result of this review.

8.4 Independent validation of the findings

8.4.1 One of the Key Informant Interviews was with an international hotel group. They provided an overview of comparative costs, specification and built quality drawn from their organisation's experience of constructing similar buildings in 7 of the countries in the sample set.

8.4.2 The results of their overview are included at Figure T

Figure 'T' - Comparative price/quality analysis – international hotels group

International Hotels Group

Comparative price/quality analysis

	Avg. Cost per room ExHI	Efficiency Index	Position	Design/Build Quality / 100	Construction Quality / 100
Belgium	€ 65,000	1.00	1	100	95
Germany	€ 70,000	1.08	2	110	110
Holland	€ 65,000	1.10	2	100	100
Italy	€ 62,000	1.44	4	100	95
France	€ 62,000	1.48	5	90	80
Spain	€ 70,000	2.48	6	85	75
UK	€ 70,000	3.00	7	100	100
UK2*	€ 70,000	1.80		100	100

Notes
Costs exclude land, fees and profit and are based on comparable spec products
Data is subjective and we have tried to balance the fact that UK, Spain and Germany have many more hotels than the others for comparison purposes.
Spain is a problem for us as the buildings are over spec'd and we would expect a target price of € 62k rather than matching the UK.

* UK index adjusted to take account of the hourly rate on-costs for sub-contract labour and bonuses.

Source: International Hotel Group/ Bernard Williams Associates

8.4.3 Using this data the Research Team incorporated in the Figure an index using the same hourly rates as used in the general index above. The overall levels of the indices and the corresponding rankings as shown in Figure T are very similar to those indicated at Figures R and S above.

8.4.4 The indices of design quality and built quality are interesting in themselves as they confirm the Research Team's preliminary findings in respect of each country in the Figure. The issue of materials quality adjustment was discussed briefly in 8.3.27 above and further consideration of the potential use of quality indices in the model is given at Addendum 1. However no adjustment has been made in this respect in this scoping study.

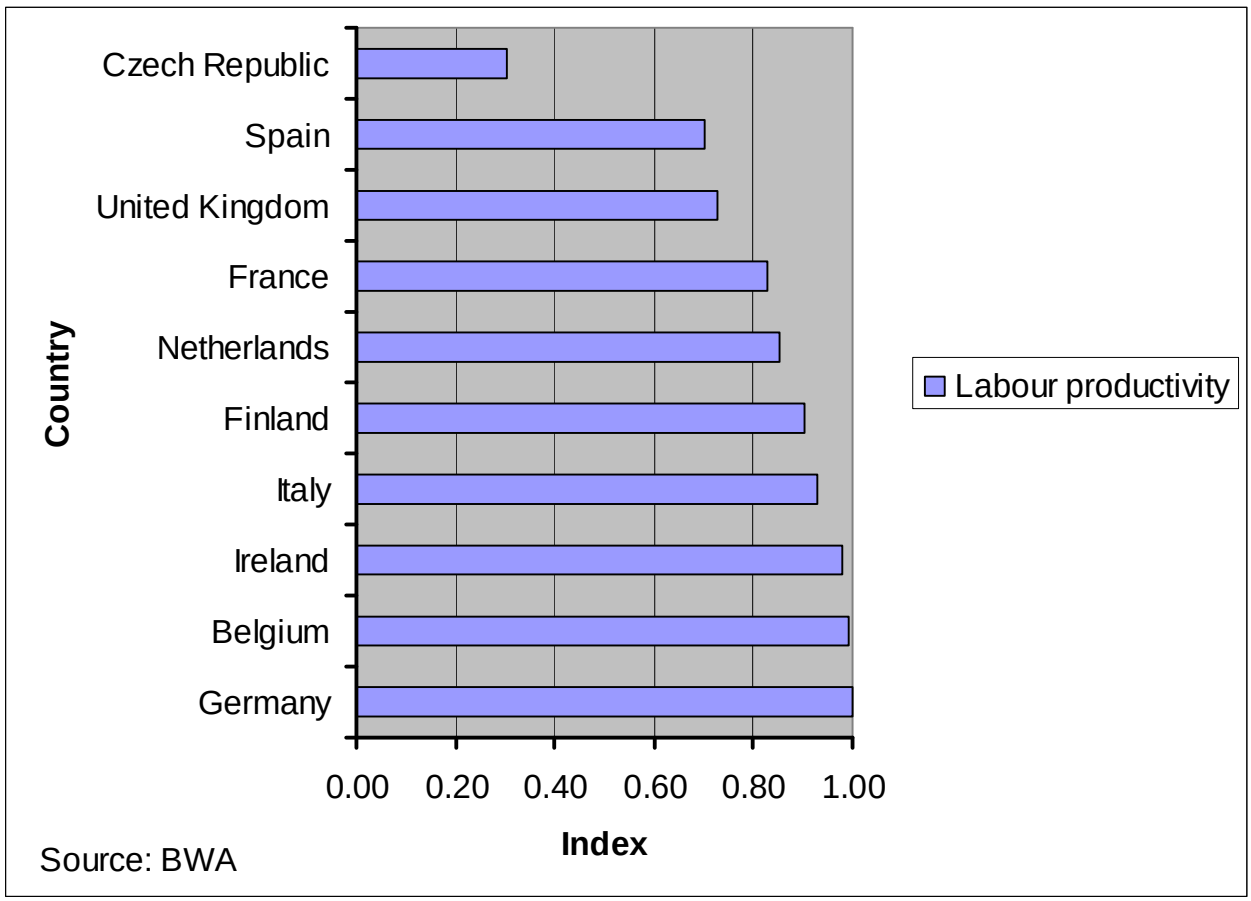
8.4.5 As a further test on the validity of the findings from the cost-comparison-based index at Figures P and Q the Research Team decided to calculate the output per construction employee by reference to the Construction Gross Domestic Product (CGDP).

8.4.6 Figures for CGDP were available from Eurostat for the period in question and it was decided to make an adjustment to this data to reflect the relative inefficiency of the Repairs and Maintenance (R and M) sector compared with new construction and civil engineering work.

8.4.7 The Research Team's view was that a 30% uplift to the R and M content would reasonably reflect this reduced level of output so an appropriate increase was made to each country's CGDP depending on the proportion of its R and M output compared to the country with the lowest proportion (Ireland).

8.4.8 The results of that study are shown at Figure U, and the calculations therefor are included at Appendix T. However, for reasons given at Appendix N the results from this calculation are not considered to be reliable as a primary source of information for comparative benchmarking.

Figure U – Labour productivity based on CGDP (adjusted for R and M)



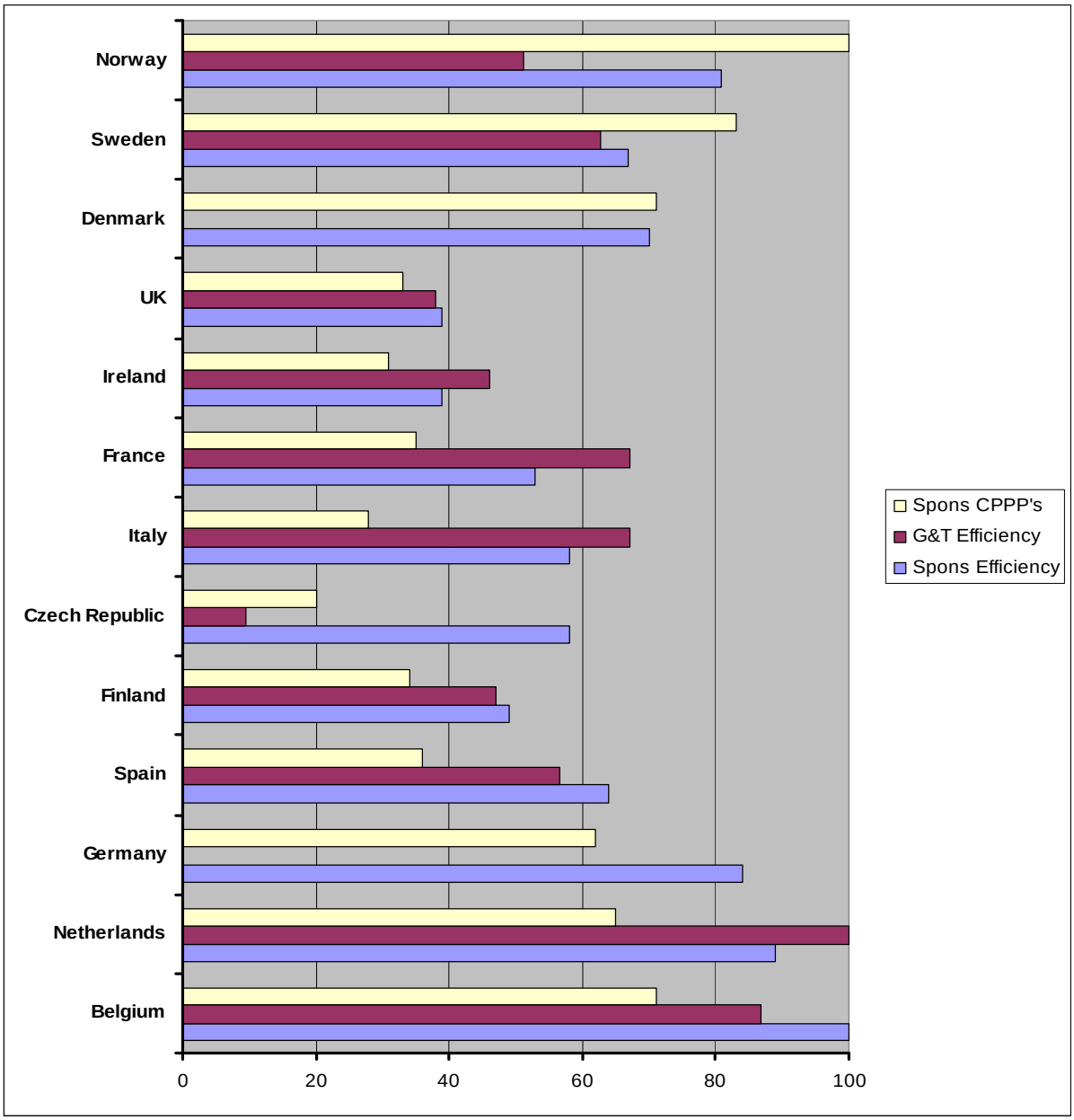
Source: Bernard Williams Associates

8.4.9 No further adjustment was made as between building construction and civil engineering due to the difficultly of isolating the proportions of the workforce engaged in each sector.

8.4.10 With the possible exceptions of Ireland and Spain the indices and rankings from this exercise are very similar to those shown in Figures R and S above.

8.4.11 As stated above (para 8.2.11) the Research Team also tested the hourly-rate /cost per sq.m. Resource Consumption Efficiency index using the Construction Purchasing Power Parity (CPPP) indices for the period. The results are shown at Figure V and the calculations are at Appendix T. The figure also incorporates the indices from Figure Q (Building 2005 Survey) and Figure R (Spons European Handbook 2000) so that an overall comparison of the three sets of results can be made.

Figure V –Resource Consumption Efficiency index at CPPP



Source: Bernard Williams Associates

8.4.12 The calculations for this figure are included in Appendix T.

8.4.13 The index finally selected for use in the benchmarking model is that from Spons Handbook and it can be seen that, with the exception of Norway, Sweden and Denmark the CPPP figure is usually below, but in alignment with, the Research Team's Spons- related index. This is believed to be because in those countries where construction site labour rates are high the CPPP adjustment factor does not reflect the likely extra efficiency resulting therefrom; it also does not allow for the difference in proportion of the cost of components on projects as between countries.

8.4.14 It can also be seen that the Building 2005 Survey (G and T) related Resource Consumption Efficiency index (where available) closely follows the Spons- related

index except for Norway and Czech Republic. Figures were not available for Denmark or Germany in the Building 2005 Survey data.

8.4.15 Overall the Research Team were confident that the greater variety of building types and the very detailed level of analysis used in calculating the Spons related index gave it more reliability than that derived from The Building 2005 Survey (which is in no way a criticism of that particular feature) and that the latter generally supports the findings in Spons.

8.4.16 The CPPP results in general support the trends in the unadjusted Spons index; however, given the question marks concerning the reliability and appropriateness of the CPPP indices it was decided not to use them any further in the development of the model.

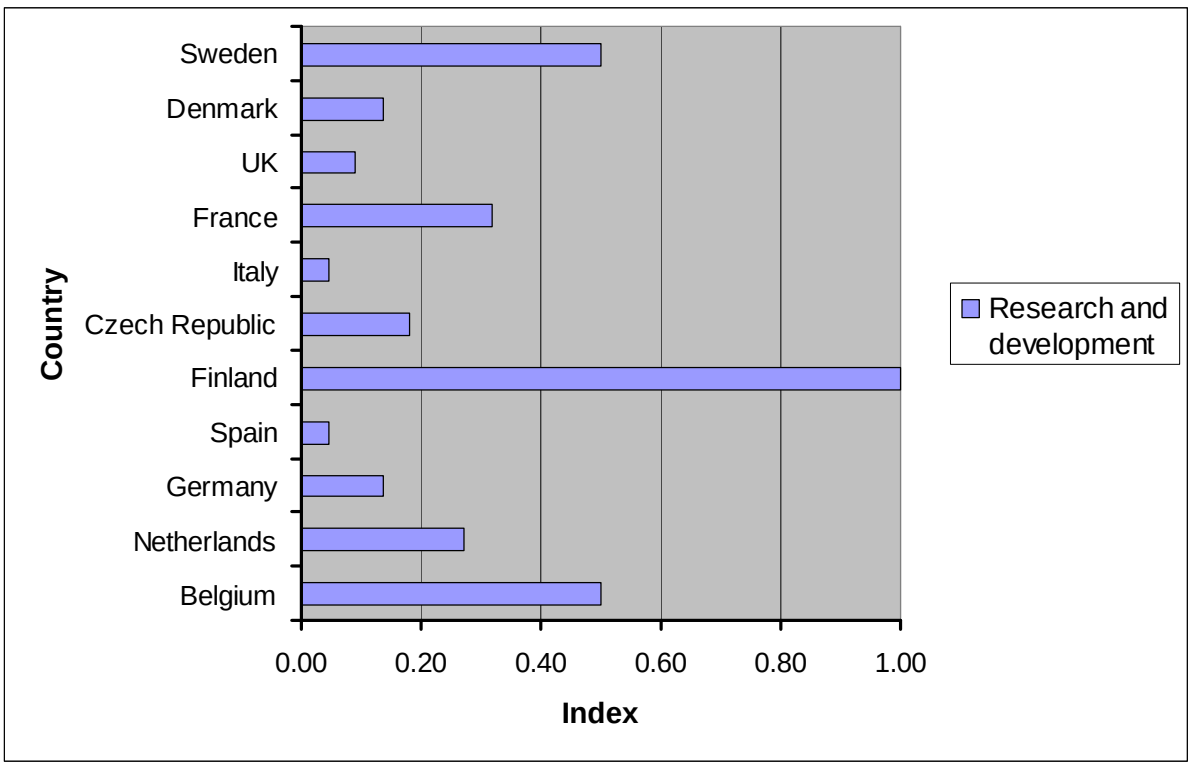
8.4.17 Overall the results of the tests for national labour productivity (Figure U), the Resource Consumption Efficiency index based on Building 2005 Survey and the CPPP adjustments to the Spons-related Resource Consumption Efficiency index (Figure V) all supported the latter which was thus confirmed as the most suitable basis for inclusion in the benchmarking model.

8.5 Innovation and Research/Development

8.5.1 It was apparent that the countries with the most innovative approach to the development and use of resources were generally represented at the high end of the rankings for investment in research and development.

8.5.2 The respective contributions of the countries in the set to Research and Development is shown at Fig W.

Figure W – Countries' contributions to Research and Development



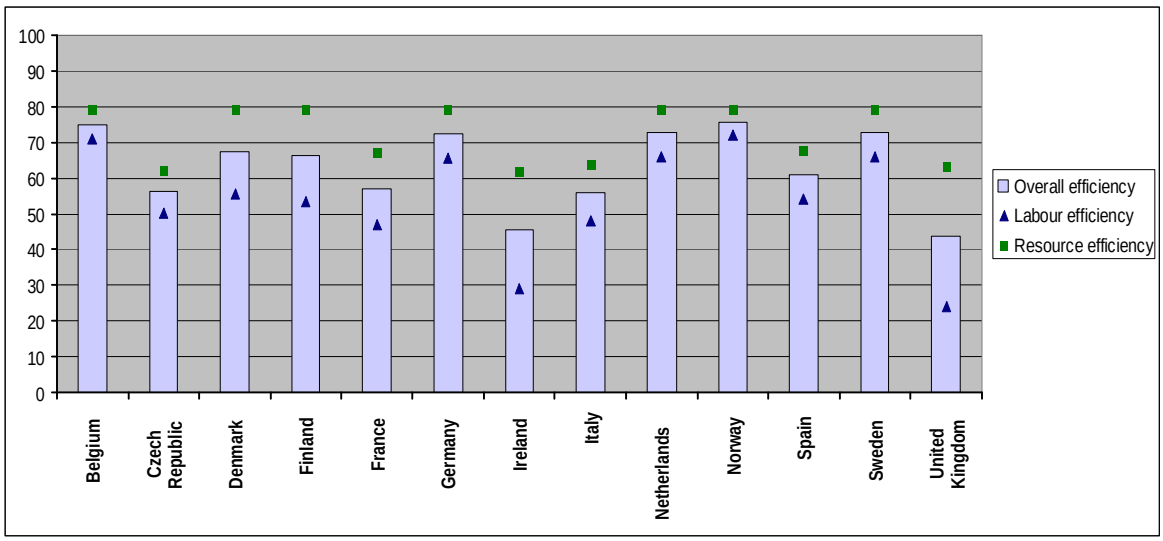
8.5.3 The rankings here generally reflect the levels of innovation, although in one or two cases current levels are depressed due to serious economic downturn. Although the Research Team has serious reservations about all calculations based on the employment headcount (see Appendix N) the differences between the least and greatest in the figure are clearly too great to be the consequence of inconsistent headcount.

9.0 DEVELOPMENT OF THE RESOURCE USAGE EFFICIENCY MODEL

9.1 The consistency of the two indices

9.1.1 As is shown at Figure X there is a strong correlation between the Resource Consumption Efficiency index derived from the analysis of the resource drivers (see Figure P) and the index of Resource Consumption Efficiency based on out-turn prices (see Figure R)

Figure 'X' – Comparison of indices based on resource drivers and project resource consumption



Source:Bernard Williams Associates

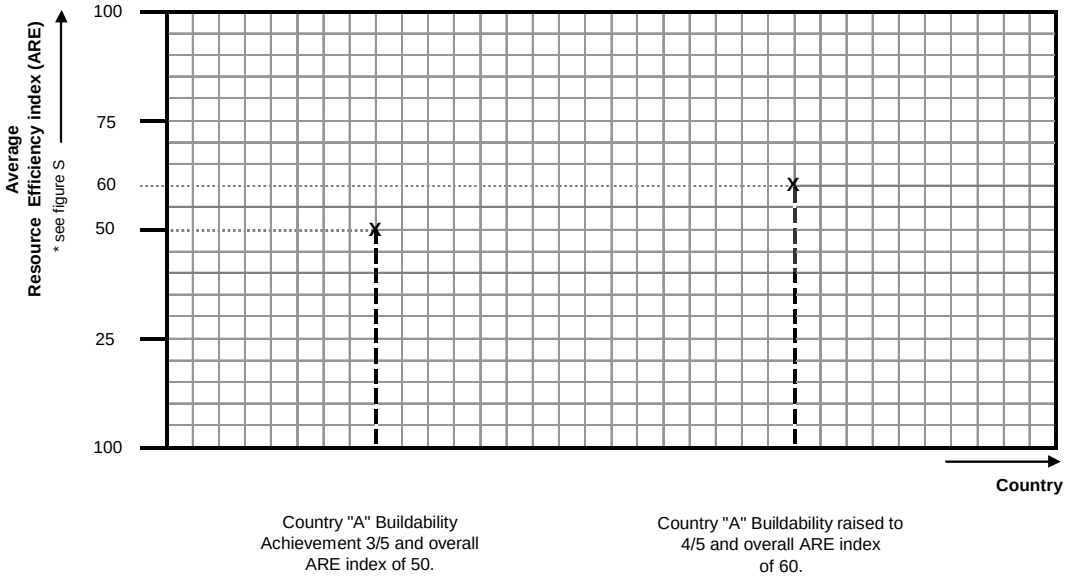
9.1.2 This correlation justified proceeding to the final (optional) stage of the research which was to develop a prototype Resource Usage Efficiency benchmarking model. For purposes of developing the prototype model it was therefore decided to select the average of the two indices for each country as the sole index.

9.2 Development of the model

9.2.1 This model is in electronic format so only a graphic interpretation is able to be included in the hard copy of this report. Figure Y illustrates the operating principles of the model using the sole (average) index derived from Figure X.

9.2.2 This indicates that if Country 'A' were to raise its overall efficiency with regards to 'buildability' from 3/5 to 4/5 then the (average) Resource Usage Efficiency index would increase from 50 to 60 (hypothetical values).

Figure 'Y' -The principles of the Resource Usage Efficiency benchmarking model



Source: Bernard Williams Associates

9.2.3 Clearly it is not be to be expected that the model could ever work as precisely as is indicated in Figure Y and the prototype model at Appendix U (and Annex 2 of the electronic version of this report). However, the principles are considered to be sound and the model could be expected to be made more robust if the underlying data could be subjected to the rather greater in-depth evaluation recommended in the conclusions to this study (see Section 15.3).

9.2.4 The scale of the Resource Consumption Efficiency index (based on the average rates for site labour) as used in the model is not completely accurate in every case – see para 8.2.14. Its use here is mainly for the purpose of illustration of the principles although the rankings are reasonably indicative.

9.2.5 As explained in paras 2.5.17 – 22 a refinement of the hourly rate index incorporating the effects of different cultural approaches to construction has been developed during the final stages of Report writing. This index, together with a description of its construction and inclusion in a further development of the model is included Addendum 1 to this Report.

9.2.6 Nevertheless, countries can already deduce from the initial model the effects of their industry's apparent shortcomings on the efficiency of the way their resources are used – and a reasonable estimate of its significance/value in real terms.

9.2.7 The following sections briefly consider the roles of the stakeholders in construction, their influence on the resource drivers and areas for potential immediate improvement in their contribution to the process.

10.0 A REVIEW OF THE FACTORS FOUND TO BE RELEVANT (OR POTENTIALLY RELEVANT) TO LEVELS OF EFFICIENCY

10.1 Dossiers of information

10.1.1 In order to facilitate:

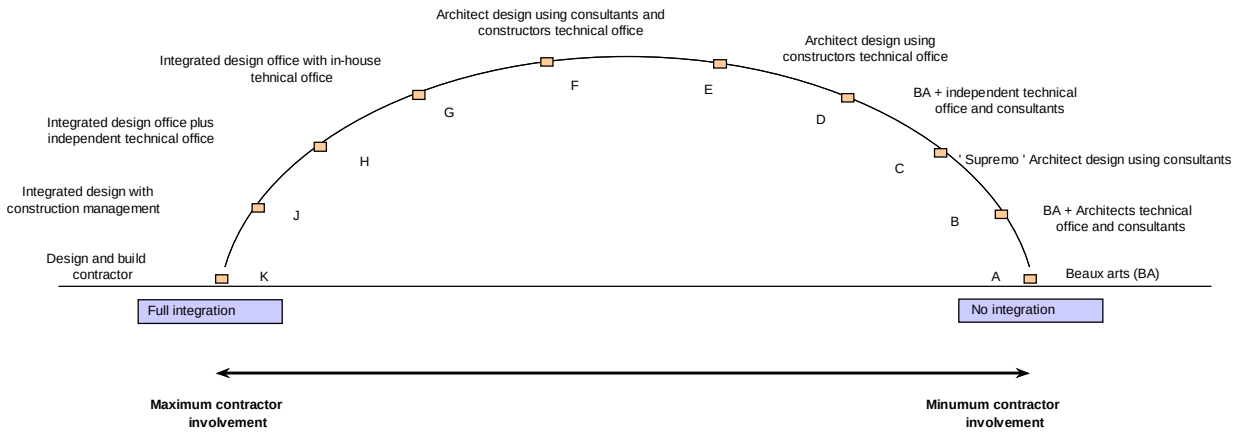
- Ÿ cross-country comparison of key factors
- Ÿ highlighting of gaps in information availability

the Research Team created a dossier on each country using an Excel spreadsheet – see Appendix V.

10.1.2 These dossiers, completed as far as possible as at the report writing stage, were based largely on the information recorded at Appendixes I and M. Although not a specific requirement of the brief for the project they will be sent to key informants (post-project) for validation/completion in the interests of further research in this field.

10.1.3 Amongst other things the dossiers contain references to the various roles of architects, technical offices and constructors with regard to selection of process and materials. These features are seen to be a critical determinant of resource-usage efficiency and the relative extent of architect/contractor responsibilities/influence drawn from the dossiers is illustrated at Figure Z.

Figure 'Z' – Relative influence of architect and constructor on choice of materials and processes



Source: Bernard Williams Associates

10.1.4 This and the other information from the dossiers, literature review and Key Informant Interviews was used as a point of reference as to qualifications and explanations of the findings in Section 15 - Conclusions.

10.1.5 Since the conclusions from the research indicated a strong correlation between the efficient use of resources and the specification of components (i.e. traditional v industrialised cultures) it seems clear that access to considerable expertise in making such decisions is critical to the overall efficiency of use of resources on a project.

10.1.6 Where, as is believed to be the norm in most countries, this expertise is not directly available from within the design team then some construction management input will probably be required if optimum efficiency is to be achieved (i.e. somewhere between options D and K in Figure 'Z'.

10.17 For this reason, design processes which permit or encourage the proactive involvement of the constructors (or consultants with the necessary expertise in construction economics) are considered more likely to generate a more efficient use of resources on a project.

10.1.8 This does, of course, have significant implications for the apportionment of liability for any failures – see 14.3.9 -14

11.0 AN OVERVIEW OF THE PROJECT OUTCOME

11.1 Innovative elements

11.1.1 The following elements are considered to have been innovative:

- development of a classification system for research literature in the field
- creating a database for this classified information
- in-depth analysis of resource drivers
- creation of a resource-usage efficiency index
- relating the index to sectors
- modelling the index by relating calculated achievements against theoretical efficiency indices
- avoiding the use of purchasing power parity by using simply the hourly rates of pay for on-site labour as a divisor (see further extensions of this technique at Addendum 1).

11.2 Quality and reliability of the data

11.2.1 This has been addressed specifically in the appropriate sections of the work.

11.2.2 Overall we believe that there is a general consistency between:

- results using different sets of cost data
- questionnaire/informant responses and the Research Team's findings

The Research Team is therefore reasonably certain that there are no fundamental flaws in the data which would invalidate the conclusions.

11.2.3 In particular, given the extent of different building types compared and indexed in the analysis of 'Spons European Handbook 2000' (see Section 8.3) it seems unlikely that the overall index thereby derived could be seriously inaccurate.

11.2.4 The Research Team carried out independent spot checks on all the data sources eg: confirmation of rates/hour and building costs per m². In the few isolated cases where significant and obvious anomalies have been discovered the Research Team used its own directly obtained data in place of the published figures; however, the results were found not to be sensitive to these adjustments.

11.3 Reliability of findings

11.3.1 Although this was a relatively low-budget research study – given the magnitude of the issues to be addressed – the Research Team believes that the approach adopted, using experienced practitioners to interpret the data and draw conclusions therefrom, is an important and valid alternative to research carried out using a more conventional, mainly academic, approach.

11.3.2 Expert knowledge of the pitfalls facing an unwary, inexperienced researcher attempting to use the data sources adopted here was fundamental to the Team's confidence in the selection and use of data sources.

11.3.3 Discussion of the findings with the MSG and key informants led to the conclusion that most experts found the results credible given their own experiences.

11.3.4 Nevertheless it must be recognised that considerable further research will be needed before it would be possible to state categorically that there were no possibly significant variations from the data presented and the conclusions drawn from it.

11.4 Problems encountered and how to overcome them

11.4.1 The principal problem was persuading busy people to give their time to the project without payment.

11.4.2 This could be overcome in future by allocating funds in the research budget for facilitated workshops involving selected experts who would be paid a reasonable academic hourly rate – as is the case when experts give presentations to academic courses.

11.4.3 The relationships between the European trade and professional associations and their members do not provide a fruitful avenue for making contacts with researchers.

11.4.4 It is possible that the Commission could consider how it might help those organisations to create greater interest among their members in the Commission's research initiatives.

11.4.5 The Research Team believes that the database and classification system for learned papers and books developed during the project could be of great use to future research teams in the field. However, it would need to be expanded and updated outside of this present project.

11.4.6 Language translation of technical material was a major problem. The Commission could help by:

- creating a list of accredited translators specialising in the various fields
- allocating budgets for translation as part of a project's expenses

11.4.7 On the positive side, communications with the Commission's representatives were excellent and the Research Team had no suggestions for improvements in that area.

12.0 COLLABORATION ESTABLISHED DURING THE WORK

12.1 The list of contacts established

12.1.1 The list of all collaborating organisations and personnel is contained in Appendix E.

12.1.2 These included:

- Ÿ National Administrations
- Ÿ Industry Associations
- Ÿ Public Authorities – national and regional
- Ÿ Industry experts – academic and commercial
- Ÿ Special knowledge bodies (eg: Research Institutes etc)

12.1.3 Press releases were sent to 70 media publications but it is not known how many actually gave publicity to the project. It is however known that Construction Europe put in a major reference in the December 2005 issue – see Appendix F.

12.1.4 Many of the bodies and personnel who have collaborated with the Research Team on this project have expressed interest in and enthusiasm for the prospect of being consulted/involved in any further initiatives in this field and/or development of the model.

13.0 CONCLUSIONS FROM 'REVIEW OF PREVIOUS STUDIES'

13.1 Synopsis of key findings

13.1.1 A schedule of the papers to which the Research Team has referred is included at Appendix I (and also at Annex 3) together with a brief note concerning the information drawn from each for use in the study.

13.1.2 The usefulness of the review became more apparent in the later stages of the project when gaps in the knowledge-base became clearer

13.1.3 There was a general lack of material dealing in depth with the resource drivers identified in this Report.

13.1.4 Some of the data in the literature relying upon published statistics was apparently incorrect; this was in part due to the difficulties of interpreting official statistics and in part to inadequate working knowledge of the factors underlying the sources of data.

13.1.5 The data-base is presented in its entirety as a standalone annex to this Report at Annex 1. Read in conjunction with Appendix I (and Annex 3) it can be used as a stand-alone Report on the literature review in the context of this study.

14.0 CONCLUSIONS FROM INVESTIGATION OF FACTORS INFLUENCING RESOURCE USAGE

14.1 The intentions of the study

14.1.1 It was not part of the terms of reference for this project to reach categoric conclusions as to the reasons for one country having an apparently better use of resources than another. However, the proposal did indicate that it was expected that some immediately useful conclusions would emerge, and they have. These are summarised below.

14.2 The country rankings

14.2.1 Neither the indices created nor the rankings derived therefrom can be taken as definitive; they have been computed from the best data available but primarily for the purposes of proving that such a methodology is feasible.

14.2.2 Nevertheless a very distinct pattern has emerged in which those countries which appear to have the best resource-usage, as calculated here, all benefit from one or more cultural features in their construction industries which are believed to be directly correlated to such apparent efficiency.

14.2.3 The following factors are common to all or most of the countries which achieve the best resource-efficiency ratings from this study:

- a pre-disposition to use prefabricated components and systems
- extensive mechanisation of materials-handling on site
- total or partial delegation of the choice of materials and detailed design development to the constructor
- a well-paid, well trained, industrious workforce
- limited scale of sub-contracting
- well-developed, lean construction management
- single-point responsibility for design and construction

14.2.4 Some countries were already majoring on the ‘Bauteam’ approach to integrated design/construction using a negotiated target cost with shared cost savings; most of these countries were already among the most efficient but still considered that the lack of a **single point of responsibility** for design and construction in their conventional culture was a disadvantage.

14.2.5 The countries which were not among the best performers in the Resource Usage Efficiency index had construction industry cultures which were more or less diametrically opposed to those of the rest of the peer group.

14.3 Other possible indicators and influences.

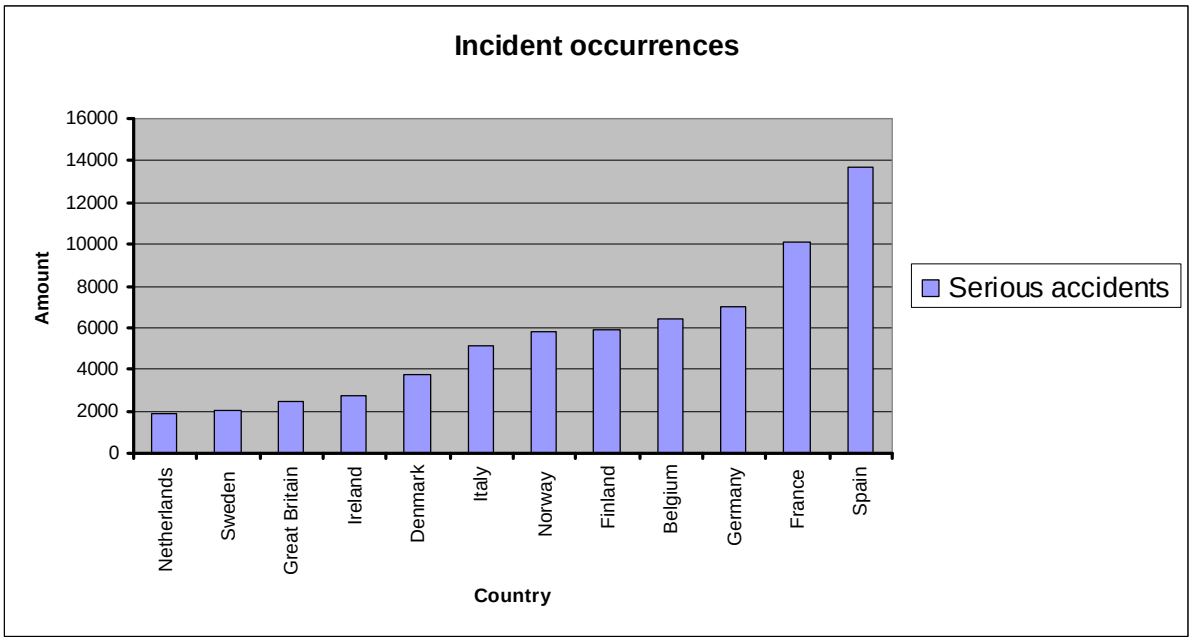
14.3.1 The Research Team was unable to establish clear conclusions in respect of three key issues which arose in the course of the study which could be indicators and/or causes of resource-usage efficiency:

- Ÿ health and safety management on sites
- Ÿ the use of direct trade contracting
- Ÿ liability and insurance.

14.3.2 The most recent Eurostat Health and Safety at Work statistics for Serious and Fatal Accidents on construction sites are given at Figure AA and BB

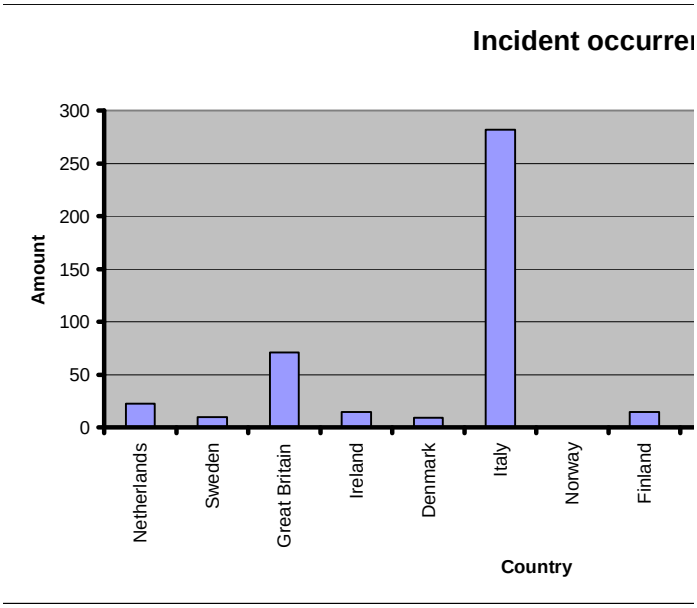
.

Figure 'AA' - Statistics for serious accidents on construction sites



Source: Eurostat

Figure 'BB' – Statistics for fatal accidents on construction sites



Source: Eurostat

14.3.3 It was expected that the countries with the most efficient resource-usage would have the better-managed sites: on the assumption (a view expressed or confirmed by all of our key informants) that 'a well-managed site is a safe site' then the leading countries in the index would be at the top of the safety league too. However, this was not always the case. One or two of the apparently less efficient countries had good site safety records and some of the countries with good efficiency ratings were at the wrong and of the safety rating.

14.3.4 The experience of UK and Ireland in early implementation of the 'health and safety planning supervisor' role probably explains their better-than-average results in this area. However, the fact that two of the best performing countries in the index ie: Germany and Belgium, were well down in the safety league suggests a need for further investigation of this anomaly at a future time.

14.3.5 The comparison between the Netherlands and Belgium is particularly interesting in the light of the opinions expressed in Key Informant Interview No. 8 which describes the Belgium culture as 'chaotic' and 'flexible' and the Dutch culture as 'rigid'. Both countries produce buildings with efficient use of resources, but the Dutch sites are also very safe, which cannot be said for those in Belgium.

14.3.6 It would therefore appear that a well managed site in construction terms is **not** always a safe site, and that a safe site is **not necessarily** well managed in other respects.

14.3.7 **Direct trade contracting** under the direction of the architect, a maitre d'ouvres en bâtiment, Bauleiter etc. was expected to yield inefficiencies compared to professional construction management by dedicated construction companies (management contractors or general contractors). However, although this seems to be borne out in the respective Health and Safety statistics for both France and Germany, where the

system is most common, there is quite a disparity between the two countries in the resource-usage efficiency index.

14.3.8 Again, a future investigation into this apparent anomaly could be expected to be extremely fruitful.

14.3.9 With regard to **liability for design and failure and insurance against risks** the picture was very varied as between the set of countries. – see Appendix W

14.3.10 In those countries where the constructor took the lead in design detailing there was no apparent lack of willingness so to do, although the extent of and location of insurance cover for consequent liability seemed to be generally something of a muddle – at least to the outside observer.

14.3.11 Where this position was rationalised by overall project insurance cover as in Belgium (and less holistically in France) it was only applied to about 10% of projects so could not be categorically stated to be the major reason for that country's overall high level of resource - usage efficiency.

14.3.12 Nevertheless, when considered in the context of a lack of formally imposed Building Regulations, it does clearly influence the lean and innovative approach to many key buildings in Belgium (and in France, although the latter's liability insurance system can be litigious and less conducive to innovation than in Belgium, and does not appear to result in particular efficiency in the use of resources).

14.3.13 The involvement of non-architects in proposing economic design solutions is really a matter of building effectiveness which is outside the scope of this study. As such the issue of indemnity insurance has not been considered here in further depth.

14.4 The model

14.4.1 The model linking the conclusions from our study is described at Appendix U. The Excel model derived from this is provided as an annex to the electronic version of this report at Annex 2.

14.4.2 An amended version of the model incorporating a more robust version of the Resource Consumption Efficiency index is included at Addendum 1.

15.0 OVERALL CONCLUSIONS

15.1 Results of the study – in principle

15.1.1 The results from the study can be briefly summarised as follows:

- § it was proved to be feasible to identify and (at a very high level) quantify differences in resource-usage efficiency (including as-built quality) between the countries in the sample
- § it was also possible to identify the principal issues of culture and methodology to be explored when attempting to identify the root causes of the differences
- § certain features were present in the cultures of the most efficient industries which appeared to present 'prima facie' evidence of their importance; these features were borne out by the responses to the questionnaire surveys and the key informant interviews
- § it was possible to produce a simple model enabling countries to compare their performance and methods against the others in the set and to understand where improvements might be achieved
- § the use of all the established methods and indices using macro-economic statistics was found to be invalid and/or unreliable for international construction cost efficiency comparisons.
- § the Total Project Labour Input (TPLI) Index developed in the final stages of the research and described in Addendum 1 is considered to give a strong pointer to a potential solution to the acknowledged problem of international construction cost comparisons.
- § in general, it proved to be feasible to compare countries' industries' performances by using a combination of project cost analyses, informed commentary, published literature and expert interpretation; a similar approach in greater depth could be expected to be extremely rewarding.

15.2 Results from the study – technological findings

15.2.1 The conclusions regarding technological issues are addressed in detail in Sections 13.0 and 14.0 above.

15.2.2 Overall the key determinants in resource-usage efficiency as reflected in the correlation of the resource usage efficiency index and the hourly rate/sq.m. index at Figure X appear to be:

- Ÿ rationalisation of the on-site/off-site production balance
- Ÿ mechanisation of materials handling on site
- Ÿ attention to the principles of 'buildability' in the design stage
- Ÿ involvement (possibly integration) of the constructor, or experts in construction economics, in decisions about design, specification and detailing

from the earliest possible point in the process, and certainly no later than the 'detailed design and specification' stages

- Ÿ training and motivation of the workforce – plus their inherent qualities of industry and diligence
- Ÿ best practice management

15.2.3 These factors represent the Research Team's considered views in the light of every aspect of the issues addressed in the study. They are borne out by the literature review and the Key Informant Interviews. A detailed cross-reference from the literature review and Key Informant Interviews to these conclusions and the audit trail leading to them has been prepared in Addendum 2 to this report.

15.2.4 The role and influence of architects, technical offices (bureaux d'etudes) and other designers varied from country to country; however, only in the least efficient countries (according to the indices) was the all-powerful role of the designers (and attendant diminution of the constructor's role in selection of components and processes) an obvious influence on resource-usage efficiency (see also Appendix I)

15.2.5 There was some anecdotal evidence (undocumented) to suggest that resource-usage efficiency resulting from extensive industrialisation of the process in some countries is producing a less varied built environment than in those where designers have more catalogues from which to choose – and elect to use them freely.

15.2.6 It is considered that it would be counter-productive to draw specific attention in these conclusions to good or bad performance in any one or more countries. They will know who they are by looking at the data and drawing their own conclusions. In any case, this study has only been concerned with **construction efficiency** not the **effectiveness of the output**; the latter is actually more significant at a macroeconomic level. Insofar as the design process is a determining factor in the latter as well as the former **the results of this study must not be seen as a definitive judgement on the overall effectiveness of any one country's construction industry over another's**.

15.3 Potential for further research and development

15.3.1 Key areas for research needed for improving the quality of results obtainable from a study of this nature include:

- Ÿ building cost analysis – all categories in each sector in each country
- Ÿ hourly rates of pay and labour on-costs for all categories of worker in each country
- Ÿ extent of the migrant 'declared' and 'undeclared' workforce in each country
- Ÿ construction PPPs – their construction and validity for this purpose
- Ÿ more detailed evaluation of all the issues addressed in the Questionnaire

- how the EC could help researchers to get better responses to their enquiries
- measurement of the performance of buildings – functional and physical – to facilitate better comparison of value

16.0 SUGGESTIONS FOR FURTHER COMMISSION INITIATIVES

16.1 Benchmarking – 'first-strike' process : definition

16.1.1 This project has entailed the type of benchmarking study which the Researchers describe as 'first-strike'; this has been defined as 'ways in which basic information gathered during the course of a high level study can be used to highlight areas where there is clearly something …. to be investigated immediately' (Bernard Williams – 'An Introduction to Benchmarking' - IFPI Ltd 2000).

16.2 Follow-up initiatives

16.2.1 The normal consequence of such a study is that the sponsor would commission further studies to explore either:

- potential irregularities in the data
- areas where production process improvements seem, on the face of it, to be necessary
- areas where best practice is apparent – and its applicability to others, particularly those in the benchmarking set

16.2.2 Suggestions for improving data credibility have been given in the conclusions at item 15.3

16.2.3 The most obvious **areas for improvement** of the construction process would seem to be:

- allocation (and possibly integration) of responsibility for design and construction
- rationalisation of on-site/off-site manufacture
- mechanised methods of materials handling on site
- application of the principles of 'buildability' in the design process
- training and motivation of the workforce
- health and safety management
- general management skills
- control and management of change

16.2.4 Areas where **best practice** is apparent include:

- systematic approach to industrialisation – on- and off-site
- 'just-in-time' component delivery and installation
- integrated design/construction project arrangements

- combination of construction economics skills with other disciplines (e.g. the Bauleiter in Germany)
- 'informed client' involvement in project design and execution

Bernard Williams Associates
March 2006