Prefabricated **Schools**

Executive summary of a review of recent small scale prefabrication projects at Eastern Region schools

by Dr. Christopher French, PhD., Dip Arch., R.I.B.A.

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Cover Picture: Structherm prefabrication project under construction

Foreword

by Building Research Establishment

Public and private expenditure on construction of buildings is as high as it has ever been. This increased spend has come at a time when drivers such as skill shortage, legislative change, quality, and health and safety improvements are at the forefront of industry's concerns. This poses the question, how do we increase our output of buildings when these drivers seem completely at odds with increasing the volume?

As an industry we, with the backing of Egan and others, felt that doing more construction off-site would help improve an industry that had not changed many of its delivery methodologies, products or processes for over 100 years. The Government named this approach 'Modern Methods of Construction' or MMC and hopes to achieve "a step change in the construction industry to produce the quantity and quality of new buildings we need".

Schools - a key driver for change

Building Schools for the Future (BSF), the Government's largest programme of investment in school buildings for the last 50 years, is well underway. With an investment of £5 billion per annum for the next 10 years, it aims to rebuild or refurbish every secondary school in England. This represents an opportunity that will not arise again for many generations. Add to this a similar objective (although possibly with slightly lower funding levels) for the primary sector, due to start in 2008, and the commitment the Government is making in the schools sector is very considerable.

This commitment, however significant, must not be misunderstood. The BSF programme is an educational transformation programme. Its objective is to bring about a change in the way education is delivered at a national level by focusing on the educational outcomes rather than outputs. This means that to fulfil the Government's objectives both client side and supply side must consider the value of all that they do in terms of how it improves the outcomes for all stakeholders involved with the school.

The role of MMC in building schools for the future

The role of MMC varies significantly whether schools are being rebuilt or refurbished (approximately 50/50 for the BSF programme), but the key challenges are to achieve high levels of design and construction within a tight timeframe whilst giving value for money. When BSF is in full swing a project will be completed nearly every day and this will struggle to be achieved without consideration of MMC. As discussed, the Government has recognised the importance of MMC to its building programmes and is clearly trying to encourage its adoption in the housing and other sectors.

The most highlighted benefit of off-site construction is the potential to increase construction speeds. Construction speed is enhanced by less reliance for specialist skills on site and reduced risks associated with adverse weather.

In order to fully realise the potential of MMC it is important that the advantages and disadvantages of the different types are fully understood, so that the right decision is made in selecting one system over another.

Scope and Methodology

Commission

This research was commissioned and funded jointly by NPS Property Consultants Ltd and Essex County Council and carried out on their behalf by an independent researcher, Dr Christopher French, between May 2005 and May 2006.

Drivers for the Review

The desire to investigate the use of off-site prefabrication on Local Authority school building projects came from a situation where some schools and education project officers were urging designers to use prefabricated systems in the expectation that they would see substantial savings in cost and quicker completions.

Much of this expectation was based upon data provided by the manufacturers of volumetric buildings, and independent information on which to base a decision to use prefabrication or traditional construction was at best hard to come by.

Size of Projects

To ensure the review was manageable and useful conclusions could be drawn. It was decided at an early stage to restrict the size and location of projects to be studied to small scale buildings of under £0.5m in value to provide either 2 to 4 classbases or a new hall. The desire to include as wide a sample as possible led to the inclusion, however, of one or two significantly larger projects than the threshold, but this was thought to be a reasonable compromise.

Eastern Region

The property departments of the five shire counties in the eastern region comprising Norfolk, Essex, Cambridgeshire, Suffolk and Hertfordshire have a good working relationship, often working in partnership, and it was decided that the research would be restricted to these Eastern Region Authorities.

Methodology

The research includes 21 reviews of projects carried out in the Eastern Region Counties since 2001. These projects have a good geographical spread and involve classbases and halls using several different volumetric and panel systems.

Outcomes

The desired outcome of this review is a balanced assessment of the pros and cons of off-site prefabrication versus traditional forms of construction, based on actual projects which might provide guidance to clients and designers on the issues to be considered before making decisions on project procurement options.

Full Length Report

This report is a summary of the research author's findings and assessments. A CD is available from Lansdowne Publishing Ltd, 11-12 School House, 2nd Avenue, Trafford Park Village, Manchester M17 1DZ, containing a 300 page illustrated report with all the material covered by the review, which will allow readers to drill down into the collected data, read reports of individual project reviews, see plans, photographs of the buildings and read interviews with the various stakeholders.

Volumetric Sure start Unit at Hazelmere Primary School, Colchester, Essex.

The Eastern Region Scene

This review has been undertaken in the Eastern Region partly because the two sponsoring partners are based in that region and partly to ensure the project was of a manageable size given the time and funding available.

Four of the five authorities that have contributed to the review, have approached off-site prefabrication from a different standpoint:

Essex County Council

Essex County Council has pursued a programme of off-site development for their smaller education projects for over 5 years. The first batch of projects emanated from a competition held with the Design Council, which aimed at finding prefabricators and designers with new ideas. The successful designers and prefabricators were commissioned to develop five projects using a timber panel system to construct classbase extensions and new halls on various school sites throughout the county, and they are all now complete and the subject of this review.

The first batch encountered several difficulties, mainly around cost control and the supervision and programming of site work, due to the manufacturers and designers relative inexperience.

The County Council were, however, committed to developing MMC and they commissioned a second competition using its framework designers to develop a timber panel and steel framed volumetric system for several children's centres, classbase extensions and new halls at Essex schools.

The eight projects using three different timber panel and steel framed volumetric systems are now complete and are included in this review.

Timber Panel System Hall at Rickling Primary School, Essex.

Steel Framed Volumetric Classbases at St Andrews J & I School, Colchester, Essex.

Timber Panel System Hall at St Marys Primary School, Ardleigh, Essex.

Norfolk County Council

Norfolk County Council and NPS Property Consultants Ltd (NPS) have been using off-site prefabrication construction methods for the last five years and four of these projects are included in the review.

Norfolk County Council and NPS have used the Guildway timber frame system, which consists of timber-framed panels delivered to site with plywood sheathing. The panels are then bolted together onto a prepared solid concrete base by the general contractor and a pitched trussed rafter roof is erected upon the panels. The building is then clad with a range of materials on site and windows and doors inserted. The mechanical, electrical and finishes are completed on site in the traditional way.

The Eastern Region Scene (Cont.)

Timber Panel System Nursery Unit at Woodside Primary School, Norwich, Norfolk.

NPS has also used a few volumetric systems manufactured by companies such as Terrapin where the client has requested their use or where the minimisation of the site construction period was advantageous.

Cambridgeshire County Council

Cambridgeshire County Council and its in-house property professionals have pursued off-site prefabrication as a way of tackling the various skill shortages in the county and speeding up the construction process.

Cambridgeshire looked at a number of systems about four years ago including insulated concrete panels, timber frame and metal frame, but concluded that the most promising of these was the Structherm insulated concrete panel system.

This system comprises a series of storey height structural panels of a reinforced concrete and insulation sandwich construction, made in a factory and delivered to site for erection by a team of specialists who clip the panels together to form a rigid load bearing inner skin for the external walls and internal partitions which help to brace the structure. Structherm can also provide a flat or pitched roof structure.

Structherm is very much the principal specialist sub-contractor to a general main contractor. The main contractor undertakes the lion's share of the work on site, but Structherm take design responsibility for their element of the building and warrants the design.

Hertfordshire County Council

Hertfordshire County Council has a long and distinguished history in the field of off-site prefabrication, having been involved in the development and use of the post war lightweight steel frame and concrete panel system called SEAC (South East Architects Collaboration). The system was used for some time, but the last SEAC system buildings were constructed in Hertfordshire during the late 70's.

The County's Property Department and its private sector successors have, since then, used in the main traditional methods of construction for building creating detached, pitched roof "pavilions", and a number of value for money initiatives have been run in Hertfordshire comparing building methods and specifications adapted for County Council projects with those used in the house building sector.

Two prefabricated projects are included in this review, a teacher resource centre at Birchwood High School, Bishops Stortford using the Elliot volumetric system clad in timber for its construction and a new two storey teaching block at Knights Templar School, Letchworth using the Rollalong volumetric system clad in brick.

Concrete Panel System Classbases at Sir Harry Smith Community College, Whittlesey, Cambridgeshire.

Steel Framed volumetric Teachers Centre at Birchwood School, Bishops Stortford, Hertfordshire.

The Project Reviews

Collecting Information

The author visited a selected sample of projects throughout the Eastern Region where off-site prefabrication had been used as a significant part of their construction, interviewed stakeholders to gather information and views about their perception of the projects using a predetermined list of subjective and objective criteria.

Even distribution

Projects which met the size and type criterion set for the study were limited to certain localities, but a reasonable mix of locations, different systems and size was, achieved within the 21 projects studied.

Halls and Classrooms

Most of the projects were multiple classroom projects, but Essex County Council has completed a number of new halls at primary schools over the last few years and these have been included as they present a particular challenge to the prefabricators due to the required height and span.

Assessment Matrix (AM)

In addition to visiting the schools and collecting objective data such as costs, programmes and plans, building users, with help from the author, were asked to complete an assessment matrix where they scored various aspects of the project from 0 to 10.

Inevitably when involving different people, with their own "window on the world", in the assessment of different projects which were developed in differing circumstances, care should be taken in interpreting the results and drawing conclusions particularly when comparing one prefabrication system with another.

Programme dates and project costs incorporated in the text are more objective measures of performance and, wherever possible, have been checked with the project sponsors. Costs have been adjusted to bring them to a common baseline to allow comparisons, but the author takes no responsibility for their accuracy.

Main Issues

It was important, before carrying out the case studies, that the main issues were identified and fully explored before the collection of data and visits to schools. The following issues are important to clients and designers alike:

- **Comparative costs for traditional and modern methods of construction**
- **Comparative time scales**
- **Flexibility and Adaptability**
- **Suitability for project and site context**
- **Comparative quality**
- **Identification and Categorisation of Problems**
- **Restrictions and Opportunities for design variety and innovation**

Costs

Essex County Council Projects

Observations and comments are based on a relatively small sample of projects carried out by Essex County Council between 2001 and 2004 covering a range of facilities that have been broadly categorised as either, classbase projects including children's centres or hall projects. None of the projects has had the final account cleared, therefore the latest available anticipated final cost statement has been used to investigate the price drift between tender value and final value. A similar sample of traditionally procured and constructed projects has been used for comparison purposes.

For the purposes of this report the costs are given for the building alone; external works have been excluded from the analysis. In some cases this has proved to be quite difficult as each of the off-site fabrication companies choose to present their costs in their own specific way.

Inflation

All the projects that have been analysed have been procured during the last four years. To remove the effect of inflation during this period of time all costs have been brought to a common price base, namely 4th quarter 2005. The tender price index applicable during the quarter in which the work was tendered has been used to re-base all of the individual projects. In the case of the comparative traditional projects where a project specific tender price index has been calculated, this has been used to standardise the costs in preference to the quarterly index.

Professional fees

No attempt has been made to include professional fees as part of this research. For most of the off-site fabrication projects it is true to say that there was a small design element included within the tender sum, although this was not always readily identifiable. Such allowances have not been deducted from the value of the project.

Conclusions

Typically the capital cost of off-site classbase projects was some 10% less than traditional projects.

For halls, off-site construction was substantially more expensive than traditional construction with the average building costing almost 35% more in terms of cost per square metre floor area. This is perhaps the most significant factor that can be drawn from this data and probably reflects the fact that large volume hall structures do not lend themselves to off-site fabrication because of transportation difficulties and limitations on the size of unit that can be carried on the public highway without a special escort.

There was very little difference in certainty of cost between off-site fabricated projects and traditional projects, with the anticipated final cost increasing typically by 3% - 5% over the contract value (excluding contingencies), although the classbase projects manufactured off-site appeared to show a slight increase in certainty of cost over their traditional counterparts.

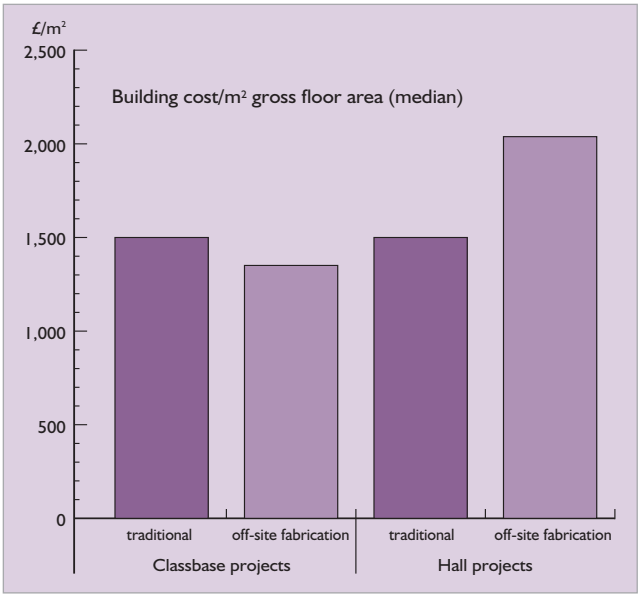
Costs for Projects from other Authorities

Costs have also been collected for the case studies from other eastern region authorities and these have been presented in a similar format, but this information is rather basic and has not been the subject of a rigorous elemental breakdown as in many cases the information was not available. The cost per square metre has, however, been adjusted to the same price base and location index to make it directly comparable to the Essex data.

Individual Projects

Presenting this data as averages does give the reader some idea of the overall trend, but there is a danger that they will be misled into thinking that there is no real cost advantage in using off-site prefabrication. This is clearly not the case as there are some significant cost savings identified for certain individual projects compared to traditional construction. Readers do, therefore, need to drill down into the facts contained in the full report and understand the particular circumstances of each project and how these savings were obtained.

Comparison of Median Costs of Traditional and Prefabricated Projects



Programme and Time Scales

The following observations and comments are based on a relatively small sample of projects carried out by Essex County Council between 2001 and 2004.

The review has concentrated on the construction phase of the programme where off-site fabrication was expected to save time (and the inevitable disruption to school life). It was felt that trying to analyse the pre-contract period would be of little benefit as all projects, whether traditional or prefabricated, are susceptible to delays that are irrelevant to the method of construction, e.g. planning objections etc.

For off-site prefabricated projects the period of time from placing the order to start on site, in other words the actual off-site fabrication period, has been given to show the overall time from commitment to completion. However, the reliability of this data is questionable and any analysis of the results that takes into account this period of time should be treated with caution.

Time on site

Not surprisingly there was a substantial saving in on-site time. The classbase projects were typically constructed in about 4 months compared to 7-8 months for traditional projects of a similar nature. For halls, the time on site was about 6 months and indicated a saving in time of 2-3 months over traditional construction.

Time off site

When the off-site manufacturing period is included the overall time from placing an order to hand over is similar for classbase projects, whereas hall projects fabricated off-site appear to take longer than traditional construction, although the data for calculating the off-site period is not considered to be that reliable.

Programme drift

The actual time on site for classbase projects fabricated off-site typically over -ran the initial contract period by almost 50% and in two out of eight projects over ran by almost 150%. None of these projects finished ahead of the programmed completion date set at the time of placing the order. For traditional projects this over-run was only about 15%, with three out of eight projects finishing on or before the programmed completion date set at the time of placing the order. However, shorter contract periods for off-site construction projects inversely affect the percentage increase. In other words a one-week extension of time on a 10-week contract is 10%, whereas a one week extension on a 20 week contract is only 5%. The typical extension of time for off-site construction projects is about 6 weeks, whereas for traditional construction it is nearer 4 weeks.

For halls fabricated off-site the percentage over-run on site is slightly higher than that for classbase projects at about 56%. This compares with just less than 30% for traditional projects. When translated into actual time, off-site construction projects over-ran by about 10 weeks, compared to 8 weeks for traditionally constructed halls.

When the manufacturing period is added into the construction time for projects fabricated off-site the differences are reduced, but still discernable. The available data for the manufacturing period for hall projects is, however, considered unreliable and might account for such a significant decrease in the differential between traditional construction and off-site fabrication projects.

Clearly off-site construction does save time on site. However, when the off-site manufacturing time is included then the saving in overall time becomes far less significant. Whichever way the data is analysed it would appear that the off-site construction industry tended to be over optimistic with their initial forecast of the time needed to carry out the projects analysed, and in particular they underestimated the on-site construction period.

Time Scales for Projects from other Authorities

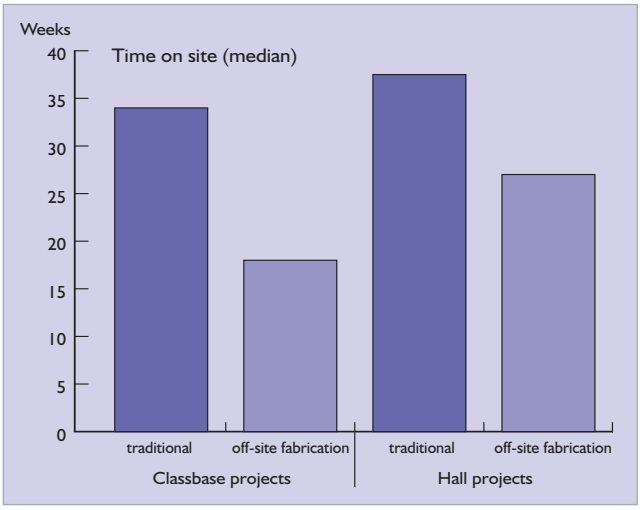
Programme data has also been collected for the case studies from other eastern region authorities and these have been presented in a similar format, but this information is rather basic as some programme information was not available.

Individual Projects

Presenting this time data as an average does give the reader some idea of the overall trend, but there is a danger of misinterpretation.

There are significant timesavings and readers should drill down into the facts contained in the full report to understand the particular circumstances of each project and how these savings were obtained.

Comparison between Median Time on Site for Traditional and Prefabricated Projects



Assessment Matrix

All of the assessment matrices, completed for each project review, have been collated into a master comparator to establish if there are any trends emerging.

It should be remembered, however, that many of these matrix scores are based upon the subjective views of the users.

Scale

Generally most of the scores allocated to the various AM elements do not show vast differences especially when they are averaged over a range of projects and a difference of at least 2 or more points out of 10 might be viewed as a significant trend.

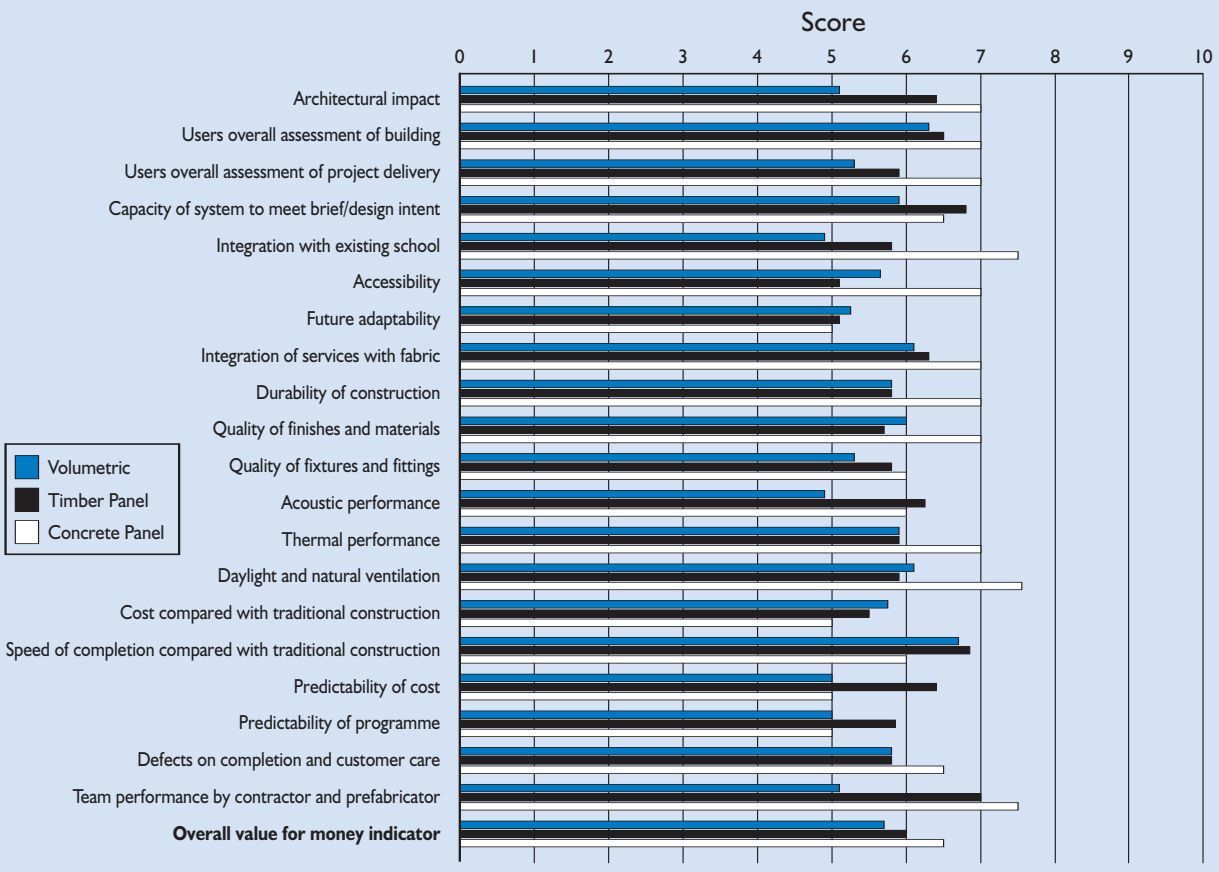
Individual projects and systems do show marked trends in certain areas, however, and these do warrant comment.

The samples are relatively small, particularly the insulated concrete panel system, and caution should be exercised about the conclusions drawn until the system has been used more fully in the Eastern Region.

Types of System

The assessment matrix does not show any marked difference between types of system, but it is fair to say that the concrete panel system has done consistently better than any other. However, the very small sample of projects may have more relevance than the inherent benefit of concrete panel systems.

Comparison of Assessment Matrix between Different Prefabrication Systems



Assessment Matrix (Cont.)

Individual Projects

Clearly the matrix does illustrate significant differences in scoring individual projects. It is, however, difficult to draw conclusions other than that the use of prefabrication did not deliver the expectation of a consistent high quality product and service across the board. Conversely there were some excellent examples of off-site prefabrication used in projects that were well received by their users.

Building users did not express any preconceived ideas that they were for or against prefabrication in principle, but demonstrated a range of views as to the merits or otherwise of off-site construction.

They were, however, concerned about the durability of components and finishes which clearly related to the adequacy of the specification required from the prefabricator rather than the principle of off-site fabrication.

There appears to be little evidence of innovation in the development, construction or procurement systems adopted for the projects reviewed.

Quality of Design

The quality of the design was variable, but was not necessarily limited by the use of off-site prefabrication. The use of prefabrication for halls did provide additional challenges for designers and fabricators alike and this was reflected in some of the scoring. There is work to be done for designers and fabricators to better understand the opportunities and limits for school construction offered by prefabrication systems.

Essex County Council's experience of off-site engineering has revealed a considerable number of design integration, specification and procurement failings that offset the expected benefits. Whilst some off-site manufacturers are very receptive to the client's engineering needs and standards, others have provided the "standard product" irrespective of its suitability. Some manufacturers need to make considerable improvements to match the standards currently achieved by on-site services, engineering and traditional build.

Project Delivery

The arrangement of work undertaken off and on site and the integration of prefabricated elements with the whole development package were key issues in the perceived success or otherwise of a project. There is work to be done integrating the site based construction and prefabrication processes and putting together a more integrated customer focussed project delivery mechanism.

There appears to be both time and cost advantages to be gained by the use of prefabrication, but these do not follow automatically from the choice to fabricate off-site. It is very important to select the most appropriate elements, systems, suppliers and delivery methodologies most likely to meet the requirements of the brief and site specific constraints. It is also important to communicate expected performance standards and where necessary unique requirements for whole buildings, building elements and components.

A robust risk management system operated by the client or agent would appear to be as or more important for projects involving high levels of prefabrication. It is essential for each active project participant to understand their role and who is best placed and responsible for managing risks associated with the quality, cost and programme issues inherent in the manufacture, delivery and integration process.

Successful projects involving significant elements of off-site fabrication require high levels of planning and exceptional teamwork from an integrated client, consultant, fabricator and constructor team.

Guide for Clients and Other Stakeholders

When to consider off-site prefabrication

It is undoubtedly true that the construction industry has been making a real effort in recent years to improve performance through integration of the supply chain and by employing more efficient methods of construction and procurement.

One area for improvement has been in the greater use of prefabrication where better quality control, improved health and safety, and progress can be achieved unaffected by the unreliable United Kingdom weather, can be achieved. Many advantages are claimed for prefabrication some of which can be demonstrated. All stakeholders involved in the procurement, design and construction of small scale education buildings should be mindful of the benefits of supporting modern methods of construction and the off-site manufacturing industry, but might be best advised to consider project management, design, procurement and construction strategies on a project by project basis.

Issues for Clients

Usually the client for such projects is likely to be the local authority, but with increasing delegation this might be individual schools. Clients are advised to consider, the context of their project, their required project outcomes, and 'what's on offer' in the wider construction market place before deciding on any specific course of action.

Probably the greatest consistent advantage offered by off-site prefabrication over traditional construction is the saving in time on site, but clients should consider if this is of significant importance for them. Clients should assess the value of time saved on site and whether this will benefit the client or school users.

The impact on the budget is another important consideration, and if clients are tempted to use prefabrication to resolve a budgetary problem, they need to be aware that off-site construction will not necessarily or significantly reduce costs below that of a traditionally constructed building. Like-for-like specifications, quality and value for money are issues that should be investigated in any comparative assessment of off-site prefabricated or traditional build strategies.

Issues for Schools

Before selecting a prefabrication system for a new building, building managers and users should consider certain questions:

Many of the off-site prefabrication systems are best suited for freestanding pavilions located adjacent to the main school. They are often difficult or expensive to link. How will this impact on operations within the school?

How and when in the future will the building need to be adapted? How easy or difficult might such changes be? In principle a prefabricated building should be no more difficult to adapt than any other type of building, but enquiry prior to purchase is always advisable.

The environmental conditions inside the new buildings at certain times of the year will also be affected by the construction system used. Many prefabricated systems have low thermal mass, which can lead to overheating. Can thermal mass be incorporated within the prefabricated system to help mitigate temperature variations throughout the day and night?

Ask the manufacturer to calculate the number of occupied hours per annum the internal air temperature will exceed 28°C to check compliance with DfES Building Bulletin 87.

Will the project require remodelling of the existing building either to provide access to the new building or to adapt existing spaces displaced by new provision? If so then users and clients should consider letting this work as a separate contract.

Supervision of the site works is a recurrent issue. Clients and their property advisors should undertake appropriate risk assessments and institute the required checks.

It is evident that some design teams and building contractors are more open and knowledgeable than others about the use of prefabrication and modern methods of construction. Clients will derive the greatest benefits from prefabrication when they have the full support of the whole team.

Issues for Design Teams

Off-site prefabrication is best delivered if the whole design team is convinced of its advantages and fully committed to its use.

If a decision is made to use off-site construction then design teams should ensure that the contractual arrangements between the client, members of the design team and contractors are

Guide for Clients and Other Stakeholders (Cont.)

appropriate. There are two views of best practice. Contractors and manufacturers are convinced this will only work through some kind of design and build or partnering relationship, whereas designers feel that the use of prefabricated components are best managed through a simple sub contract. Perhaps the former is more appropriate where off-site prefabrication is more complete and the latter where on-site construction provides the greater proportion of the work.

Designers need to be aware of the opportunities and limitations inherent to the prefabricated building systems and components offered and selected. They should also understand the strengths and weaknesses of input and output specifications and the risks taken in undertaking either strategy. Clearly spending more time inspecting works on or off-site usually delivers benefits in quality.

Poor communications encountered in many traditional and prefabricated projects can cause problems. Design teams should develop and manage a proper network between all parties.

Issues for Manufacturers

Manufacturers should consider project specifics before offering their systems to clients and design teams. They should be open to either amending their design and specification to meet the project brief or clarifying the difference between the client's expectation and the manufacturer's offer.

Initial contacts should not create an environment in which the client and building user acquire an over-expectation of what can be delivered for the budget.

Clearly every system manufacturer wishes to operate profitably and should explain to the other stakeholders their requirements and objectives. Running a factory may have different imperatives and every one should understand and work together in the best interests of the project.

Integration of off-site and on-site work is a problem on some prefabrication projects. Clearly some manufacturers need to improve their skills or partner with others who can offer them enthusiasm, efficiency and improved local project management.

It is also clear that some manufacturers consider that they may have been kept at arms length from the building users and that a direct relationship would have provided greater customer satisfaction.

Many manufacturing plants for prefabrication are based in the northern half of the country. This has meant, therefore, that prefabricated components and buildings are made some distance away from many of their customers in the Eastern Region. Manufacturers might consider a more regional approach to manufacture and their supply chain.

Poor customer care and slow response, to making good of defects, needs to be addressed by manufacturers and traditional contractors alike.

Manufacturers could derive market advantage if they could identify ways in which higher levels of specification and bespoke design could be introduced without having a disproportionate affect on price.

Very few clients, building users or designers are prepared to accept standard designs and specifications where they do not fully meet their requirements and aspirations.

Issues for Contractors

Many of the off-site prefabrication projects studied employed a general contractor to organise the work on-site and finish off the building to a greater or lesser extent.

These contractors were usually part of the local construction industry experienced in erecting buildings and using traditional methods of construction. When invited to act as the site agent for a prefabrication company they clearly needed to make judgements about the possible risks involved. Some of the contractors adopted successful strategies and have completed projects without difficulty, whereas others struggled.

It would appear that the most successful were those, in which the contractor managed the integration of prefabricated components or attended on the installation of volumetric buildings. The less successful were those where the contractor used prefabricated roof or wall panels without sufficient knowledge or experience of their use.

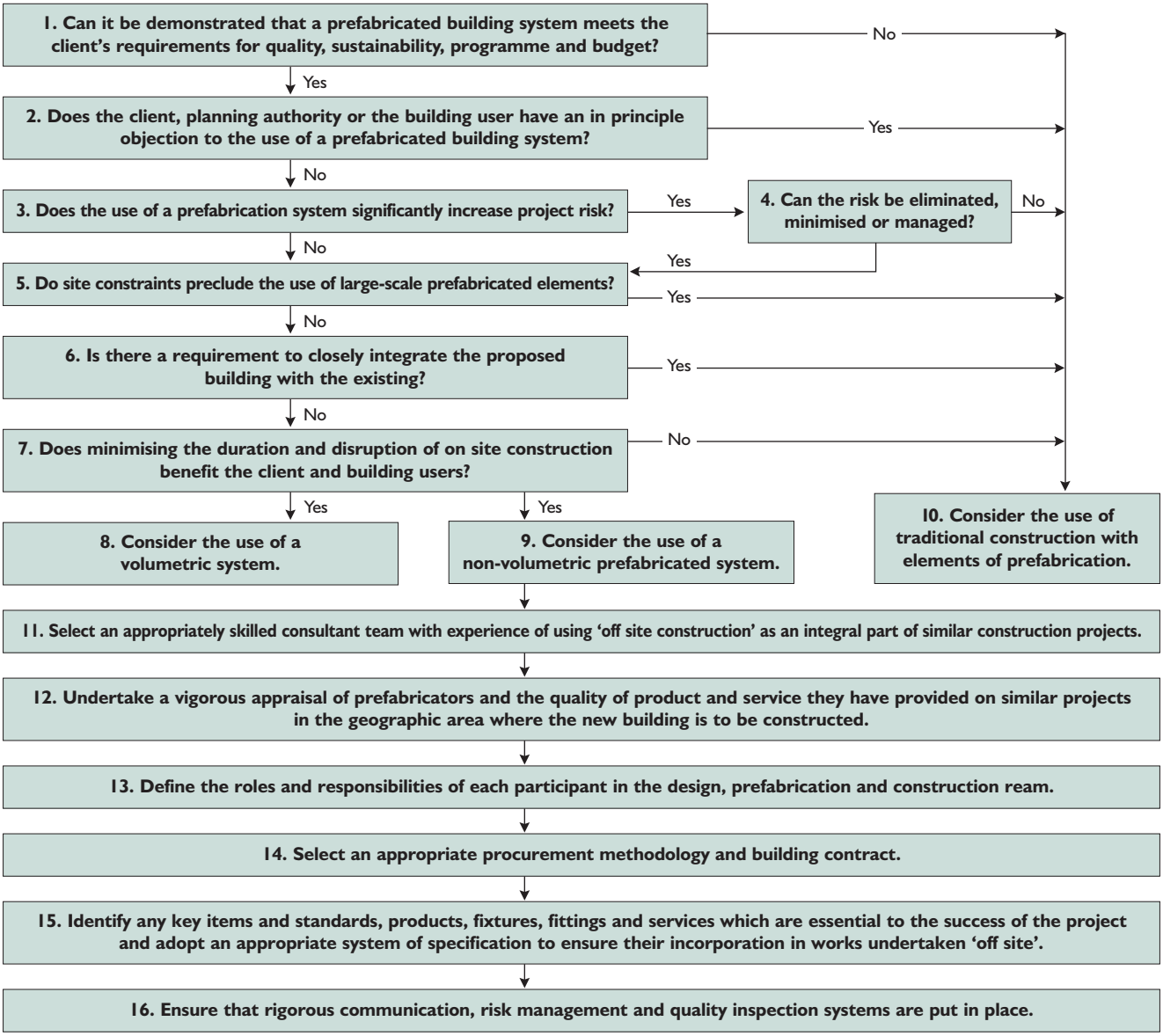
Contracts with traditional contractors on site had less site supervision problems and fewer communication problems with designers, quality inspectors and users. The making good of defects and general customer care appeared better when a locally based general contractor was responsible for site activity.

Construction selection flowchart

'Modern methods of construction' are essential to the future efficiency of the construction industry and the delivery of new building to the required quality, on programme and within budget. Therefore the selection flow chart considers three generic and alternative design and build methodologies all utilising some aspects of 'off site construction':

- **Volumetric building**
- **Non volumetric prefabricated system building**
- **Traditional building with elements of prefabrication**

Clients and other stakeholders flow chart guide to prefabrication choices



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