

REVIEW OF THE UK HOUSING HISTORY IN RELATION TO SYSTEM BUILDING

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ABSTRACT

Housing demands along with the unique conditions after World Wars encouraged the UK government to massively invest in prefabricated methods of construction to address the housing shortages. System building transformed the UK construction industry and greatly affected the socio-economic conditions of the UK the consequences of which are still felt. Despite several efforts of the UK government and private sector, prefabricated methods of construction have been less successful in the UK due to several reasons. This paper is a comprehensive review of the UK housing conditions with regards to housing demand and supply, economic conditions, and policies during the 20th century. The main drivers for moving towards industrial methods of constructions and high-rise flat buildings, and the influence of Modern Movement on industrial building, and mass production, as well as the reasons for the failure of such methods are evaluated and explained in detail. Although the unique post-war conditions created a proper environment for great innovations, it also caused some irreversible damages to the UK construction industry. The study concludes that the UK is currently facing similar issues and the drivers behind the application of prefabricated methods of construction (currently known as Offsite and Modern Methods of Construction) are

almost identical to those of the 20th century. The UK, therefore, needs to firstly learn from its previous mistakes and secondly consider comprehensive research to evaluate and address the barriers towards broader application of such methods to avoid similar social and economic problems.

Keywords: *industrial building, prefabrication, construction methods, system building, UK, housing*

1 INTRODUCTION

Generally, industrialised building systems in the UK have not been very successful due to various reasons including inconsistent governmental policies. Industrialisation of the construction industry was criticised by the society because quantity was valued much more than quality. In many cases designers failed to consider technical matters in conjunction with aesthetics while local authorities were criticised for losing their tenants' identity which caused several social problems such as depression, vandalism and other crimes (Osbourn, 1989).

In fact, the history of UK housing and introduction of new methods of construction in the 20th century are linked to several factors such as the World Wars, Modern Architecture, and Welfare State policies which considerably influenced the construction industry. Huge destruction after World Wars resulted in massive and urgent need for new housing and encouraged the UK government to enter the housing market. Consequently, the massive size of housing programmes which were outside the capacity of existing traditional building resources, including building materials and skilled labour, gave rise to the idea of applying alternative construction methods which were capable of using new materials and non-skilled labourers outside the construction industry (Bendixson, 1965; Finnimore, 1989; White, 1965).

The general belief was that by applying advanced technologies, housing would change from an expensive capital investment to an easily available product. It was hoped that like many other goods, houses could be mass manufactured from main components (Finnimore, 1989; Harvey & Ashworth, 1997). The 1960s was the era of high rise flats applying prefabricated building methods. However, at the same time, arguments against such types of buildings and methods of construction were becoming more evident (Bowley, 1945; BRE, 2002; Finnimore, 1989; Harvey & Ashworth, 1997; UWE, 2009b). During the 20th century about one million prefabricated homes were built (BRE, 2002) which led to negative public attitude toward prefabrication due to the low quality of design (Harvey & Ashworth, 1997), poor materials and building skills (Post, 2003).

There have been extensive research on the general history of the UK housing conditions (Bagenholm, *et al.* 2001; Balchin & Rhoden 2002; Bowley 1945; Bullock, 2002; Burnett, 1993; Cleeve Barr, 1958; Holmans, 1987; Harvey & Ashworth, 1997; Muellbauer & Murph, 1997; Olechnowicz, 1997; Ravetz, 2001; Revell & Leather, 2002; Rodger, 1989; Short 1982; Wellings, 2006; White, 1965); however, less research has been conducted to review, highlight and summarise the most crucial factors with regards to industrialisation and system building, which not only changed the construction industry but also transformed the appearance of the UK cities and led to negative effects on the social and economic conditions of the

country (Osborn, 1989). To this end, this paper intends to explore the history of the UK housing with regards to system building and prefabricated methods of construction during the 20th century. It is aimed to discuss the reasons for the development and failure of such methods. The current situation of the UK housing has strong roots in this period.

2 RESEARCH METHODOLOGY

The research methodology of this paper is desktop research in which data is collected from relevant documents including books, papers, websites etc. published by individual researchers, UK government and other research bodies. Some keywords including UK housing, prefabrication, system building, industrial building, Modern Movement, Modern Architecture, World Wars, and Welfare State, etc. are used to find relevant data and studies from sources such as electronic databases and search engines such as Google Scholar. The outcomes of the literature review are then discussed to identify the critical factors which affected the UK housing market and policies during the 20th century. The focus of the study is on industrial building and main drivers behind the fundamental shift from traditional to prefabricated methods of construction.

3 HOUSING DEMAND AND SUPPLY AND ECONOMY SITUATION

During the 20th century, housing demand and supply were fluctuating showing the cycling nature of the UK house building. There have been several booms and busts in the housing market (Muellbauer & Murph, 1997); however, the general trend of housing has been downward (see Figure 1 below). The rate of new house building in England decreased from over 250,000 in mid 1970s to 200,000 in 1989 and 150,000 in 2004 (Wilcox, 2005). This has been because of two main reasons: first, dramatic reduction in the government's investment in social housing; and second, massive decline in the rate of private sector house building. The low level of house building caused house prices to increase dramatically while interest rates dropped and the economy improved (Wilcox, 2005).

After an increase in housing production in 1950s, private sector faced a period of recession. There were however some peaks in 1967, 1972, 1983 and 1988 followed by recessions in 1970, 1974, 1980 and 1992 (see Figure 1 below). Social housing also decreased considerably during 1950-1960 due to the lack of support from the Conservative government. After this period, there were some peaks in social housing in 1967 and 1975 and depressions in 1973, 1981 and 1991. The number of built houses by the government

reached 26,500 units in 1991, the lowest since the First World War (Balchin & Rhoden, 2002). The government dramatically decreased the allocated budget to social housing during 1993-1995 (Garnett & Perry, 2005). In general, the number of houses built in the UK has been fluctuating since 1965 but the general trend has been downward since 1967 (see Figure 1 below).

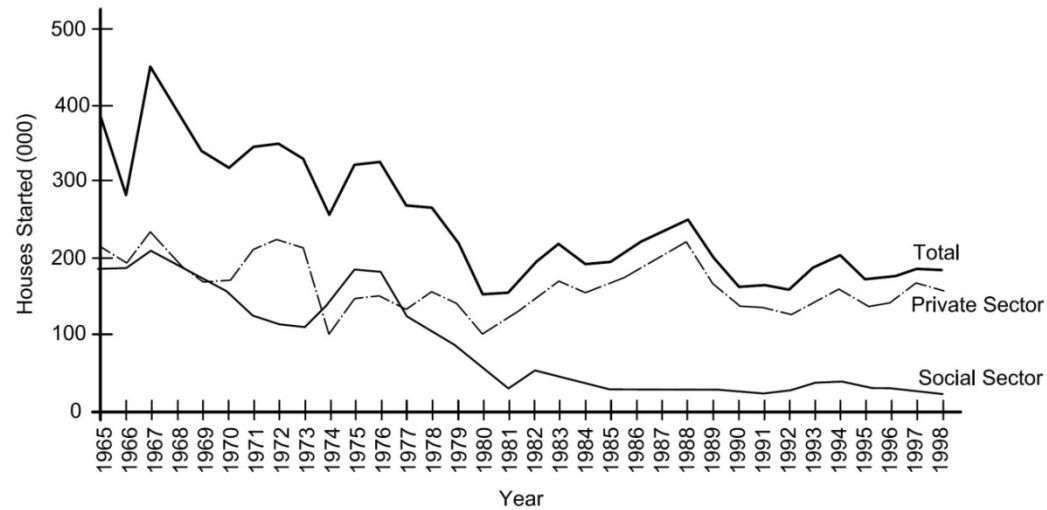


Figure 1: UK house building cycle, 1965-98; Adapted from (Balchin & Rhoden, 2002)

Housing shortage was almost over by 1970s, and by 1981 there was a surplus of about 910,000 houses which decreased to 480,000 in 1998. Housing surplus of 1998 did not however show the real situation in terms of demand and supply since there were more than a million houses in poor conditions (Balchin & Rhoden, 2002). The relationship between demand and supply also differed greatly in different parts of the country (see Figure 2 below) since there were plenty of cheap houses in the North and Midlands

while there were housing shortages in the South and London (Balchin & Rhoden, 2002; Burnett, 1993).

During the 1990s, there were many signs indicating the end of economic recession. Inflation fell from 20% in 1980 to 2-3% in 1996, interest rates decreased from 15% to less than 5%, and unemployment decreased from 12% in mid 1980s to less than 6% by 1990s. In spite of these positive signs, house building and sale did not increase due to the lack of confidence in the

economy (Harvey & Ashworth, 1997). Despite very low interest rates on mortgages which made houses affordable, the memory of very high interests of 1980s, along with the possibility of increasing interests in the future, stopped people from applying for mortgages (Balchin & Rhoden, 2002; Harvey & Ashworth, 1997).

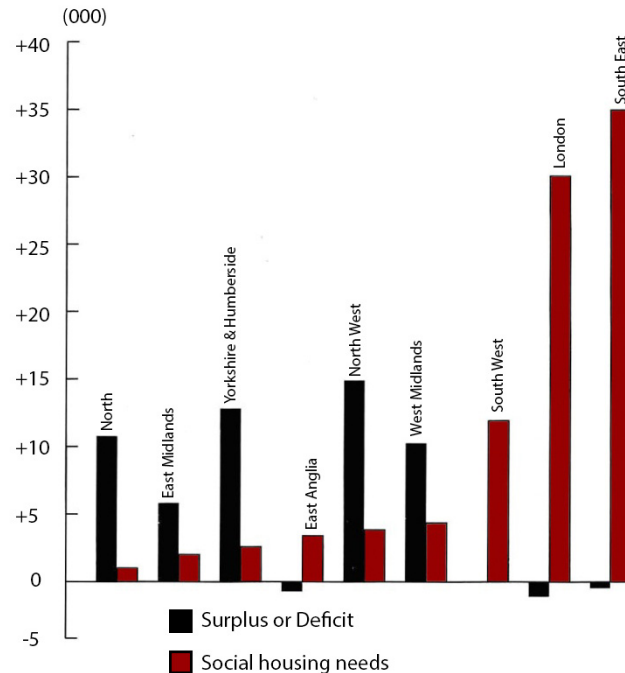


Figure 2: housing surplus and deficit in England, 1998
Adapted from (Burnett, 1993)

Currently, UK housing industry is recovering slowly from the effects of the global economic problems caused by the international “credit crunch” in 2008 (Allen, 2013). According to CIH (2012), around 233,000 housing units are needed per annum during the next two decades. This is while the current recession has considerably affected these figures. Housing supply in

2010 sunk to 102,730 units, its lowest rate since 1924 (CIH, 2011), and only 146,000 units were added to housing stock in 2011 which is 43% less than 2008 (Pawson & Wilcox, 2013).

4 THE UK GOVERNMENT’S INVOLVEMENT IN HOUSING

There have been some issues in the UK’s recent history including housing shortage caused by World Wars, slum clearance, and the high rate of new forming families which encouraged the government to enter the housing market. Housing shortage after the First World War in England and Wales in 1919 was around 600,000 which increased to 805,000 by 1921 (Bowley, 1945). In 1945 after six years of war, 475,000 houses were destroyed or uninhabitable (Cleeve Barr, 1958). Only 200,000 houses were built in this period (White, 1965). In addition to the destruction caused by the war, the population of England and Wales increased by eight million (from 38 million in 1921 to 46 million in 1961) while the number of households almost doubled from 8.7 million to 14.9 million (Halsey, as cited in Burnett, 1933). During 1961-1981 the population increased by about 7% while the number of households increased by about 20% (Burnett, 1993). It was estimated that 300,000-450,000 new houses were required in England and Wales during the first decade after the wars (BER, 2002; Malpass, 2003). Government’s intervention was therefore inevitable due to such substantial housing demand.

In 1945 the government did not have any hesitation to act as a major player in housing as a result of the national needs. By 1957, 2.5 million new houses and flats were built, three quarters of which were constructed by local authorities (Burnett, 1993). The new government set itself an ambitious objective of 500,000 new residential units per annum by 1970 (Short, 1982) which was not achieved due to economy crisis in 1967 (Burnett, 1993). However, the rate of house building remained high with a peak in 1968. Between 1965 and 1969, about 1.8 million new houses and flats were built which were almost equally divided between the government and the private sector (Burnett, 1993).

In general, the government's involvement in housing differed from time to time mostly depending on which party was in power. Figure 3 summarises the UK housing policies between 1945 and 1997. During 1945-1955 the government's policy has been mainly on building new houses due to housing shortage. After 1955 the emphasis shifted to housing quality which was divided into two main categories: A (1955-1968) and B (1968-1997). Between 1955 and 1968, the emphasis of the UK government has been on

slum clearance and building new houses, whereas during 1968-1997 the policy has been maintaining the existing stock. The other phenomenon of this period (1970-1977) was decline in the council housing by handing over the housing market to the private sector. However, after 1985 housing quality issues forced the government to intervene in the housing market once more (Burnett, 1993).

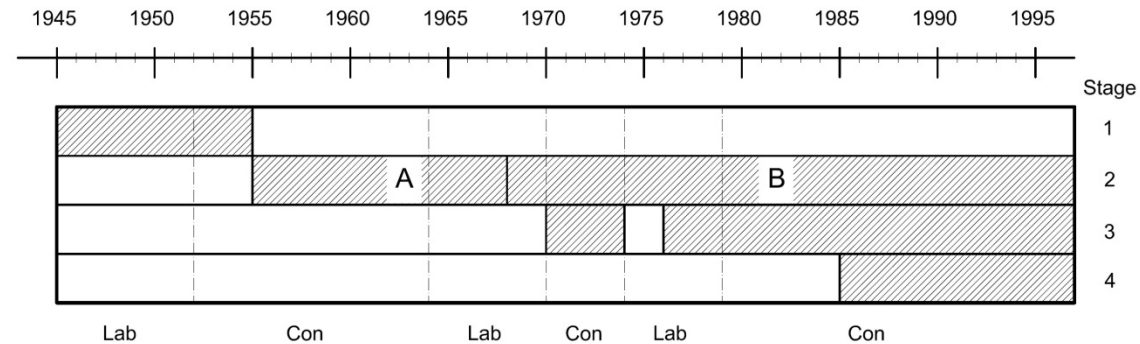


Figure 3: UK housing Policy during 1945-1995; Adapted from (Burnett, 1993)

4.1 The temporary housing programme

In February 1944, Winston Churchill declared his ambitious objective of producing 500,000 temporary houses from steel as a military task which was managed by the government, and implemented by the private sector (English Heritage, 2011; Finnimore, 1989). The government's aim was to supply these houses without increasing demand on conventional building resources and skilled labour. Accordingly, the government supported prefabrication and helped sponsors and local authorities by offering subsidies to offset the higher costs resulting from the application of new technologies (Finnimore, 1989). As a major strategy, prefabricated bungalows were considered and developed during this period. However, the objective of producing 500,000 temporary houses failed since it was reported that only around 150,000 bungalows could be constructed without increasing demand on conventional resources for permanent dwelling (Finnimore, 1989). There were 156,623

prefabricated bungalows (prefabs) produced under the Churchill's programme (English Heritage, 2011; UWE, 2009a; Vale, 1995) four types of which were produced sufficiently to be called mass-produced (Vale, 1995):

- Arcon (38,859 units)
- Uni-seco (28,999 units)
- Tarran (19,041 units)
- Aluminium (54,500 units)

Prefabs were designed to last between 10 to 15 years however many of them lasted much longer (UWE, 2009a; Vale, 1995; White, 1965). While Churchill's objective of building temporary houses for homeless was a short-term programme, the government's long-term objective had always been to provide permanent houses for people (BRE, 2002; Vale, 1995; White, 1965).

5 FLATS: A NEW TYPE OF HOUSING

Until after the World Wars, flats were not a common type of housing in the UK. Mass destruction caused by World Wars and slum clearance associated with introduction of new methods of construction, which suited high rise block towers, created a situation in which flats became very common in the following years (Vale, 1995). With regards to slum clearance, flats were considered by the central government and local authorities as an answer to the problem. The idea was that the occupants of the demolished slum could be resettled on the same site. In addition, it was believed that there could be some saving on infrastructure since the existing water and electricity supplies could be used for new buildings instead of moving dwellers to other areas which required new infrastructure. Moreover, it was assumed that flats would be cheaper in total since the cost of land could be shared between the dwellings (Vale, 1995). Another argument suggests that high-rise flats were built under an architectural idea influenced by the Modern Movement and its pioneers such as Le Corbusier and Gropius who introduced the theory of vertical garden city (Bowley, 1945; English Heritage, 2011; UWE, 2009a; UWE, 2009b; Vale, 1995).

Although very little (only 5% of all subsidised buildings), 1930s saw an increased number of flats as an alternative to traditional two storey cottages. Certainly this was not because of lower construction costs of flats since soon it was proved that five storey flats were one to two third more expensive than traditional houses (Burnett, 1993). It was realised that for the same floor area flats were between 50% (Finnimore, 1989) to 100% (Bowley, 1945) more expensive. The additional costs of flats at the time appeared to be due to the lack of enough research in design and construction methods to make flats more cost effective (Finnimore, 1989). It was not until 1964 when it was demonstrated that flats built with large prefabricated concrete panels could be cheaper than other types of buildings. Governmental statistics in 1964 indicated that flats with over four storeys were more than

2% cheaper than conventional systems if large-panel prefabricated systems were applied. Small concrete panels proved to be uneconomical (Finnimore, 1989). It has been argued that the efficiency and cost saving of new construction methods had more to do with proper management and cost-effective design than technical innovations. In fact, new methods of construction attracted well organised contractors which could have achieved the same efficiency by applying traditional methods of construction too (Finnimore, 1989). Therefore, such houses and flats could have been cheaper regardless of the method of construction.

The portion of flats increased significantly and reached 55% by 1964. By 1966, high rise flats with five or more storeys accounted for 26% of all constructed buildings. There was however a fast decline in flat building to 10% by 1970 (Bowley, 1945; UWE, 2009b; Vale, 1995). The 1960s was the era of high rise housing blocks when prefabricated elements were applied greatly in buildings. About 30% of the local authorities' housing during 1966-1972 was completed by system building with a peak of 41% in 1970 (Finnimore, 1989). A disaster ended the golden age of flat buildings. The objection against high rise flats is usually linked to the Ronan Point disaster in 1968 when a gas explosion caused structural failure of a 22 storey prefabricated block (see Figure 4 below). However, this was not the only reason for rejection of the flats. In fact, the Ronan Point accident supported the opinions already discussed widely against high-rise tower blocks as an unacceptable type of building in the future (Bowley, 1945; BRE, 2002; Finnimore, 1989; Harrison, 2009; Harvey & Ashworth, 1997; UWE, 2009b). Later, it was discovered that the reason of failure in Ronan blocks was insufficient design joints. The blocks were demolished in 1991. During demolition more construction faults were discovered such as mixed mortar with tin cans, and newspapers, and critical areas mortared with only half of the specified depth. Such poor design, supervision and management caused industrialised housing to be reduced from 43% in 1960s to only 2% in 1990 (Harvey & Ashworth, 1997).



Figure 4: The Ronan Point disaster, 1968
Source: ©London Borough of Newham – Heritage & Archives

6 System Building, Modern Movement and the Welfare State

After World War II, what was later known as system building was introduced to the governmental housing programmes (Finnimore, 1989; Riley & Howard, 2002). System building was more than just a new method of construction since it changed the role of all key players in the

construction industry including clients, architects, manufacturers, contractors and labourers. System building was introduced as a theoretical idea by the Modern architects and was considered more than just an affluent economy (Finnimore, 1989). Modern Movement raised the argument that mass production was needed to cope with the massive social demand. After the Second World War, mass production became the objective of housing policies (Finnimore, 1989). In fact, since the beginning of Modern Movement in architecture, building industrialisation had always been studied and supported. The most idealistic outcome of these efforts, to move the building process and production from site to the factory, was the prefabrication of entire buildings including all their details (McEvoy, 1994). The Modern Movement also argued that architects should familiarise themselves with new building sciences and technologies to take the responsibility of this project. Such a social role for architects was defined by being employed in the government (Finnimore, 1989). The unique post-war conditions and reconstruction programmes after the Second World War offered a great opportunity for Modernist architects to enter the government for the first time and apply their theories including prefabrication, mass building and high-rise building. The local and central government's architects therefore became pioneers in applying new building methods in their projects. The reality is that after the wars in a unique situation which resulted from social policies, architects were able to create a new role in the building economy for themselves by the support of the system building which led to their success (Finnimore, 1989). The professional skills of the Modernist architects were much appreciated by the politicians and therefore they used their power in the government to plan the state's research programmes and to apply modernist design ideas and promote their own systems (Burnett, 1993; Harrison, 2009).

The other issue that should not be neglected in the development process of system building is the relation of Welfare State policies with the system building. Welfare State policies created an extraordinary demand for housing for about thirty years. Difference between demand and supply for social housing was one of the main reasons for developing system building. Massive housing programmes, when building resources were limited, created an environment in which alternative methods of construction were

considered seriously. System building supported traditional building resources firstly, by employing unskilled labourers from other industries and by manufacturing components offsite; and secondly, by introducing new resources (e.g. new materials) to the construction industry (Finnimore, 1989). The Welfare State was the key client and investor in the economy and housing industry after the Second World War. It has been suggested that the extraordinary rapid growth rate of Europe after World Wars was mainly due to the huge demands associated with massive investments of the welfare which stimulated the housing market too. In 1968, the Welfare State purchased half of the new work in the housing market (Finnimore, 1989). It was argued that the welfare policy could be considered as a demand stabiliser and growth stimulator than a pure financial and economic policy (Cippolla, 1976).

7 POST-WAR METHODS OF CONSTRUCTION

The post-war construction methods could generally be divided into two main categories of traditional and industrialised methods. Traditional methods are mainly referred to brick and mortar and industrialised methods are mainly referred to pre-cast concrete and timber frame methods.

7.1 *Bricks and mortar*

Since its appearance, system building has always been a challenge for traditional methods of construction but has never been capable of replacing them. Although in 1970 the portion of system building increased to 40%, social housing has always been grateful for the volume of housing done by traditional methods. Not only traditional methods allowed for better building design but until the 1960s they were statistically cheaper than industrialised methods. Brick and mortar offered the most efficient houses despite several efforts of the government, sponsors and the Modern Movement to make industrialised methods more efficient. Moreover, traditional methods exploited many of the new technologies and components used by system building which made traditional methods increasingly efficient and modern after the wars (Finnimore, 1989).

Meanwhile, it should be borne in mind that bricklaying has historically been an expensive trade in the UK construction industry. The result of a research by the UK government in 1917 revealed that including the cost of material and labour, out of eleven businesses involved in house construction, bricklaying with 31% and carpentry and joinery with 26% were the most expensive trades. However, although carpentry and joinery moved toward prefabrication, brickworks remained unchanged (Finnimore, 1989). Bricklaying traditionally remained the major cost in house building and therefore the future desire of system building was to find an alternative for it. In 1948 another research by the government revealed that the costs of construction had increased three and a half times compared to pre-war. It was found that the situation was mostly as a result of 45% higher labour requirement which meant 31% less output. The reasons for lower productivity were firstly the effects of war which deskilled the construction industry and secondly the result of rather low motivation caused by the labour market in an environment full of employment opportunities when the construction industry was in desperate need for labour (Finnimore, 1989). The high costs of skilled labourers and traditional materials were the major reasons for moving towards labour saving methods to replace traditional methods (BRE, 2002).

7.2 *Industrialised systems*

More than 500 new systems were registered between 1919 and 1976 (BRE, 2002). The theory behind such methods was the replacement of time-consuming building skills, such as bricklaying with some substitute factory made systems which were carried out by unskilled labourers (Finnimore, 1989). Generally, there were four main categories of (a) concrete slabs or blocks which formed a cavity wall, (b) concrete cavity blocks which made the full thickness of the wall, (c) in-situ concrete walls, and (d) various kinds of reinforced concrete construction. Several advantages were claimed by the supporters of prefabricated methods including cost and time efficiency, quality and design improvement, efficient use of available equipment and labour, ease of removal and reassembly, and improvement in working conditions (White, 1965). Most of these are still claimed by the supporters

as the advantages of prefabricated methods (Bagenholm *et al.*, 2001; BRE, 2002; Burwood & Jess, 2005; NAO, 2005; Post, 2003).

Concrete systems

Application of reinforced concrete goes back to the 19th century when it became a major common material in construction because of many advantages compared to other building materials. Its key components including sand, water and gravel were cheap and available almost everywhere; its production was not very complicated; was easily shaped; and was durable, strong, and usable as exterior façade with little treatment. These advantages made reinforced concrete comparable with stone, timber, brick and steel in different buildings (Warszawski, 1996). After the Second World War with developing transportation and assembly methods, the full potential of precast concrete was discovered. Prefabricated concrete was now a real alternative to the conventional methods of construction which soon became the main building method. However, it was not able to compete with conventional construction methods in small projects (Warszawski, 1996).

During the 1950s, construction methods for multi storey dwelling towers were mostly in-situ concrete systems. However, such methods were quickly outdated in 1960s by the introduction of pre-cast concrete panels which were bought from France and Scandinavia and became very popular due to their production advantages (Finnimore, 1989). Foreign systems were adopted greatly in the UK during late 1950s. This was when housing programmes, grew considerably and investors became confident about local authorities and the government's commitment to the system building. Subsequently, this caused a phenomenon in which foreign and UK building systems flooded into the housing market and local authorities. Since the number of systems was far beyond the housing capacity, it soon became obvious that only some of these systems had the chance to become successful (Finnimore, 1989). There were several pre-cast and cast in-situ concrete systems applied in the construction projects from which the following could be mentioned:

- Bison's Wallframe (Bendixson, 1965; Vale, 1995)
- Wimpey No-Fines (Bendixson, 1965; BRE, 2002)
- Easiform (Bendixson, 1965; Finnimore, 1989)
- Reema (BRE, 2002; Harvey & Ashworth, 1997)
- Wates (Bendixson, 1965; BRE, 2002; Vale, 1995)
- Larsen / Neilson (Vale, 1995)

Soon, excessive use of prefabricated systems gave rise to the argument among architects as to whether they should accept the simplicity and uniformity of such materials or to cover them with some claddings with traditional materials. Ultimately, covering supporters won the argument and many new towns and houses were covered by claddings of tiles, bricks, etc. (BRE, 2002; Burnett, 1993). These efforts could be regarded as hopeless attempts to recover some British identity since UK housing elements such as pitched roofs and chimney stacks had virtually disappeared from the houses (Burnett, 1993). Prefabrication became less attractive than other building systems mainly due to the failure of designers and manufacturers to make products economical and aesthetically attractive. They also failed to consider the systems as a whole and not just as individual components. This resulted in less demand and consequently higher costs compared to other construction systems (Warszawski, 1996).

Timber frame

Although timber is very suitable for prefabrication purposes, the use of timber frame systems became common only after the use of system building reached its peak during the 1960s. Yet, timber frame was developed and broadly applied in Britain by as far as in 1976 more than half of the system building was timber frame. Moreover, timber frame was the only system building which was broadly applied by speculative house builders. Timber was an imported material and its use was therefore strictly restricted during the early years after the wars. However, it developed considerably during the 1930s by introduction of plywood which was light, strong, and manufactured in industrial scale (Finnimore, 1989).

Timber frame was attractive to sponsors for its manufacturing qualities and to architects and clients for its flexibility in design. Moreover, since buildings built with timber frame were identical to those with traditional methods, they were broadly accepted by speculative developers. There were some other advantages for prefabricated timber frame houses compared with concrete and brick methods. Their erection was quicker; their foundation was lighter and therefore cheaper; their lower u-value also meant reduced heat-losses through the building fabric (Harvey & Ashworth, 1997). Time wise, building a small brick house may take about 3000 man-hours whereas a timber frame house takes about 1200 man-hours from which about 200 man-hours are used for the manufacturing of the components (Harvey & Ashworth, 1997).

The main system which was used for the timber frame buildings was “platform frame” in which a platform was built and the load bearing walls were placed upon it (Allen & Iano, 2004; BRE, 2002). Platform frame conquered the timber industry since it needed less investment compared with concrete and steel methods. After the downfall of pre-cast concrete in 1960s, timber frame and conventional methods of construction, which had improved in terms of productivity, were the main players in the UK construction industry (Finnimore, 1989).

8 CONCLUSION

Unique post-war condition of the UK along with massive urgent housing demand, skilled labour and raw materials shortages, and high costs of construction encouraged the UK government to consider new and innovative methods of construction, including prefabricated methods, to address these issues. This situation created a unique environment for Modernist architects to enter the government and put their theories such as the mass production and industrialisation in practice. What happened in this period had a phenomenal effect on the future development of new building technologies in the UK. Several innovative methods were developed and were mostly applied in high-rise flat buildings. Meanwhile, traditional methods of construction developed greatly by becoming more efficient through applying

new theories and technologies. Later, the process of industrialisation was increasingly criticised by the society and some architects since building quality was neglected in favour of quantity. Ronan Point disaster put an end to the accelerated use of prefabricated components.

Apparently the history is repeating itself for the second time as the current housing and skilled labour shortages as well as high construction costs in addition to new challenges such as sustainable development and targets for reduction in CO₂ emissions have encouraged the UK government to consider prefabricated methods of construction for a second time. The government and the private sector are currently promoting prefabricated methods of construction mainly under broader terms known as Offsite Manufacturing (OSM) and Modern Methods of Construction (MMC) which include: volumetric systems, panel systems (open & closed), hybrid systems (semi-volumetric), sub-assemblies and components, and site-based methods (Hashemi, 2009). Supporters of such methods claim similar advantages to those of the 20th century’s prefabricated methods such as improved speed, improved quality, improved health and safety, improved control conditions, addressing skilled labour shortages, minimised waste and energy consumption, enhanced value for money invested, and cost predictability (Bagenholm *et al.*, 2001; BRE, 2002; Burwood & Jess, 2005; NAO, 2005; Post, 2003).

There are however several barriers towards broader application of these methods some of which, such as negative public attitudes, are the direct results of the mistakes made during the 20th century (Hashemi, 2009). UK should therefore learn from its previous mistakes to avoid repeating the same social and economic problems (e.g. lost identity, poor quality of design and construction materials, dullness and lack of variety in the products etc.) of the last century. Yet, much more research is required particularly in areas such as transportation, long-term quality/viability, and costs for successful application of such methods of constructions in the UK.

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