

# APPLICATION OF KANBAN IN THE UK CONSTRUCTION INDUSTRY BY PUBLIC SECTOR CLIENTS

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## ABSTRACT

Kanban is a one of the lean approaches adopted within the industry in order to pull construction materials through their production systems on a just-in-time basis. The approach is developed in the automotive industry and now being widely implemented within the construction industry with many success stories. The objective of this approach is to accomplish management of products and materials with least waste; e.g., unnecessary inventories and processing time, waiting time, as well as physical waste. The primary means for achieving the objective is to simplify the processes of acquiring, storing, distributing and disposing of selected products and material on site.

This paper talks about a particular type of kanban, called supplier kanban. The supplier kanban is the one which transmits a replenishment signal to outside suppliers and from suppliers to manufacturers of the products as well as signal for delivery of material just-in-time on the construction site. Here the author talks about a material management strategy adopted by Fusion 21, a group of local authorities and housing association that use supplier kanbans to signal the need for delivery of selected products from preferred suppliers and manufacturers to site just-in-time for the operations and maintenance of their social housing stocks. Fusion21 is at the forefront of procurement partnerships in the social housing sector and is the winner of the Housing Corporation Gold award for 'Innovation in Procurement'. Fusion21 members own over 135,000 properties throughout the UK with membership expected to increase significantly over the next 4 years. Fusion21 jointly procures construction related contracts on behalf of its partner organisations and already manages numerous frameworks for various elements with current activity of over £45M per year.

## KEY WORDS

kanban, just-in-time, lean construction, material management, supply chain integration, pull

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## INTRODUCTION

The concepts of lean construction have been adopted in different forms by different public sector clients within the UK construction industry, especially by the local authorities, housing associations, Registered Social Landlords (RSLs), and Arms Length Management Organisations (ALMOs), for the upgrade of their social housing stocks. The strategies adopted might not be given the tag of lean construction or lean processes but the underpinning concepts and practices are applications of lean thinking. The author has undertaken a research project to explore and explain the current changes in the procurement systems within the construction industry and the changing role of supply chain partners involved in these new ways of working. The concepts and practices presented in this paper are among some of the findings of the research, where the evidence of lean supply chain was found and reported here. The author presents perception of some of the actors within the industry about lean construction and lean processes, and use of 'kanban' approach, which result in waste minimisation; product supply just-in-time; increase value for money for clients; and increase process efficiency through continuity of work. The author concludes that understanding of lean concepts and approaches has brought benefits within the involved supply chain participants, especially Small and Medium sized Enterprises (SMEs). The paper talks about the approach for the flow of materials for maintenance of gas central heating adopted by a group of clients (including Local Authorities, ALMOs, Housing

Associations, and RSLs) under an umbrella called Fusion 21.

The paper provides an overview of the Fusion 21 partnership, and the kanban approach based on experiences in other industries. This paper then defines the kanban approach, its components, processes, and the expected benefits and its application within the above mentioned organisation. The importance of supplier integration is highlighted as key to the success of the approach, which is carried out by Fusion 21 team with their consultants.

## FUSION 21

Fusion21 was established five years ago with a goal to implement a £225 million housing improvement programme across Merseyside (UK) and generate efficiencies by tackling two common issues:

- Rising construction contract prices; and
- Skill shortages within the construction industry.
- Fusion21 has a growing number of housing association partners. Fusion21 members are committed to working together to generate sustainability within the housing and construction sectors by:
  - *Maximising efficiency by developing strategic procurement partnerships (COST);*
  - *Supporting industry and our communities by providing training and employment opportunities for local people (SOCIAL); and*

- *Developing increased environmental awareness and performance systems*
- *(ENVIRONMENT).*

The success of Fusion21 has been based on working collaboratively to deliver efficiencies within the construction supply chain, by adopting new approaches to procuring both materials and labour as a strategic procurement partnership, for a wide variety of work in tenanted properties.

Fusion21 partners, contractors and suppliers show willingness to participate in collaborative activities and share common values and vision. They have aspiration to change with Fusion 21 to being more effective and efficient and therefore, work as an integrated team on the framework agreements. The most important characteristic of the partnership is the trusting relationship among the involved parties.

Fusion 21 also recognises the link between labour shortages and procurement costs. Fusion21 Skills provide sustainable construction training and employment for hundreds of unemployed. In the last five years Fusion21 has delivered some outstanding results:

- Skills Training and Job Creation resulted into 404 permanent jobs and 531 local people into training;
- Delivering the following Cashable Efficiency Gains e.g.
- 2004/05 = £2.98m (9.6%)
- 2005/06 = £5.4m (11.6%)
- 2006/07 = projected £4.2m (8.7%)

- Increased resident satisfaction: Customer satisfaction @ 95% through Key Performance Indicators (KPIs)

Fusion21 Skills has a unique new construction training centre and offers free training to local people across Merseyside to help launch careers in the construction industry. The centre is accredited by the Construction Industry Training Board and gives trainees recognized qualifications in everything from plastering & joinery to on-site health and safety. The centre is an investment in the local economy and, above all, a major opportunity for local people to follow the successful trainees who have already gained construction jobs through previous Fusion21 training programmes. Fusion21 was also the inaugural winner of the Housing Corporations 'Gold Award' in 2006 for 'Innovation in Procurement'.

#### FUSION21 PROCUREMENT MODEL

Over the last five years the members of Fusion21 have been working to develop a supply chain model within which efficiencies and competencies can be shared (see Figure 1). With a combined maintenance programme worth at least £305m over four years, Fusion's partners have combined their procurement activities to directly benefit the communities they serve. The Fusion 21 model operates as follows:

The Fusion 21 model uses e-procurement systems to minimise administrative costs, optimise efficiency by forecasting, managing and evaluating contracts and allows clients to specify, agree and pay for materials directly. This makes the whole procurement process far more transparent and guarantees the best

product, supplier and price for every job. Key benefits of this model include:

- Allows standardised high quality material to be procured and directly paid for by the landlords;
- Minimises administration costs and allows visibility to all involved parties within the supply chain; and
- Introduces orders to invoicing system, creating an efficient and measurable system for raising and paying invoices against agreed payment terms.

Fusion21 has established successful Framework Agreements in the last five years for work streams including Property Maintenance, Gas Servicing & Maintenance, Digital TV, Consultancy, Void (Empty Properties) Management, External Redecoration &

Pre-painting (in progress), and Electrical Wiring and Fitting Work. These frameworks are specially-made Fusion21 agreement, controlled by Key Performance Indicators (KPIs).

#### SCOPE OF FRAMEWORK AGREEMENTS

Fusion21 enters into Framework Agreements to provide a single point, one stop procurement solution across the UK, to carry out planned repairs and maintenance on social housing, sheltered accommodation, and other properties as owned or managed by current (and future) Fusion21 Partner Organisations. Fusion21 members currently collectively manage over 135,000 properties throughout the UK. The number of organisations working closely with Fusion21 (and their associated stock) is expected to increase significantly over the next 4 years.

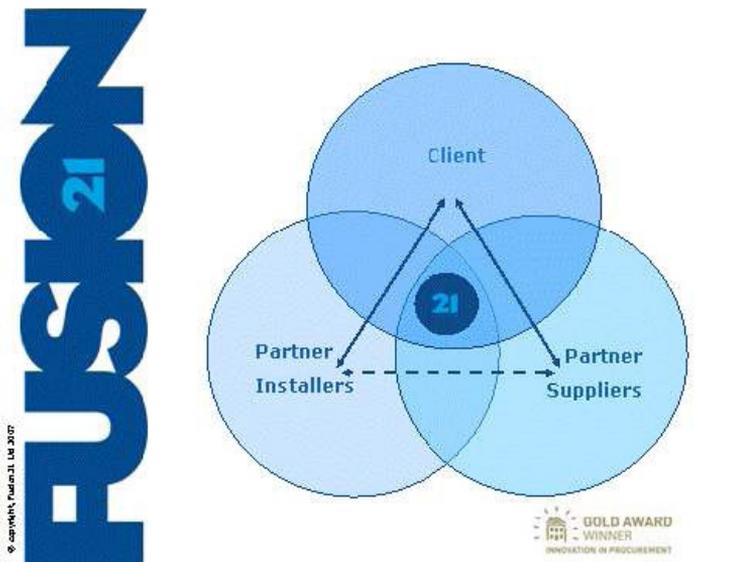


Figure 1: Fusion 21 Model

## **MATERIAL SUPPLY CHAIN MANAGEMENT**

Materials management serves the purpose of providing the right materials when needed at an acceptable cost. Doing so involves specifying materials required, acquiring those materials from suppliers, and distributing them to construction sites. Failing to allow a continuous flow of materials will have a negative impact on labour productivity and project costs as well as increase waste.

Material management is a vital part of the production system for a construction project. "Up until the 1980s, procurement in construction was achieved through purchasing processes based mainly on the concept of one-to-one transactions between a buyer and a seller in order to meet individual project needs. Construction companies at that time had been focusing their efforts on developing in-house resources and processes, creating internal organizational boundaries based on functional specialization. In the late 1980s, this focus changed and internal integration was adopted as a new goal. Subsequently, external integration became the new goal, and was achieved by engineering and construction firms integrating their materials management practices with their first-tier suppliers" (Arbulu and Tommelein, 2002a). The kanban strategy presented here is an example of external integration with first-tier suppliers.

This paper presents that innovative procurement of construction materials and their management goes beyond traditional practices. This includes functions like identifying, acquiring,

distributing, and disposing of materials on construction project sites. Stukhart and Bell (1985) recommend the following goals for material management:

- obtain the best value from the perspective of the customer (not necessarily the best price) for purchased materials;
- assure materials are in place when and where required;
- reduce inventory and surplus;
- assure quality requirements are met; and
- provide efficient low cost movement of materials to site and within site storage areas.

In this paper, the kanban strategy emphasizes site material management and the process of distribution of selected products to the installation areas.

## **THE KANBAN STRATEGY**

Kanban is a lean approach developed in the automotive industry as a mechanism to pull materials and parts throughout the value stream on a just-in-time basis. "In Japanese, the word kanban means 'card' or 'sign' and is the name given to the inventory control card used in a pull system" (Arbulu et al., 2003; The Productivity Press Development Team, 2002). The aim of a 'pull' system is to produce only what is needed, when it is needed, and in the right quantities. In a lean manufacturing environment, kanban is an advanced visual control system focused primarily on eliminating overproduction, increasing flexibility to respond to customer demand, and reducing costs by eliminating waste. In this environment, two different types

of kanbans have been developed: (1) transport kanbans, and (2) production kanbans (The Productivity Press Development Team, 2002). Transport kanbans are used to: a) signal the need to replenish materials from a preferred supplier (supplier kanbans), b) signal delivery of products/materials just-in-time to the construction site, and c) signal the movement of parts or subassemblies produced within the factory to the production line (in-factory kanbans). Similarly, production kanbans are signals to either initiate production (production-ordering kanbans) or to communicate the need for machinery changeovers (signal kanban) (Arbulu et al., 2003).

In the construction industry, the evidence of the use of kanbans of any type is limited. This paper then proposes the use of supplier kanbans to signal the delivery of products just-in-time to the construction site for installation in the context of the Fusion 21 organisation.

The kanban strategy is currently being implemented in the repair and maintenance of social housing stock by Local Authorities and RSLs in the U.K. The strategy is developed based on the following principles:

- products must be pulled through the supply network as needed by the workforce;
- products must arrive just-in-time, i.e. at the right place, at the right time, in the right quantity; and
- the supply network and material management strategy should achieve the best value for the customer and clients.

The components of the kanban strategy are: (1) installation/repair/maintenance

site (2) Collection/delivery vehicles or 'milk runs', and (3) supplier kanbans. Figure 2 provides a graphical representation of these components.

'Milk runs' are routes through preferred/nominated suppliers to collect and deliver products. A special fleet of vehicles called milk run vehicles collect materials from preferred suppliers and deliver in time on site for installers to install on a daily basis. Up to three or four collections per day per milk run vehicle ensures the right amounts of product required on a specific day is delivered to the site.

An e-Procurement system is used as kanban signals to pull products from selected manufacturers (selection is based on quality-price mechanism and negotiation) through suppliers to site on a just-in-time basis. Online request forms are used as kanban signals between Fusion 21 and the manufacturers. Fusion 21 uses an e-Procurement system, as mentioned above, which is administrated by a consulting organisation. Since the product is delivered just in time on site, there is no concept of a 'warehouse' as far as the client is concerned. The system is designed to (1) support the kanban and milk run operations, (2) improve inventory accuracy, (3) decrease order processing time, (4) eliminate collection and delivery errors, (5) improve the use of human and warehouse resources at manufacturer's, (6) reduce storage costs for client, (7) improve installers' service levels, and (8) increase client satisfaction.

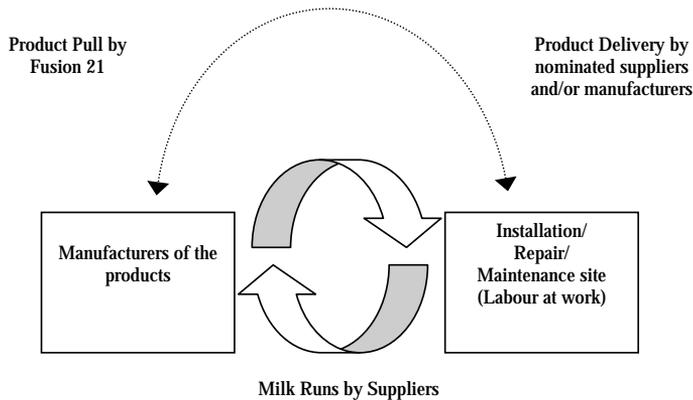


Figure 2: The Kanban Strategy: Components and Mechanisms

The kanban strategy involves the following major tasks:

- Product request/order placement for just in time delivery; through the e-procurement system, Fusion 21 places an order for the required product on site with specific dates and specification as well as delivery time. The number of units for each product and their installation service are established through the current and future demands from the client;
- Picking and delivering of order on site by Fusion 21 nominated suppliers or by the in-house logistics department of the manufacturing organisation; and
- milk runs by suppliers collecting and delivering the products.

### THE NEED FOR SUPPLIER INTEGRATION

Each installation site of social housing requires many different products that are collected and delivered daily by suppliers. One of the most important communication links between

client/contractor and suppliers is the transmission of information related to what type of products, in what quantities, and when and where construction teams expect the products to be delivered. The kanban strategy requires suppliers to change the way they work and adopt new processes. If suppliers do not understand the kanban process, the collection and delivery operation will fail. Therefore, to implement the kanban strategy successfully in the above-mentioned case, the integration of all suppliers, installers and manufacturers is a 'must'.

Supply chain integration is not an easy task in any circumstances, much less in a complex environment like construction. To move towards this type of integration, this paper presented the role of Fusion 21 a 'supply chain integrator' whose main focus is on the value stream rather than on a traditional myopic view of a single stakeholder. Arbulu and Tommelein (2002b) suggest that supply chain integrators could provide the glue to bring people and organizations together, which is seen in the above-mentioned case. Parker

and Anderson (2002) proposed that supply chain integrators must possess business and interpersonal skills, complementing technical skills that will allow them to maintain the integrity of the final product. In the Fusion 21 case, the above was achieved through an e-Procurement system.

The Fusion 21 team, as supply chain integrators, also focus on (1) evaluating the suppliers' capabilities and level of flexibility to adopt new processes, (2) identifying and eliminating waste in the supply chain and focusing on creating value for everyone involved and not only the final customer, (3) working with suppliers and manufacturers to identify the root cause of a particular problem and develop a corresponding solution, and (4) proactively identifying potential improvements to the supply chain as a whole.

The kanban strategy also has a positive impact on labour productivity since construction teams can get what they need without delaying production. In the case of an unexpected increase in daily demands from the site, products can be delivered and replenished quicker than by traditional methods which rely on next day deliveries in most cases. This is possible because preferred suppliers carry the stock levels for each product based on future site demands. The key advantage of the kanban system is that construction teams can get products on a daily basis according to site needs. Fusion 21 projects do not use last planner system.

## DISCUSSION

The Fusion 21 case study was part of a research project carried out by the authors, which analysed different

supply chain management strategies adopted by different public sector clients. Case study research methodology was used and interviews were conducted to collect the data from the industry participants on four different cases. For further details on the entire research project, refer to Khalfan and McDermott (2006). This paper only describes a part of Fusion 21 case study; a material management strategy developed by Fusion 21 to manage the collection and delivery of products to site on a just-in-time (JIT) basis. The strategy uses kanbans to pull materials from preferred suppliers to meet site demand. The paper highlights the need for an important shift from a tactical view with emphasis on order placement and price savings to a more strategic view with emphasis on value-adding activities and total cost waste reduction throughout the value stream. The term 'value stream' refers to the set of interdependent activities and operations that are executed to bring materials to the final customers on site. "A value stream perspective should look across individual functions, activities, departments, and organizations, and focus on system efficiency rather than local efficiency within any one of these, elimination of this waste will contribute to improving supply chain performance" (Arbulu and Tommelein, 2002b).

The concepts of lean construction have been adopted in different forms by different public sector clients within the UK construction industry, such as Fusion 21 and their partner local authorities for the upgrade of their social housing stocks. The strategies adopted might not be given the tag of lean construction or lean processes, but the underpinning concepts and

practices suggest these as an application of lean thinking.

To reduce the overall cost of refurbishment projects, Fusion 21 only hires contractors and installers on a plant and labour basis, and provides them with the products and materials needed for installation through a separate contract with suppliers and manufacturers. A two-stage procurement process is carried out including Pre-Qualification Questionnaire (PQQ) and invitation to negotiate (ITN). The whole process is based on a quality-price mechanism and not on the lowest tender. The process includes submission of: Pre Qualification Questionnaire, References, Audited Accounts, etc. Fusion 21 conducts site visits and audits technical capabilities before sending invitations to tender, followed by invitations to interview and final presentations. The PQQ is open for anyone to complete and submit but the selection of the suppliers and installers is done based on the mechanism mentioned above against the present and forecasted future demand.

Fusion 21 has managed to bundle and aggregate the demands (Khalfan et al., 2005) of their partnering organizations for social housing renewal and refurbishment. For example, Fusion 21 has bundled the demands for gas central heating (GCH) systems including the number of boilers and other materials required per year for the next ten years. Once the numbers were identified, the demand was broadcast to the market to encourage an aggregated supply; resulting into suppliers and manufacturers responding with a match to the demand. Fusion 21 was then able to negotiate reasonable prices

with them for the products with agreed profit margin.

Meanwhile, Fusion 21 trains local people to work with installers/contractors. Training for local people and developing their careers in the construction industry is one of the most important aspects of the framework and partnership which focuses on reducing the skill shortage within the UK construction industry. An apprentice or trainee gets on-the-job training and goes to the college in the evenings, for vocational and construction skills qualifications. The college fee is paid by Fusion 21, and the installers/contractors working with Fusion 21 are asked to provide on-the-job training to these selected apprentices. On-the-job training also consists of two-week full time training which includes: induction, health and safety, partnering culture and attitude, etc. Once training is complete, the apprentices have three options: join the contracting organisation where they got their training; work for other installers within the region; or start their own subcontracting work. The sustainability aspect of the training programme is that local people get training through the programme and could end up finding jobs within the same local area/community. This would be the value, added by the scheme where local people are trained and retained within an area/region. The other aspect of the partnership is sharing knowledge among all involved partners.

#### REAL WORLD SCENARIO

In the past, the participating organisations used to carry out refurbishment works independently within the North West of England. They used the same contractors/installers and similar

products, but since they were procuring work independently, they were in competition with each other to secure resources and were not in any position to negotiate prices for labour and products. Now, they are procuring the same work under one umbrella, which has added the performance factors and specification into the process as well.

#### LEAN SUPPLY CHAIN

Supply chain integration is done at the operational level within Fusion 21. Through integration, business gaps are identified and filled in with appropriate steps. With only 2 tiers of the supply chain, clients and the contractors/suppliers, the short and lean supply chain is generating cost savings for the client organisations and enhancing productivity for installers and subcontractors on site. Simultaneously, Fusion 21 procures from installers/contractors that employ direct labour. Significant cost savings have been reported by the client on procuring materials directly from manufacturers, as well as reduction in project time, process improvement, and an increased client's satisfaction through the adoption of the kanban approach. The integration has also achieved reduction in waste at the stage where it occurred in the process rather than at the stage where it was usually detected in the past (Vrijhoef and Koskela, 2000)

#### SUMMARY AND CONCLUDING REMARKS

The authors talked about a material management strategy adopted by Fusion 21, a group of local authorities and housing association that use supplier kanbans to signal the need for delivery of selected products from

preferred suppliers and manufacturers to site just-in-time for the maintenance of their social housing stocks.

The reason for hiring the SMEs as subcontracting/installation organisations is to use direct employees of those organisations who are available locally. At the same time, local trainees and apprentices also work with installers on site to acquire tacit knowledge and develop their skills. Further improvements within the framework and partnership can be brought in by looking into the enablers of and resistance to change; gaps in the strategy; capability of the participants; implementation of best practices; learning and Knowledge Management, etc. (Khalfan and McDermott, 2006).

The major benefits that are being achieved in the following broad area by adopting the partnering framework, positive initiative by clients (Khalfan and McDermott, 2005), and development of short and lean supply chains: Less waste and duplication; Improved delivery; Greater certainty of cost; and Better whole life cycle costing. The following gives a representation of the gains of long-term partnership, which are not present in traditional projects: Savings on Tendering / Procurement Costs; Time Savings on Programme; Lesson learned and rolled forward within the delivery team; Benefits of Performance Management Systems; Fewer Delays; Added Value to the client; Knowledge retention, capture, use, and creation; Building of Trusting relationship; etc.

Some big regional main contractors are not happy with the above direct arrangements of clients with SMEs. They think that clients need to look for main contractors for big programmes, especially for

upcoming work in the North West of England, and not to go out to procure it with SMEs. They think that they can offer, through value engineering and bulk purchasing power nationally, good value for money for clients, which clients would not be able to get because they do not see all the logistics involved in the whole procurement process but main contractors do it on a daily basis.

The paper has illustrated a combination of lean and material management techniques working in unison to generate value for the Fusion 21. It has demonstrated the application of lean concepts in support of value-adding strategies. This paper has presented a real example of supplier

integration through the application of supplier kanbans. The need for supply chain integration is highlighted through a role called supply chain integrator, which is being carried out by Fusion 21 in the above mentioned case, with a focus on the value stream and bringing people and organizations together.

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