Review of Construction Supply Chain in Building Refurbishment

REMI Project

WP1 M1.2 derivable

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1. INTRODUCTION

Since 2008, UK government has been targeting a total 80% reduction in CO_2 emissions versus a 1990 baseline. Currently, UK households account for approximately 27% of the entire UK CO_2 emissions. Consequently, to achieve such a massive reduction by 2050, radical changes to the UK housing stock must be undertaken. With only a small proportion of homes being renovated each year, the government must consider stimulating substantial investment towards mass-scale renovations to deliver the necessary alterations to the built environment.

However, for this to be viable there must be a related demand and supply - stakeholders must see a financial benefit if they are to invest time, money and resources. As a result, the renovation market must move away from bespoke, custom retrofits and make way for an industrialised product that can be made accurately, efficiently and economically.

The traditional construction supply chain is not efficient. It is fragmented, such that multiple organisations temporarily coordinate to deliver a 'construction' product or solution, generally introducing numerous failures during the process. In particular, the relation between main contractors and different smaller sub-contractors appears to be more adversarial and lacks collaboration and communication.

Moreover, construction is a sector dominated by single skill trades with even these being in short supply compared with demand. This results in a high staff count on site during refurbishment works adding to the disruption in the home. Productivity is also reduced as a result of the inability to balance work across trades and ensure tradesman do not spend time waiting for others. As a final result the end clients often have to suffer due to poor services.

This piece of work is intended to provide understanding of the extent to which traditional construction supply chains are not working successfully. Particular emphasis will be given to finding ways to remedy common failures and to exploit best practise indeed. To this end, an ideal, improved construction supply chain is presented to be used as a reference for an Energiesprong refurbishment approach.

In particular, the present report aims to inform the other project work packages for reviewing the REMI project feasibility and to feed back on the issues that are associated with offsite manufacturing and construction and refurbishment industry.

2. EXISTING APPROACHES REVIEW

In order to analyse the feasibility of the Energiesprong concept transition to the UK market, a review of existing approaches, best practice and failures in traditional construction supply chains is below provided. This chapter has been based on a previous review on the *Construction Supply Chains in the Refurbishment Industry,* which provided understanding on existing approaches and guidance on best practice from other sectors.

A Manufacturing operation should function through the practice of using robust standard operations, efficient use of time, labour, materials and machinery producing goods that are of high quality, cost effective with just in time delivery. This allows organisations to operate using Lean principles. This facilitates maximum productivity at the lowest operating costs which in turn delivers greater efficiency and profit.

Unfortunately the construction industry has not evolved in line with other technologies; in fact it is the only industry that still operates using outdated techniques and processes. The illustration below in Figure 2-2 clearly shows how through manufacture and technology, products have and continue to evolve and develop over time, constantly improving on quality and performance. However, the construction sector seems to be generally stuck in a repeat cycle where there's an evolution vacuum; there is little evidence that the construction industry has reviewed, evaluated or challenged the way it operates in the past 100 years. The lack of innovation in the construction sector is a major issue; continuing to be 'traditional' in its overall approach to the process, including trades' and managers' qualification. Little changes are slowly being observed as driven by clients who demand higher quality products and enhanced performance. However, the construction sector needs to strongly drive forward innovation and change in order to improve in both quality and efficiency.

Then

Now

Figure 2-1 – Industry technology evolution across different sectors.

The traditional complexity of construction supply chains is a clear example; construction supply chains are usually fragmented, involving multiple organisations and a large number of key players in order to deliver the 'construction product/project'. The main players involved are listed as follows:

- a project client;
- a main contractor;
- a project management consultant;
- subcontractors,
- designers and architects;
- various suppliers who provide labour, materials, and equipment.

Generally sub-contractors work on site to deliver the product while the main contractor together with the client and the designers lead the preparation of the product. However, even if in theory the chain seems to work properly, the fact that multiple organisations actually coordinate the delivery of the same product requires high level collaboration and communication, which are typical points of discussion rather than estimated values of the process. The apportionment and management of risk in the process also leads to additional cost and complexity.

For instance as pictured in Figure 2-2, looking at the supply chain structure of a Solid Wall insulation (SWI) process, it can be observed that generally the client, identified as the 'Resident', has at least eight visits from different people in order to plan the delivery of the 'work/product'. Usually people tasked to deliver the work, such as sub-contractors or the main contractor, are not fully informed, implying multiple visits to the customer before having completed the work. In general a lack of communication, collaboration and coordination between the involved actors characterises the process, especially between the main contractor and the sub-contractors. Deviations to product delivery are thus typical across apparently similar refurbishment jobs and as a final result the end clients often have to suffer delays to completion and additional disruption due to poor services.

In contrast to many other sectors, the construction sector is still dominated by single skill trades which usually results in a high staff count on site and an extended refurbishment time as different trades come and go for different parts of the job, sometimes needing to be on site together. Productivity is also reduced as a result of the inability to balance work across trades and ensure tradesman do not spend time waiting for others. In addition the turnover of staff on site can result in loss of the achieved learning/skill and project information.

Many factors hinder the effectiveness of the construction supply chain, and they are often interconnected. However the poor management of multiple relationships across the construction supply chain is one the main ones impacting on the overall quality of the process. This results in poor supervision, with additional or duplicate work and no consistency in the conducted works.

In general, common construction supply chain failures are caused by a lack of effective management indeed; low productivity, quality control problems, overruns of both budget and schedule, and conflict (in the form of adversarial contracts) are typical issues. Three key factors relating to failures in the traditional construction supply chain are listed below in Table 2-1.

Table 2-1: Key factors and failures in traditional building supply chains.

Factor	Failure
Project driven chain	Difficulty to set long-term management
Product bespoke nature	Issues in supporting project innovation as requested by the client; Poor and unsatisfactory service.
Insufficient collaboration	Multiple visits to the client; Delay in product delivery; Poor service; Added risk cost.
Different aims and self-interest	Lack of a common and strategic alliance
Inaccuracy in provided information *Communication issues*	Knowledge gap; Loss of information about previous project steps. Product mark up.
Lack of trust and responsibility	Multiple visits to the client Duplication of available information

Traditional construction supply chains are not efficient because they are **project driven**, rather than process-based. The lack of a supporting robust process may lead to missing important elements at key stages of the works. This is due to the management of multiple organisations at the same time in order to deliver the product, which does not allow management of the process to be set, refined and established to ensure adherence to project delivery timescales – the approach tends to be more reactive and 'fire-fighting'.

Additionally, the **bespoke nature** of the construction product requires a direct interaction with and influence by the customer at a level of detail that is not typical in other sectors – for example a customer can choose options and variants, different sizes etc. when buying cars or clothing but the bespoke 'made to measure' route is only pursued at the very top end of the market. Given its fragmented nature, the supply chain is often unable to follow the specification changes required by the client without impacting on the delivery timescale. This also results in impacting on the client final satisfaction and on the delivered service quality.

The third most important and common failure factor is the **inefficient collaboration** between the multiple actors involved in delivery of the works. Collaboration and good partnering is inadequate in the face of complexities inherent in traditional construction supply chains due to different interconnected factors listed in Table 2-1. In general a strategic alliance across the entire supply chain and based on common aims is usually missing. Each involved actor has his own aims, with short-term self-interest and benefits. The relationship between main contractors and different smaller sub-contractors appears to be more adversarial and lacks collaboration, being based on absence of trust, different aims and objectives, lack of mutual benefits and general communication problems. This generally results in an increase in total product/work cost to the customer by the inclusion of additional risk cost by each involved actor.

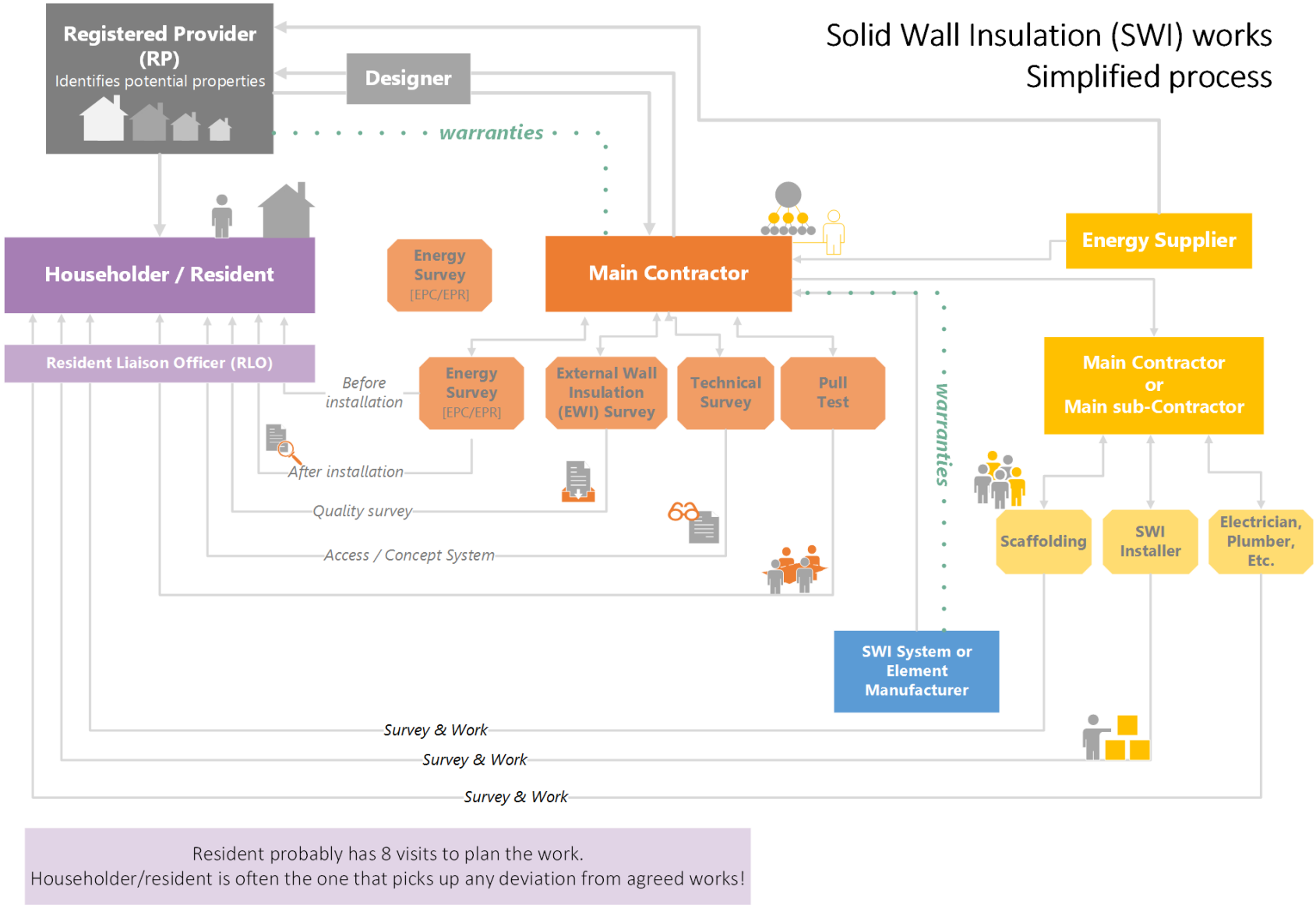


Figure 2-2 – Solid Wall Insulation – Traditional Supply Chain process

3. IDEAL SUPPLY CHAIN

Based on main failures of the existing traditional building supply chains, this section aims to present alternative solutions for an ideal and successful building refurbishment supply chain.
Construction projects are bespoke and short term, and project clients have continuous inputs. However, the very nature of the current service means that the project clients often contract separately with different trades and providers for the maintenance and improvement of their properties- for example carpenter, plasterer, electrician. Clients thus embed themselves in the supply chain for a refurbishment project exacerbating the challenge to deliver a well-coordinated project on time and budget.

BY contract and by way of a challenge to the current UK practice, an Energiesprong refurbishment project is delivered in less than ten days on site. This can be feasible with off-site construction techniques being a significantly portion of the construction supply chain. The process will thus be seen as a long-term contractual agreement between the construction contractor and the project client for maintenance, including various performance warrantees. To this regard, various steps need to be undertaken in order to clearly address main failures in traditional construction supply chains as previously identified.

Firstly, refurbishment works need to be process-based and not project-driven. A long-term management needs to be carried out in line with the project delivery timeline. A clear project plan has thus to be defined in order to identify aims and objectives for each project phase. This will also mean identifying freeze dates for major changes and variations to the projects to be allowed; major changes to the works should be accepted during the first phases; only minor variations with no delay in the works, should be allowed during later project changes. A good project management process is essential to guarantee that the works are carried out in line with project plan and the expected timeline.

Additionally, long-term collaboration between key actors needs to be defined based on strategic and tactical agreed objectives. This will mean stepping away from the short-term, project-based alliances which are one of the main root causes of the supply chain fragmentation. In order to further facilitate collaboration across the process and without causing disruption to the resident, the key actions to be undertaken are reported below:

- Agreement on common objectives and goals;
- Accuracy and clarity on provided information;
- Select collaborative actors for the project team;
- Effective resident notification and communication;
- Qualified and trained actors;
- Agreement on the handling and management of risk.

The all involved actors then need to be able to access and, as appropriate, update a common data and information set for the project. This will prevent information loss, multiple and unnecessary visits to the client and consequently information duplication. Good collaboration between the involved actors will also cut additional risk costs.

Below an ideal and efficient supply chain structure for an Energiesprong like approach is presented from different perspectives. Some overlapping on the different diagrams may be possible.

The first one concerns the general supply chain process of a building subjected to refurbishment, with special regard to the process timeline. Overall six main phases have been identified, as pictured in Figure 3-1. All phases are inter-connected. A direct flow of information from one phase to the others, is required for the process to be successful. The building will be selected in a previous stage depending on the property suitability and on the client's desire for an Energiesprong refurbishment approach.

The first phase of the process, referred as *Pre-refurbishment*, regards the collection of all available information about the state of the art of the building subjected to renovation. All gathered data are to be used for creating a virtual building model to assess the building actual performance and to study refurbishment solutions during further phases of the whole process. The detail of the model may vary based on the user's experience and expertise (BIM model, simplified parametric mode, etc.). The model has to take into account the building dimensions, as well as the building performance with regard to the building envelope, services and building operation.

After this 'building scanning and data gathering' phase, the following is the *Design* phase. The building refurbishment need to be designed on different perspective, as outlined in Figure 3-1. Depending on the project plan, commissioning could also be included from early design stages.

Figure 3-1 – Building refurbishment process.

Next, *manufacture services* for the project delivery are to be provided with regard to both the building fabric and services. Building elements and fittings to be installed will be assembled and transported to site. Particular attention, during this stage, will be taken with regard to logistics, including site access and transport.

The fourth is the *Installation* phase, which requires experienced and qualified teams to manage the installation process. An efficient management of the involved resources and works to be conducted is necessary to secure the project quality and compliance with the planned timeline.

The last two phases, *Commissioning* and *Management & Monitoring* aim to verify and test the building performance as in line with the expected designed one and in compliance with current regulation. The commissioning phase could also be extended and include monitoring activities for a post-occupancy evaluation.

Figure 3-2 illustrates the refurbishment process from the Registered Provider (RP)'s perspective. As it can be observed particular attention is paid to the relationship between the various actors involved in the process and to the information exchange. The RP generally manages connections with the technical expert, the customer (Resident) and the Solution Provider. He is expected to receive technical support for the building design and performance by the appointed designer/professional, who also supports the Resident and the Solution Provider (SP).

A contract is generally procured by the RP to a Solution Provider (SP) for the project delivery and maintenance. Then the SP coordinates the delivery of the project via services provided by the manufacturers and installers. The customer liaison officer coordinates the final delivery of the project to the customer.

Based on a tenancy agreement, a direct contact is also established between the RP and the Resident. Inputs on the guaranties and warranties are provided to the RP, supported by technical data provided by the manufacturer.

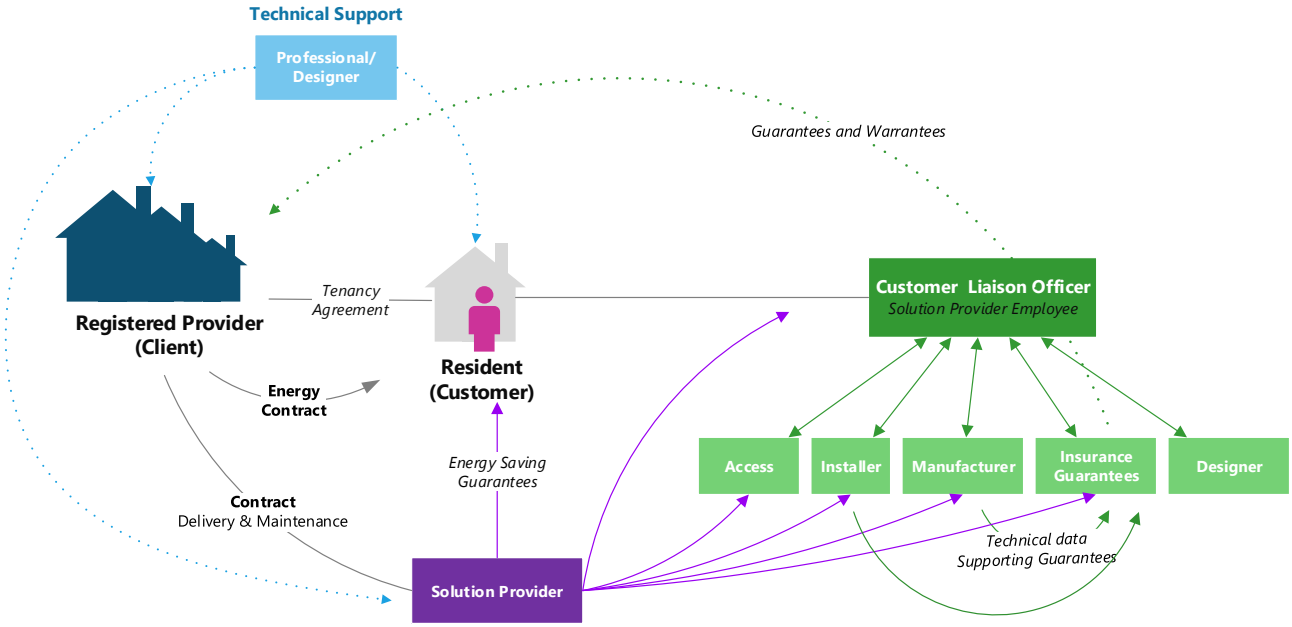


Figure 3-2 – Building refurbishment process – Registered Provider's Perspective.

Figure 3-3 illustrates the building refurbishment chain from the Main Contractor's perspective, with a special focus on each task aim and connection across the process. Once the Client appointed the Main contractor for the project, the first step is the collection of the necessary information about the building, as mentioned during the pre-refurbishment phase. This information will feed in the delivery strategy to be defined and will provide understanding for the building design. Further steps are identification of the project goal/outputs and the overall scope of the work. This will allow to appoint the supply chain and to schedule the first visit to the property. During these first phases major variations to the project are allowed. Once the project has been defined, and before the commencement of the works, a readiness meeting with the client is required. The Main Contractor will then appoint sub-contractors and coordinate their services for the installation and delivery stages.

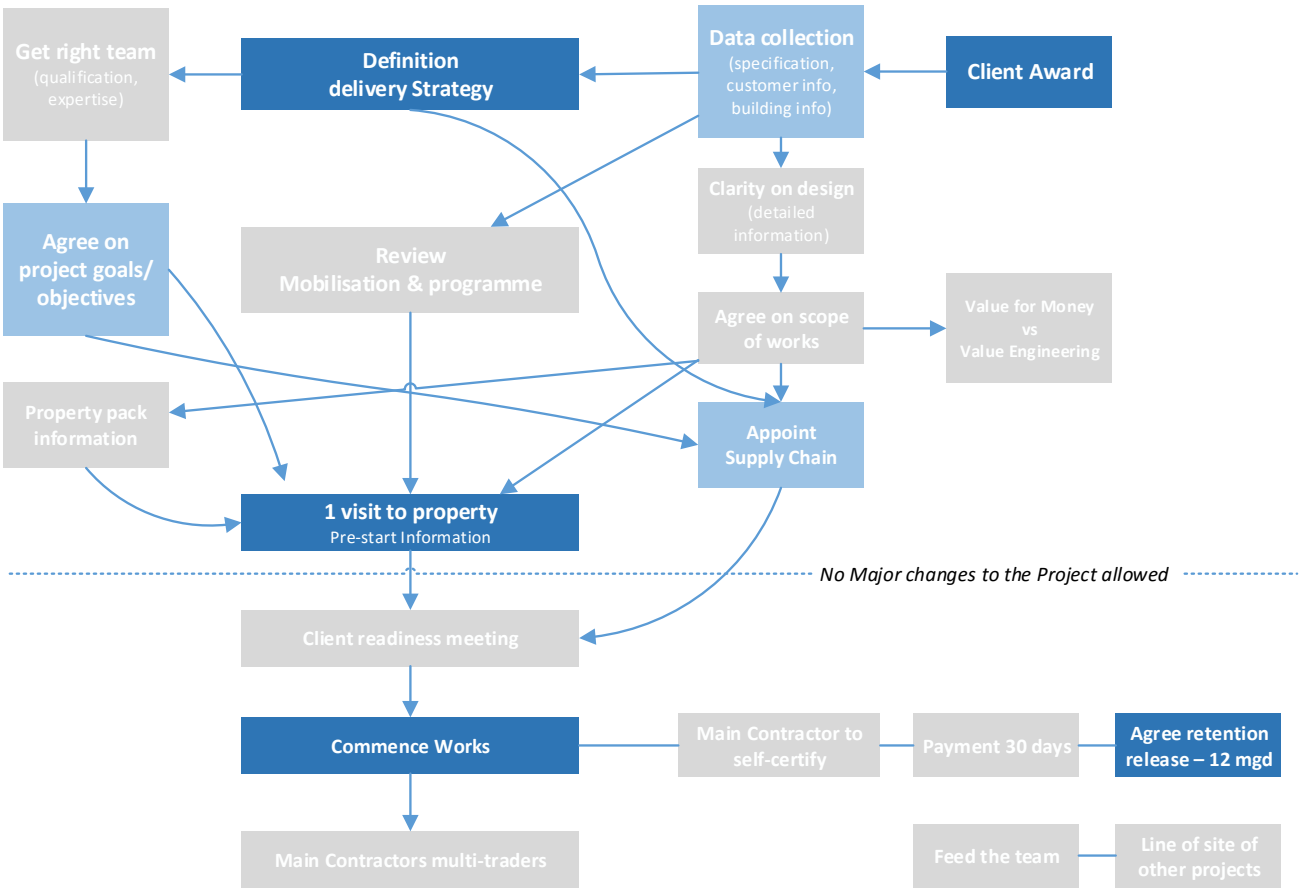
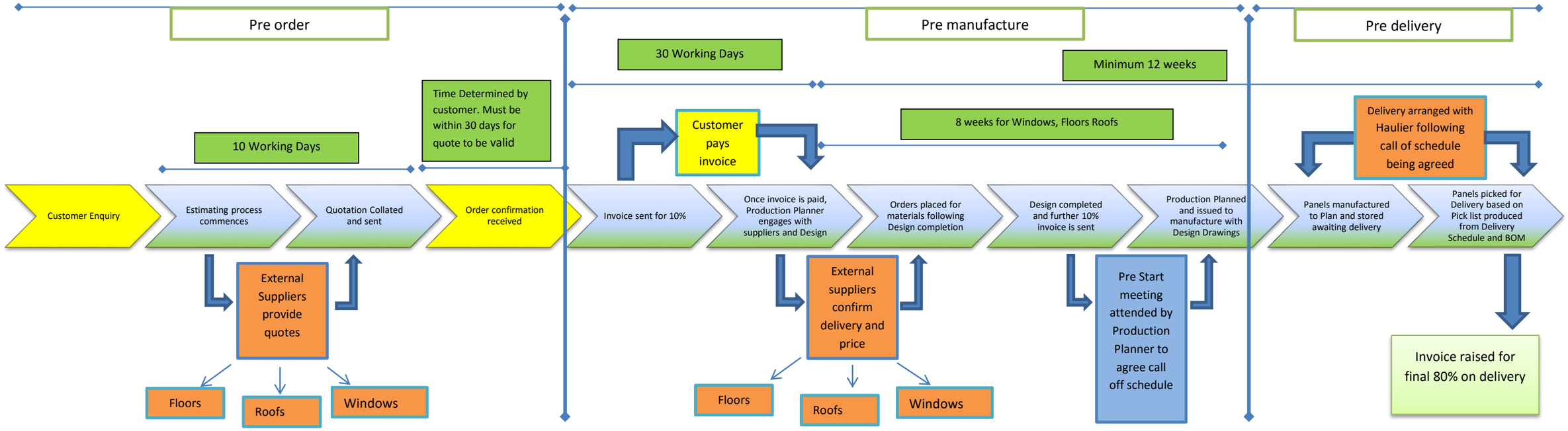


Figure 3-3 – Building refurbishment process – Main Contractor's Perspective.

Figure 3-4 illustrates the ideal supply chain structure from a Manufacturer's perspective for a REMI like refurbishment project and is based on an actual process employed in an off-site manufacturing facility for new homes. Energiesprong like panels are to be manufactured off-site and then installed on site. Special attention is paid to manufacturer's actions across the project process. Actions from the customer and the suppliers also feed in at some stages of the process. The customer is mainly involved in early stages for the project enquiry. After that, the manufacturer has 10 working days, with feedback from external suppliers, to provide full quotes about the project. Once the project confirmation has been received, together with a down payment from the customer (10% of invoice), the Production Planner engages with suppliers and designer in order to start the project design and provide quotes about the project delivery and cost. This stage usually takes up to 30 working days. After that, up to 8 weeks are needed to finalise the project design (walls, roof and windows) and to plan the off-site production. Last stages regard the product delivery and installation of the off-site manufactured panels. Once the first invoice is paid at least minimum 12 weeks are required for the project completion.



Key

Manufacturer's Actions

Customer's Actions

Suppliers' Actions

Figure 3-4 – Building refurbishment process – Manufacturer's Perspective.

The ideal construction supply chain presented for an Energiesprong-like approach, relies upon on a better project management. As can be observed from the process schemes from different perspectives, previously presented, key features are the good planning of the different project phases and the good collaboration between the different actors; this will prevent delay in the project delivery, remove unnecessary and duplicated risk cost and deliver improved service to the client.