Summary:
This paper shows that how modular construction is widely in used in the Europe specially in the UK for multi-story residential buildings up to 25 story high.

Architectural aspect of Modular Construction: Size of a typical module is 3.3 to 3.6m wide, 6 to 9m long and a total area of 25-35m^2 for single person accommodation. Usually two modules are suitable for a 2-person apartment (with one bedroom) and a 3-4 modules is good for a family sized apartment. Another thing about it is typical floor plans for spatial relationship of modules around a core which consist of a cluster of modules and corridor arrangement of modules. In addition it’s mentioned that Kitchen and bathroom are usually arranged next to the corridor or other accessible space.

Structural aspect of Modular Construction: Because of the influence of the tolerance in the installation procedure the structural behavior of modular assemblies are complex and some factors should be considered while designing modules like, mechanism of force transfer of horizontal loads and influence of installation eccentricities. For high-rise buildings the modules are designed to resist only vertical loads and horizontal loads are transferred to a concrete or steel core. Likewise concrete and steel frame could extend the flexibility in space planning. Minimum horizontal force in any tie between the modules is not less than 30% of the total load acting on the module and not less than 30KN. Usually 120-min fire resistance is required for residential buildings and is done by two 15 mm plasterboard layers in the internal face of the walls and ceiling and also its good for sound impact.

Benefits of Modular Construction: Economy of scale in manufacturing of repeated units, speed of installation onsite, improved quality and accuracy in manufacture, modules can be dismantled and reused, construction waste is reduced from 10-15% in a traditional building to less than 5%, the number of visits by delivery vehicles is reduced by up to 70%, neighboring buildings are not affected as much as in traditional process because of reduction in noise and disruption, acoustic insulation is improved, better safety on-site and in the factory.

Impediment of Modular Construction: greater investment in manufacturing and requiring repeatability of output to achieve economy of scale in production, cost of manufacturing facility can be as high a portion as 20% of the total build cost.
Title: Knowledge-Based Approach to Modular Construction Decision Support

Authors: Mirza B. Murtaza, Deborah J. Fisher, Miroslaw J. Skibniewski

Year: Journal of Construction Engineering and Management, March 1993

Summary:

In this paper, through a computer system application a decision making methodology in building a power plant is provided, whether using a modular construction method or not. It performs feasibility analysis based upon five influential factors: plant location, labor related, environmental, project characteristics, project risk.

Advantages of Modular Construction: Time is saved, all interfaces are tested earlier, labor costs are lower due to stable labor force in the factory, a learning curve can be derived, potential saving of about 10% in the capital cost of project.

Impediments of Modular Construction: entail more engineering design, requires more materials and additional work, expensive mode of transportation.

Decision making methodology: Basically multi criteria decision making problems can be solved by using one of the methods of decision science like weighted factor method. However it requires that decision maker have full information about the values thus it alone may not be sufficient. Therefore this paper utilize an expert system methodology as a suitable approach for decision support because its easier to use and simpler programming. Thus totally 24 interviews with different companies were done in this report and as a result 5 major decision factor categories were distinguished. For each of these 5 categories there are some decision attribute as well as weight of each decision attribute and possible values of attributes are provided.

Introducing MODEX: is a computerized frame work for modularization expert hybrid knowledge based system in construction modularization decision making which has 3 step:

- Step1, Prescreening: a weighted factor method is used as an initial feasibility, if the total weighted score is less than 25% then use conventional method, otherwise continue the analysis.
- Step2, Detailed feasibility study: based on relevant qualitative factors and preferences by project management team, it gives advice to decision maker and determine the level of confidence assigned to the advice.
- Step3, Economic study: By combining a tentative table resulting from interviews and past records of realized modular construction projects it answers question about cost saving and schedule time.

Validation of MODEX: volunteer companies were asked to run and compare the outputs in at least 3 cases: clearly conventional, clearly modular projects, borderline situation.
Title: Towards adoption of prefabrication in construction

Authors: Vivian W.Y.Tam, S.X.Zeng, William C.Y.Ng

Year: Building and Environment, October 2006

Summary:

This paper provides advantages, hindrances on prefabrication’s application based on questionnaire survey and also a feasibility analysis on it. The questionnaire survey was sent to different parties in order to prioritize and find out the level of each factor.

The level of prefabrication’s beneficial aspect:

1. Better supervision on improving the quality of products
2. Frozen design at the early stage for better adoption of prefabrication
3. Reduce overall cost
4. Shorten construction time
5. Aesthetic issues

The level of prefabrications hindrances:

1. Inflexible for design changes
2. Lack of background research information
3. Higher initial cost
4. Time consuming in the initial design development
5. Lack of consideration of its advantages rather than conventional
6. Limited site space for placing modular element
7. Monotone in aesthetic
8. Leakage problem while joining the prefabrication
9. Lack of experience on the contractors
10. No demand for it.

In order to collect information and opinion about prefabrication 4 major types of building project (general, public, private residential, commercial) and 6 building elements (substructure, underground service and drainage, structural frame, external works, internal works, building service) was considered: Conventional construction method is 100% recommended for the foundation and basement for public housing, private residential, and commercial projects. Also it was found that there is tendency of adopting modular prefabrication for washrooms in public housing and private residential. Likewise it was shown that Private housing mainly adopt conventional construction, while Public housing rarely use the traditional. Residential projects and commercial and office projects use Semi-prefabrication and industrial, hotel and school projects rarely adopt prefabrication. Considering Construction Wastage, private housing projects generate the highest wastage level specially for steel reinforcement. Wastage in formwork, plastering and screeding for private housing is much higher than that for public housing projects.
Summary:

One of the impediments about Modular Construction is that there is a need for coordinating among members of different professionals and also pre-project planning. This issue could be overcome using BIM.

In addition this paper introduce MEP which is the coordination and fabrication of the mechanical, electrical and plumbing. This process involves defining the locations for components of building systems in where are often congested spaces to avoid interference.

Reasons of challenging MEP in Modular Construction:

- The process is highly divided between design and construction firms
- The level of technology is varied between engineers and contractors
- The process don’t provide an specific model to be used by contractors in order to avoid interferences

Locations in building which cause coordination problems: building corridors, point of entry and exit, opening in shear walls.

Implementing BIM: by using BIM an accurate virtual model of a building is constructed with accurate geometry and other data to support the procurement and on-site installation. The whole process consist of following steps:

1. Visualization, creating a 3d presentation of the project
2. Modeling, ability to generate a rendering tool to show the final product
3. Code compliance review by building officials and fire officials
4. Fabrication and shop drawings
5. Communication, collaborating among the design team, consultant, contractor, clients
6. Cost estimating,
7. Construction sequences, a complete construction schedule is provided
8. Conflict, interferences detection

In addition some example of BIM software such as Navis work is introduced and some case studies is given to show the impact of utilizing BIM.
Summary:

This thesis has provided a methodology to incorporate building information modeling (BIM), Lean construction, and Simulation modelling into a cohesive package in the context of modular manufacturing. That methodology provides an effective method of estimating wall fabrication and erection probabilistic productivity rates. A time study is done on 5 modules to show the production durations and labor requirements of the wall fabrication. Then the data is analyzed and the probable productivity is determined for each task based on the wall type and number of windows, number of doors and number of columns.

Since this thesis consist of basic methods like simulation, Lean construction and BIM, more and better understanding about them is required in order to figure out the main ideas of the thesis.