

## **Construction Logistics Management in Building Projects in Iran: the Warehousing Process**

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### **Abstract**

Logistics has been recognized as a major factor in industrial organizations for many years. However, it has not been applied appropriately in construction yet. The reason is that the nature of construction is different to other industries like manufacturing or food. Some characteristics of construction industry like matchless projects, fragmented supply chain, unique design, temporary organization, and working in different geographical locations, necessitates undertaking a new approach for managing logistics in construction projects. Construction logistics is a system with six agents (sub-systems): (1) site preparation, (2) purchasing, (3) delivery, (4) handling methods, (5) warehousing and (6) monitoring. This paper only covers issues regarding storage and the warehousing process. Owing to the space, staff and equipment that are required, warehousing is a costly element of a logistics system and therefore it should be managed efficiently. This paper aims to describe and evaluate the current practice of warehousing in construction sites to explicate existing problems and share best practice. To achieve reliable results, a qualitative research methodology is adopted which includes two parts. First, a comprehensive literature review was conducted to understand the current body of knowledge in the area. Second, twenty open-ended interviews were carried out with experienced practitioners to bring insight to the research. The study focused on the Iranian building industry as the main source of data collection. After gathering enough data, a conventional template analysis is used to analyze textual data. Results are rich and exploratory and explain opinions, norms and attitudes.

### **Keywords**

Building Projects, Iran, Logistics Management, Qualitative Analysis, Warehousing.

### **1. Introduction**

Logistics has been recognized as a major factor in the industrial organizations for many years. In Iran logistics represents more than 14 percent of the Gross Domestic Product (GDP) (Iran Logistics Society (ILS), 2007). According to recent investigations in different countries, on average, 62 percent of total logistics costs of each country go to the transportation sector, 34 percent to warehousing and maintenance, and only four percent to logistics management (ILS, 2007). Despite consuming the lowest proportion of logistics costs, logistics management has the most effect on logistics cost saving. As

logistics is very expensive, effective logistics management will help to reduce the final cost of products. It also helps organizations reach competitive advantages over competitors via distribution networks and customer services (Christopher, 1998). In Iran, because there is a lack of recognition of the importance of logistics management, logistics costs are very high (ILS, 2007). The higher the logistics costs, the higher the final cost of the products or projects. Iran Logistics Society (ILS) in 2007 announced that a considerable amount of the final price of Iranian products often consists of surplus logistics expenses.

## **2. The Iranian Construction Industry**

The construction industry plays a major role in the Iranian economy by generating employment and wealth. Having an annual turnover of US\$38.4 billion, this industry is powerful in terms of absorbing national and international investments (Australian Government-Austrade, 2007). There is a huge demand in different sectors of the construction industry in Iran. In housing and residential sectors, there is a need for 800,000 additional units every year (Ministry of Housing and Urban Development, 2009). In the transportation sector, many projects such as roads, airports and railway buildings are under construction. Only road buildings more than 1000 kilometers of road were constructed in 2007 (Fars News Agency, 2008). There are also several projects in the water, oil, gas, industrial and commercial sectors that are under construction or in the design stage. However, the process of construction is slow and inefficient in this country. To feed enormous demands in different sectors of construction industry, the Iranian government has attempted to encourage construction firms to improve productivity and efficiency of their projects (Ministry of Housing and Urban Development, 2009). The lack of knowledge of project management is an issue in the construction industry in Iran. The civil engineers and architects who often execute construction projects are not familiar with modern project management concepts such as logistics management. Therefore, much effort is needed to set a strategy for acquiring, developing and exploiting project management knowledge and techniques in Iran. Considering this, a PhD research project is defined to investigate the current practice of construction logistics in Iran and explain its strengths and weakness. One of the most important sections of the logistics system is 'warehousing and inventory' which will be discussed in this paper.

## **3. Research Methodology**

This research is based on a qualitative paradigm that gives the researcher the opportunity to emphasize more on describing logistics system by getting help from practitioners' experiences. Qualitative strategy helps the research to focus on personal histories, perspectives, and experts' experiences of the construction industry (Bryman, and Bell, 2003). The result is rich, explanatory, and describes variations, culture, relationships and norms.

In-depth open-ended interviewing is the major data collection method of this research. The companies that are involved in building projects were the points of interest of this study. Owing to the qualitative nature of the study, a small, but focused and carefully selected sample is chosen to be interviewed. Twenty-four open-ended interviews were conducted with the experienced Iranian practitioners. Respondents were asked to describe logistics practices and discuss different logistical matters in their projects. Interviewing continued to the point that the desired level of data saturation was achieved. That was the point that the interviewer understood responses are being repeated by new interviewees and critical and sensitive information could not be received from them anymore.

In the analysis stage, the conventional template analysis has been used where the researcher produces a list of codes (template) representing themes identified in the textual data (King, 2004). First, responses were classified under relevant categories. Under these categories, new sub-categories were developed by progressing through the transcript of interviews. Then, a comprehensive interpretation was developed to produce well-grounded conclusions. Wherever it was suitable, the participants' direct quotes are cited anonymously to make the interpretation more meaningful.

It should be explained that the result of this study is restricted to the participants' experiences and their viewpoints and cannot be generalized in wider contexts. Furthermore, the result may not be the whole reality as in social studies like this there may be multiple realities. However, to achieve reliable data, interviewees were selected carefully among construction practitioners who have three specifications: a) to have work experience as a senior manager, project manager or site supervisors in a building company, b) to have ten or more years of experience in building construction, and c) to be completely familiar with the culture and environment of construction industry and building sector in Iran.

#### **4. Logistics Management**

Through the past few decades, the field of logistics has been grown significantly with emphasis on several different but related areas. In addition to the procurement and distribution functions, the realm of logistics has been expanded to include those activities pertaining to design and support (Knill, 1992). Logistics may include supply support, equipment testing, transportation, material handling, storage and asset tracking (Blanchard, 1998). A general definition for effective logistics management can be explained as follows: "The efficient transfer of goods from the source of supply through the place of manufacture to the point of consumption in a cost-effective way whilst providing an acceptable service to the customer." (Rushton et al., 2006, p. 6)

In logistics management, material and information flow are at the focal point of attention (Hill and Ballard, 2001). Material flow means continuous and efficient movement of resources. Its aim is to eliminate unnecessary accumulations of inventory and ensure that materials and components are delivered on time, in the proper sequence, and exactly to the point they are needed (Knill, 1992). The information flow involves circulation of essential information among firms involved in projects. Logistical information includes client's requirements, orders status, delivery status, inventory, the time that a resource needed, site condition, and availability of cash (Hill and Ballard, 2001).

Many efforts have been made to develop the concept of effective logistics management in the manufacturing, food and retail industry (Daugherty et al., 2006; Harrison and Hoek, 2005). However, these concepts have not been applied appropriately in construction (Hill and Ballard, 2001). One reason might be the fact that construction always has been behind other industries in terms of innovation and knowledge development, and as Woudhuysen et al. (2004) mentioned, it remains a 19th century affair. Another reason is that most logistics management researchers are specialized in business, management, marketing, distribution, industrial engineering, transportation, industrial production and general supply chain management. Hence, they automatically carried out research based on basic assumptions of industries like manufacturing, food or retail that are mass production, product standardization, heavy customer service and automation. While in construction, owing to the nature of this industry, some of these concepts are not applicable or should be modified to be used. Construction industry is about uniqueness in design, single product, matchless project, temporary organization, site production, and fragmented supply chain (Cox et al., 2006). Hence, a logistics model that is designed for other industries cannot be properly applied in construction and a new framework should be developed for logistics management that understands and respects characteristics of construction industry.

Fairs (2002) explained that construction firms might cut 15 percent off their materials and labour costs by making better use of basic logistics techniques. Strategic Forum for Construction (SFfC) (2005) also believes that substantial saving is achievable by implementing an effective logistics management to the construction projects, and its range may vary from 10 to 30 percent. Hence, logistics is a concept that has a great potential to help construction firms to bring efficiency to their projects.

Based on several definitions and explanations that are provided in literatures (Guffond and Leconte, 1999; Hill and Ballard, 2001; Cox et al., 2006), ten functions of logistics management in construction projects can be explicated as the following: (1) Specifying supply sources, (2) Acquisition of resources,

(3) Logistics planning and scheduling, (4) Site layout designing, (5) Site preparation, (6) Transportation, (7) Materials and components' quality check, (8) Warehousing and inventory, (9) Material handling, and (10) Monitoring and control. This paper is focused on warehousing and inventory function of logistics system.

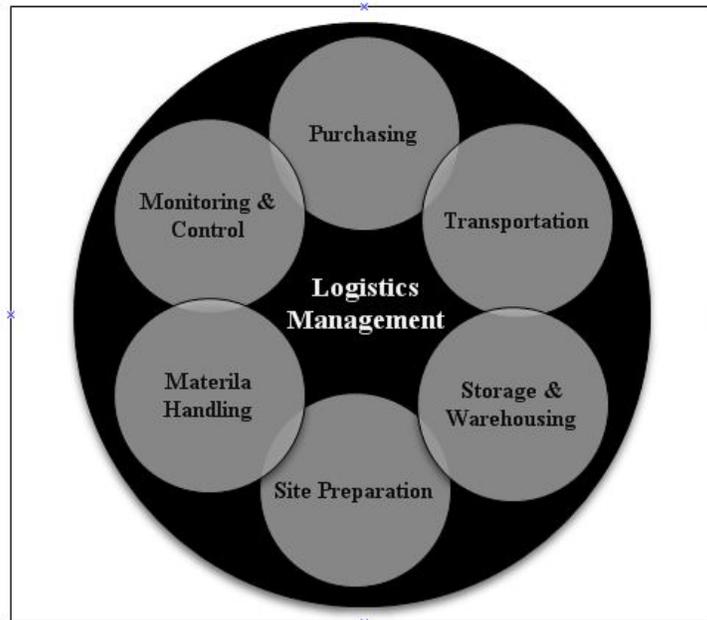
## **5. Warehousing**

Warehousing is a crucial component of logistics management in different industries. It encompasses activities that take place in warehouses and shipping areas. These activities can be subdivided into four categories: receiving, storage, order-picking and shipping (Van den Berg and Zijm, 1999). Owing to the facilities, staff and equipment that are required, warehousing is a costly element of a logistics system and therefore should be managed efficiently (Rushton, 2006). If materials are not stored at the right place and are not clearly labeled then it takes more time searching for the correct material. This is considered as waste and creates frustration among the personnel who are looking for the material (Gopalakrishnan, 2010).

There is a limited research in inventory theory to the management of storage systems (Van den Berg and Zijm, 1999). Unfortunately no research is found that considers the role of warehousing in construction projects. Hence, lessons from other industries and general warehousing research might be applied in construction sector. Generally, there are two major material storage philosophies: fixed location storage and random location storage (Tompkins and Jerry, 1998). In fixed-location storage, each item is stored in a specific location, and no other items may be stored in that location, even though that location may be empty. With random location storage, any item may be assigned to any available storage location. An item, that is stored in location A in the first month, might be stored in location B in the next month, and a different item stored in location A. It seems that owing to have various kinds of materials and limited space in construction sites, random location storage philosophy is more appropriate for projects although fixed location storage might be used for small size items that have high value. Warehouses in construction projects have similar function to a production warehouse in manufacturing industry. A production warehouse is used for the storage of raw materials, semi-finished products (like prefabricated components) and spare parts (Van den Berg and Zijm, 1999). To plan the production warehouse a policy is required to first determine which products arrive and where these should be stored. Then the policy should deal with the sequencing of order picking, retrieval operations and allocation of products to storage positions (Van den Berg and Zijm, 1999). Gopalakrishnan (2010) suggested that in a successful warehousing policy seven principles should be considered as: (1) easy identification, (2) close to the work area, (3) ease of handling, (4) proper container, (5) safety, (6) security, and (7) tidiness.

## **6. Qualitative Data Analysis**

Based on information collected from interviews the construction logistics system generally has six parts that are: (1) purchasing, (2) transportation, (3) storage and warehousing, (4) site preparation, (5) material handling, and (6) Monitoring and control (Figure 1). In this paper, these parts are referred as categories. As it was mentioned before this paper will discuss the storage and warehousing category. This category is divided into three subcategories: (1) the process of warehousing will be described, (2) the necessity and advantages of storing materials onsite will be explained and (3) disadvantages of keeping large inventory will be expressed.



**Figure 1: Logistics Management Categories**

### ***6.1. The Process of Warehousing***

The process of warehousing in construction projects is basic. After purchasing an item, it will be handed in to the warehouse and will be registered manually in an inventory book. Warehousing staffs should check the quantity and quality of the materials and components before storing them. The quantities are usually measured by counting or weighting the load and comparing the figures with quantities specified in the bill. Quality check is carried out by selecting a random sample and sending it to the laboratory for different tests. If there is a problem with quantity or quality of the load after negotiating with the supplier, materials will be returned or the money will be refunded.

Clearly, storing materials that come with quality packaging is easier than materials with poor or no packaging. Materials with poor or no packaging will be wasted more. In addition to wastage, identifying how much of a specific material with no packaging is available onsite is not accurate. This may cause problems when that material needs to be reordered because it is not clear how much extra should be purchased. This will lead to more waste and extra cost. The warehouse may have indoor and outdoor spaces. Sensitive and high value materials should be stored in indoor spaces and large materials that are less sensitive to environmental impacts should be stored in outdoor spaces.

In most construction sites the material storage areas are dirty, disorganized with poor lighting and no markings. This leads to an inefficient warehousing process, high transaction error rate, incomplete assigned tasks, and waste of time.

### ***6.2. Inventory Information***

The role of information is crucial in managing the inventory of materials, equipments and machines. The quantity, the location and the current condition of a specific material are kinds of information that should be available for senior managers, project managers and site supervisors. Project managers and site supervisors need this information because they must ensure that resources are ready for starting activities that are planned in the schedule. Senior managers should also have access to this information to distribute resources evenly in different projects. This is clearly described by a respondent: “When we want to attend

in a tender we gather information about extra materials, equipment and machines that are not being used in different projects. These can be delivered to the future projects and therefore we do not need to buy new things for the new project. And therefore we can offer lower price to the client. For example, recently we send a truck mixer, a loader and scaffolds from a project near completion to a project that we want to start very soon.”

### ***6.3. The Necessity and Advantages of Storing Materials and Equipments Onsite***

Warehousing is a necessary activity in construction projects for two reasons. First, in typical construction projects the demand for materials is usually continual. For example the cement is required for foundation, structure, tiling, and finishing. Hence, there is a continual demand for the cement in different stages of construction and therefore it should be stored onsite. Second, in most cases the supply lead time of materials is greater than the demand lead time. For instance, steel sections cannot be ordered two or three days before the time they are needed because of possible shortage of a specific section in the market or suppliers indifferences. Some respondents explained more reasons for holding inventory as: cost saving through large purchases, having the sense of confidence that materials are available onsite and conducting cost trade-off analysis with the transportation system (e.g. the use of full container loads).

In contrast to Hill and Ballard (2001) that explained inventory should be kept to a minimum, the Iranian construction firms prefer to store large quantities of materials onsite. This is mainly owing to high rate of inflation in Iran and shortage of materials in specific periods. The rate of inflation is high in Iran and was 15.4% in 2006 (CIA-The World Fact Book, 2006). This forces firms to buy materials and components as soon as possible to avoid price increase. One of the respondents has a problem with a cement supplier that is explained below: "I signed a contract to buy a large amount of cement for my project three months ago and paid for it completely. The supplier provided me with a quarter of the contract and after that he argued because the price of cement had increased, I have to pay the difference between the current price and price of three months ago. It is not fair because I paid for that contract three months ago. So why should I pay more? Inflation forces suppliers to be not committed to their contracts". Shortage of construction materials is also an issue that leads to high level of inventory. Respondents emphasized that it is necessary to purchase and store construction materials such as steel, brick, gypsum, and cement before the season that construction activities are in their peak, since most of the construction materials usually become scarce in these periods of times. Beside this, one respondent expressed the following reason for purchasing components in advance: "For one of my projects I bought eight mechanical components nine month before the installation time. The reason was that the supplier gave me a discount at that time. He said in six month time the price will definitely increase and also the discount would not be available anymore. So I had to buy components and store them in my place”.

### ***6.4. Disadvantages of Storing Materials and Equipments Onsite***

Some respondents believed that too many materials should not be stored on-site. Storing materials onsite needs large space and effective maintenance systems that will lead to cost increase. Also keeping large inventory needs large amounts of investment. Considering the high interest rate in Iran (10-15%), storing so many materials and components may cause some problems with the cash flow of the project.

Large volumes of material onsite in addition to blocking the access points to the site may make problems for personnel movement that will lead to re-handling of materials. Re-handling increases the risk of deflection and breakage and also wastes time and money. In urban areas that the space issue is more crucial some materials have to be stored in the street. An interviewee explained that he had this situation: "We are legally allowed to store materials in one third of the street width temporarily usually up to 24 hours. But in many cases we do not have enough space to bring those materials in the site. So we have to leave them there for couple of days. If one of the neighbors complains about us in the municipality we will be in trouble. First, they will send us a warning notice to clear the street in few hours. If we do not do

so they will suspend the project. So we have to be selective and efficient in terms of the volume of material that we store onsite”.

Another important point which is mentioned by the interviewees is that storing huge amount of materials and components on-site will increase the risk of burglary and fire. A respondent emphasized that “something that we store in warehouses is our capital. It might be put in fire or become robbed. So, we have to insure this capital and this will increase the total cost of the project.” In addition to insurance, facilities favor using security systems, enter/exit control, identification system, fire alarm, and fire distinguishers should be provided to keep the inventory safe.

Furthermore, preparing suitable storing places and utilizing a reliable warehousing and inventory system is a costly task. Respondents expressed that the materials such as cement and gypsum which may be depraved cannot be stored for long periods of time. These materials should be stored in dry and covered storages. Also, according to Iranian Construction Code of Practice, there is a time limitation for storing sensitive materials (e.g. cement) onsite. A respondent expressed “There is no point in storing some materials and goods like construction machine tires, chemical materials, and paint. After 18 months only the allowed usage period will be expired and we cannot use them anymore”.

Another problem of early purchasing and storing equipments for long time is that they become old. A respondents explained “In big building projects that may last more than three years you may save on buying things soon but if you buy some equipments soon they will become old when you want to hand in the project and in some cases like air conditioning units the guaranty period will be expired”. In fact owing to fast changes in technology storing, some equipment and components of building (e.g. mechanical and electrical goods) are not wise decisions anymore.

## **7. Discussion and Conclusion**

Warehousing is an important part of logistics management in construction logistics. Construction materials usually are delivered by trucks, which are unloaded at the receiving docks. Before storing, quantities should be verified and random quality checks should be performed on the delivered loads. Then, a label should be attached to the load, e.g., a bar code or a magnetic label. Subsequently, the loads should be delivered to where they are required or to the storage area.

Maintaining a rational inventory buffer is an important tool in warehousing because it allows two activities to proceed independently. Buffers can provide a workable backlog to compensate for uncertainty in the actual rates of supply and use. However, as valuable as buffers are, they are expensive and hard to size. Buffers are hard to size because the actual supply and use rates are unknown and they vary. Some associated costs with buffers are storage space, double handling, inventory management systems, and loss prevention.

Materials like steel sections might be stored for a long time. The volume of these materials that might be purchased soon and stored onsite can be determined by evaluating the economic situation (e.g. inflation rate), the available space onsite and the condition of cash flow. Furthermore, issues like deprivation, moisture and corrosion should be considered ahead of time and appropriate storage facilities should be provided to avoid these problems. Besides this, experienced personnel should be employed and a basic warehousing system and security control should be utilized. All of these incur extra cost to the project that may be unreasonable for parties involved.

For effective warehousing, first the activity and then the techniques, equipment, and information to be used in performing the activity should be defined. Second, the space requirements of each element should be determined. Third, a comparison between the available space and the total space requirements should be carried out. Forth, the stored materials should be labeled properly and an identification and retrieval system should be set. Fifth, the volume of available materials should be monitored continuously to meet construction requirements.

This paper is written generally well, but needs an additional English edit. Various sentences are unclear and need to be restructured. The writer’s topic is clear and supported.

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