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Part 1: Country Report

Korean Economy and Construction Industry

Prepared By

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1. Executive summary

Korean economy is starting to bottom out from the worst recession caused by global financial crisis. Amid a continued stabilization in the domestic and global financial markets, the Korean economy showed a rapid improvement in domestic demand helped by improving terms of trade and stabilizing inflation. Over 2009, Korea Development Institute expects Korea economy to contract 1.0 percent from a year earlier. Though there are reports that Korean economy had already escaped the grip of recession, but there are also several arguments worrying the double-dip recession. Government is planning to continue expansionary fiscal stimulus regardless of a recovery by end of this year.

Construction investment, though a relatively fast recovery in public works is expected with most of the increased government expenditure being assigned to infrastructure investment, is forecasted to remain at around 2% growth rate as the sluggishness in building construction of private sectors continues.

2. Macro Economic Review and Outlook[1]

2.1 Overview of National Economy

The Korean economy recently showed a rapid recovery in domestic demand and exports, bottoming out from the recessionary phase caused by the global financial crisis. Amid a continued stabilization in the domestic and global financial markets, the Korean economy showed a rapid improvement in domestic demand helped by improving terms of trade and stabilizing inflation. Led by China, economies of major trading partners of Korea have improved, alleviating the decline of exports and increasing industrial production continuously. The improvement in the economy possibly contributed to the ripple effect of the expanded government expenditure since the second half of last year, as its consequences emerged relatively fast. The upward momentum of the Korean economy is expected to continue, but its pace might possibly slow down. Economic indicators may show temporary fluctuations due to remaining uncertainties caused by foreign factors such as the instability of global financial markets and the possibility of delayed recovery of the global economy.

[1]Source: Korea Development Institute, Monthly Economic Trends, 2009.8

2.2 Main Economic Indicator

Korean economy recorded 3.4% year on year contraction in the fourth quarter of 2008, the first decrease since financial crisis of 1998, following 4.2% decrease in the first quarter of 2009. But in the second quarter of 2009, GDP grows at a rapid rate 2.6 per cent from the previous quarter, though it is 2.2 per cent year on year decrease. Overall consumption has continued to improve, although the recent rise in private consumption seems in large part attributable to temporary factors such as tax reduction for new car purchases. The month-on-month growth rate of equipment investment recorded a continued rise since April. The decline in Korea's exports to China has moderated fast led by the IT sector. With inventory adjustment almost coming to an end, the rising demand at home and abroad seems to lead to the rise in production. The expansionary monetary policy pursued along with the expansion of government expenditure seems to help improve economic conditions.

On the production side, the manufacturing sector decreased 7.3 percent, which was mainly due to the sharp decrease of exports including electric and electronics manufacturing and transport equipment manufacturing. The construction sector was increased by 2.2 percent in the second quarter of 2009 compared with - 2.4% in 2008, helped by the huge fiscal stimulus.

The upward momentum of the Korean economy is expected to continue, but there are several arguments for V-shaped recovery with a rapid return to growth. Unemployment is steel increasing to 3.8% in the second quarter of 2009 from 3.2% in 2008. Korea Economic indicators may show temporary fluctuations due to remaining uncertainties caused by foreign factors such as the instability of global financial markets and the possibility of delayed recovery of the global economy, in addition to the base effect of high growth rate for the second quarter. Yet, most economic indicators are still at considerably low levels, thus, it is too early to say that overall economy is starting to pull out of the recession.

Table 2.1: Main Economic Indicator

	2004	2005	2006	2007	2008	2009 (Q2)
GDP and Components						
GDP at real price (bill. Won, base year 2005)	832,305	865,241	910,049	956,515	977,787	244457
GDP at current market price(bill. Won)	826,893	865,241	908,744	975,013	1,023,938	262,631
GDP growth (%)	4.6	4.0	5.2	5.1	2.2	-2.2
GDP growth (%) for agriculture, forestry and fishery sector	9.1	1.3	1.5	4.0	5.5	-1.2
GDP growth (%) for manufacturing sector	10.0	6.2	8.1	7.2	3.1	-7.3
GDP growth (%) for services sector	2.3	3.5	4.4	5.1	2.5	0.4
GDP growth (%) for mining sector	-0.4	-0.4	-0.1	-4.1	1.3	6.8
GDP growth (%) for construction sector	2.0	-0.3	2.2	2.6	-2.4	2.2
Demographic Indicator						
Population (1000 people)	48,039	48,138	48,297	48,456	48,607	n.a.
Population growth rate (%)	0.38	0.21	0.33	0.33	0.31	n.a.
Labour force (1000 people)	22,557	22,856	23,151	23,433	23,577	23737
Labour force growth rate (%)	1.89	1.33	1.29	1.22	0.61	0.68
Unemployment rate	3.7	3.7	3.5	3.2	3.2	3.8
Inflation rate (CPI)	3.59	2.75	2.20	2.54	4.68	2.73
Financial Indicator						
Inter bank interest rate	3.66	3.4	4.3	4.86	5.04	2.33
Short term loan interest rate (Yields on CD(91-day))	3.79	3.65	4.48	5.16	5.49	2.41
Long term loan interest rate (Yields of Treasury Bonds(3-year))	4.11	4.27	4.83	5.23	5.27	3.89
Average change against USD$	1,144	1,024	956	929	1,102	1,285

3. Trading Country

3.1 Value of Import and Export

Goods account was recorded a surplus of $17.7 billion in the second quarter of 2009 from the $ 13.3 billion of deficit in 2008. It was mainly due to the sharp drop of import exceeding the decrease of export. During the first half of 2009, export was fallen about 20 per cent compared with 2008, but import was more dropped of 36%. The goods export in 2010 is forecasted to increase about 6% growth due to the base effect of the large fall in 2009 and the global economic recovery. Import in 2010 is expected to 8% growth, supported by the stabilization in the won value and recovery in domestic demand.

Table 3.1: Export and Import

(unit: bill. US$)

	2004	2005	2006	2007	2008	2009-Q2
Export	253.8	284.4	325.5	371.5	422.0	91.1
(increase rate)	31.0	12.0	14.4	14.1	13.6	-20.5
Import	224.5	261.2	309.4	356.8	435.3	73.4
(increase rate)	25.5	16.4	18.4	15.3	22.0	-36.1
Balance of trade	29.4	23.2	16.1	14.6	-13.3	17.7

3.2 Top 5 Major Trading Countries

The top 3 major trading countries of Korea in 2008 are China, Japan and America. Middle East Asia countries including Saudi Arabia and U.A.E. are the major countries of import, as about 80% of oil import of Korea is from these Middle East countries. Hong Kong and Singapore are also included in the 5 major countries of export in 2008. A share of Asian Countries in the trading to Korea has increased.

Table 3.2: Top 5 Major Trading Countries of Import and Export in 2008

(unit: mill. US$)

Rank	Import		Export	
	Country	Value	country	Value
1	China	76,930	China	91,389
2	Japan	60,956	America	46,377
3	America	38,365	Japan	28,252
4	Saudi Arabia	33,781	Hong Kong	19,772
5	U.A.E	19,248	Singapore	16,293

About 40% of the exports came from petroleum products, ships, Cordless Telephone, automobile, electronic and IC(integrated circuit). Import products of Korea is mainly consisted of oil that is about 20% of total import, and electronic IC, gas , petroleum products and unalloyed steel goods is major import product s.

4. Overview of construction industry

4.1 Value of Construction Contract

Until 2007, construction business has risen helped by buoyant housing business, regardless of government's strong regulation of real estate market. And thus residential building construction was increased in the nation wide, especially apartments in local cites. It resulted in oversupply of housing construction and an unsold apartment has increased in local areas. With the spreading global financial crisis by sub-prime mortgage in America, domestic housing business was also greatly shrunken in the end of 2007. Fortunately, since October in 2003, Korean government regulated household's mortgage loan from commercial bank to stabilize the housing price in some speculative areas, and thus there was no commercial bank that received bailout.

Non-residential building and civil engineering business sectors rose owing to macro economic growth in 2007, but non-residential building sharp fell with economic recession affected by global financial crisis in 2008. In the first half of 2009, period of the deepest recession, residential building construction contract was recorded 49.1% year on year contraction and non-residential building construction contract was shrunk by 33.7%.

Since early 2008, the expansionary policy to economic recovery has led the government expenditure to rise rapidly, letting the investment in construction, mainly for infrastructure projects, to rise fast. Over the first half of 2009, civil construction sector registered 85.9% increase, but total construction contract was decreased by 7.9% from the previous year on year, offset by a large fall of private projects.

Figure 4.1: Growth rate of construction Contract

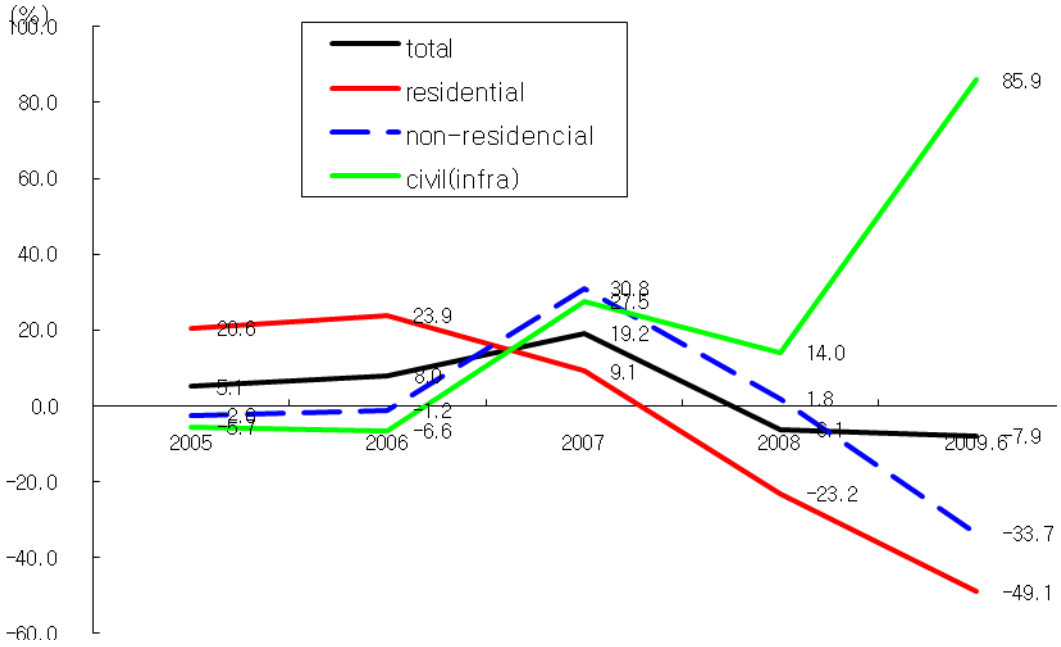

Table 4.1: Break Down of Construction Contract

Unit: bill. Won(current price).

Type of Contract	2004	2005	2006	2007	2008	2009.6
Public Project						
Residential building	3,172	3,853	5,122	7,570	9,346	3,262
Non-residential building	7,332	7,001	5,755	7,587	9,149	4,247
Infrastructure	23,261	20,972	18,643	21,932	23,354	24,278
Sub-Total	33,765	31,826	29,519	37,089	41,849	31,787
Private Project						
Residential building	32,496	39,155	48,155	50,578	35,311	8,762
Non-residential building	19,349	18,978	19,905	25,984	25,021	6,742
Infrastructure	8,963	9,425	9,740	14,261	17,904	3,480
Sub-Total	60,808	67,559	77,799	90,823	78,236	18,984
Total						
Residential building	35,668	43,009	53,276	58,148	44,657	12,024
Non-residential building	26,680	25,979	25,660	33,571	34,170	10,989
Infrastructure	32,224	30,396	28,383	36,193	41,258	27,758
Total	94,572	99,384	107,318	127,912	120,085	50,771

Source: Construction Association of Korea

4.2 Construction Companies

4.2.1 Number of Contractor by Type

Since 2006, the number of construction companies has slightly increased to 55,972 firms in May 2009. The number of General contractors is 12, 467 firms, 22.3% of total firms and 67.1% is Specialized trade contractors. During that period, the number of general contractor has kept steady decrease from 13,202 firms in 2005, to 12,467 in May 2009, by contrast, Specialized trade contractors and Equipment work contractors, which are mostly small and medium firms, saw a steady increase.

The reason why numbers of small and medium construction company has increased in the economic recession period is that competitive bidding is more severe in public project market. And this bidding system for small public project is insufficient to discriminate, more paper companies participated in that bidding.

Table4.2.1: Statistics of Construction Company

Year / Classification	2004	2005	2006	2007	2008	2009.5
Number of general contractor	12,988	13,202	12,914	12,842	12,590	12,467
Specialized trade contractors	32,990	35,547	35,040	36,422	37,106	37,572
Equipment work contractors	5,338	5,505	5,387	5,478	5,768	5,933
Total	51,316	54,254	53,341	54,742	55,464	55,972

Source: Construction Association of Korea

4.2.2 Number of contractors by employment size

About 90% of Construction firms are small companies that employed below 50 workers, about 9% is construction firms hiring employee between 50 and 299, and large firms having 300 over of workers are just below 1%. Share of firms according to employment size has not changed apparently since 2003.

Table 4.2.2: Share of contractors by employment size(%)

Classification \ Year		2004	2005	2006	2007
Total	Total	100	100	100	100
	1-49	89.0	90.2	90.5	89.7
	50-300	10.3	9.1	8.6	9.4
	300 over	0.7	0.7	0.9	0.8
Number of general contractor	Total	100	100	100	100
	1-49	98.6	98.7	98.5	98.8
	50-300	1.0	1.0	1.1	0.8
	300 over	0.4	0.3	0.4	0.4
Specialized trade Contractors	Total	100	100	100	100
	1-49	87.1	88.6	88.6	87.8
	50-300	12.1	10.7	10.4	11.3
	300 over	0.8	0.8	1.0	0.9

Source: Construction Association of Korea

4.3 Employees and Construction Labor

4.3.1 Number of construction worker by job type

The number of workers increased steadily in the construction industry. For the year of 2007, more than 1.8 million employees were working in the construction field, 7.9% of total employment. But the number of workers in 2008 decreased slightly compare to previous year with construction business slowdown, and sharp fall by 1.77 million workers in April 2009, when Korean economy was in the deepest recession affected by global financial crisis.

It is difficult to see the latest trend by job type, since the data about the number of construction workers by job type is only available till 2007, as below Table 4.3b shows. The number of building construction workers was increased amid buoyant housing and building business from 2004 to 2006.

Table 4.3a: Number of workers in Construction

Year / Classification	2004	2005	2006	2007	2008	2009.4
Number of employee in construction (thousand person)	1,820	1,814	1,835	1,850	1,812	1,773

Source: Korea National Statistical Office

Table4.3b: Number of Construction Worker by Job Type

Unit: thousand workers

	2003	2004	2005	2006	2007
Construction	1,719	1,737	1,718	1,717	1,728
General construction	589	562	571	579	576
Heavy construction	177	174	176	161	162
Building construction	412	389	395	417	414
Special trade construction	1,130	1,175	1,147	1,138	1,151
Engineering and building	485	504	475	482	477
Building installation	174	185	183	170	165
Electrical & communication works	255	256	252	246	265
Building completion	216	230	236	239	243

Source: Construction Association of Korea

4.3.2 Number of foreign construction worker by job type

There is little statistics about the number of foreign construction worker in Korea, because the foreign firms making business of construction in Korea is very few.

4.4 Productivity

4.4.1 Value added per employee

Value added product per employee in construction industry was gradually increased since 2004, even though dropped by 0.1 million Won from 33.6 million Won in 2008 to 33.5 million Won in 2007. But the relative Value added product per employee in construction compare to manufacturing sector has become smaller since 2004, registered by 52% in 2008 from 69.6% in 2004. This rate is disappointing, since service

sector industries showed gradual increase such as 2%p increase in 2008 from 36.1% in 2006.

Table 4.3.1: Value Added per Employee

(unit: mill. Won per person at 2005 price)

	2004	2005	2006	2007	2008
Construction	32.7	32.7	33.0	33.6	33.5
% of manufacturing	69.6	64.8	59.6	55.9	52.0
Manufacturing	46.9	50.5	55.4	60.1	64.3
% of manufacturing	100.0	100.0	100.0	100.0	100.0
Service	36.1	36.5	37.3	38.1	38.0
% of manufacturing	77.1	72.4	67.3	63.4	59.0
Primary sector	14.9	15.2	15.7	16.7	18.0
% of manufacturing	31.9	30.1	28.3	27.9	27.9

Source: Korea National Statistical Office

4.4.2 Physical measurement of construction productivity

We don’t have the adequate data standing for physical measurement construction productivity, since there is no labor input data which is classified by construction types.

4.5 Construction Cost

4.5.1 Major construction material average price

The official prices of major construction materials are influenced by government guideline but actual transaction value changes according to the market conditions. The demand and supply of most of the construction materials more or less can be matched domestically. Shown as <table 4.5.1>, the price of the most construction materials is almost not changed since 2003, except Steel bars. In Jun 2008, the price of Steel bar rose to about one million (Korean won per ton), almost twice, from the previous year 526, 500 won. Because the raw material of Steel bar mainly depended by import, and so the price was influenced by international market situation. June 2009, the price of steel bar down to 741, 000 Won from 888,500Won of average price in 2008, is still high compare to previous year prices.

Table 4.5.1 : Average Construction Material Price

RMC * kg/cm^3 (won per m^3)	Cement in bulk (won per 40kg)	RMC * kg/cm^3 (won per m^3))	Steel bars (won per ton)	20mm aggregates (won per m^3)	Concreting sand (won per m^3)	Common Bricks (won per thousand pieces)
2003	3,333	55,543	382,750	11,000	12,000	48,000
2004	3,404	53,827	515,917	12,250	13,000	46,000
2005	3,387	51,708	498,583	14,167	13,083	46,000
2006	3,370	49,080	455,667	11,333	13,250	45,000
2007	3,370	49,080	526,500	11,500	13,083	45,000
2008	3,370	51,248	888,500	12,417	12,000	45,000
2009.6	4,000	51,970	741,000	12,000	13,000	45,000

* RMC: Ready Mix Concrete

Source: KPC (Korea Price Information Corp)

4.5.2 Construction industry salaries and wages

For chief workers, the salary and wage has mildly increased since 2003. But special daily workers experienced negative wage growth due to decreased construction demand during the years 2003~2004. In the first half of 2008, the average wage per day for chief workers is 85,203 won (about 83.7 dollars), 81,596 won (about 80.2 dollars) for special daily wage, and 63,530 won (about 62.4 dollars) for normal daily wage.

Table 4.5.2: Construction Industry Salaries and Wages (Korean Won)

	2003.	2004	2005	2006	2007	2008
Chief worker	69,644	70,184	73,402	78,124	81,700	85,203
Special daily wage	66,596	66,504	68,917	73,572	79,027	81,596
Normal daily wage	52,429	52,575	54,171	57,321	59,715	63,530

Source: CAK (Construction Association of Korea)

4.6 Import and Export of Construction Work

4.6.1 Annual export of construction work

Total exports in construction were 47,640 million dollars in 2008, the historic record since construction export started. Among them, industrial construction exports (Plant) occupied the largest portion recording 26,748 million dollars. The export of Civil engineering and Architecture construction sectors was recorded 9,364 million dollars and 9,192 million dollars respectively. But in 2009, total export in construction effected by global economic recession was sharply reduced to 20,900 million dollars till September 2009, which was just less than a half of previous year level.

Construction import has not been recorded yet.

Table 4.6.1: Annual Exports of Construction Services

year	Total	Contract Amount by work type(million US$)					
		Civil	Architecture	Plant	Electric	Telecomm	Engineering
2009.9	20,900	3,591	5,252	11,281	231	20	525
2008	47,640	9,364	9,192	26,764	1,336	19	965
2007	39,788	5,232	8,177	25,268	690	41	381
2006	16,468	1,532	3,433	10,920	474	3	106
2005	10,859	836	1,226	8,263	374	13	147
2004	7,498	806	874	5,182	545	3	89
2003	3,668	402	532	2,491	192	8	43

Source: ICAK(the international Construction Association of Korea)

4.6.2 5 major foreign market by value

Middle-east Asian countries are usually included in top five countries for construction export of Korea. In 2008, Kuwait, U.A.E in 2007 and Saudi Arabia in 2006 are the highest country in construction exports. Singapore and Vietnam are occasionally included in 5 major export countries. The export of construction service to middle-east Asian countries is mainly plant construction sector and infrastructure construction or architecture construction sector to south-east Asian countries.

In 2008, Kuwait is the most important country in construction exports where 7,540 million dollars of construction service was exported. U.A.E.(4,841 dollars), Qatar (4,400 dollars) Saudi Arabia (4,122 dollars),and Singapore (2,917 dollars) followed.

Table 4.6.2: Top Five Countries for Construction Export

(unit : million US$)

Rank	2006		2007		2008	
	Country	Value	Country	Value	Country	Value
1	Saudi Arabia	3,624	U.A.E	5,585	Kuwait	7540
2	Kuwait	1,982	Libya	5,450	U.A.E	4841
3	Qatar	1,314	Saudi Arabia	5,055	Qatar	4400
4	Oman	1,267	Singapore	3,178	Saudi Arabia	4122
5	Vietnam	1,153	Egypt	2,081	Singapore	2917

Source: ICAK(the international Construction Association of Korea)

5. Construction Outlook 2009 / 2010

Korea's GDP growth is projected to record around 4% in 2010, as the global economy is expected to enter the recovery phase. Private consumption is expected to recover to the level similar to the pace of the income growth as the economic conditions, including the exchange rate, inflation and employment is stabilized. Construction investment, while the current scale of infrastructure investment seems to be maintained, is expected to grow in 2010 at a similar pace of the previous year as the private construction sector starts to recover from its sluggish performance.

It is expected that the growth rate in construction investment in 2nd half of 2009 will reach 2.5%, which means 3.9% increase during the 2009. The investment in civil engineering will grow 20.4% in 2nd half and 29.8% annularly, considering the exhaustion of the reserved power for a financial investment.

Table 5: Prospect of Construction Investment in 2009

(Unit: %, compared with the previous year)

Segment	1st half of 2009	2nd half of 2009	2009 annually
Construction Investment	5.3	2.5	3.9
- Civil Engineering	39.2	20.4	29.8
- Building	-14.7	-9.5	-12.1
Residential	-25.4	-10.2	-17.8
Non- Residential	-5.5	-4.3	-4.9

Source: KRIHS

The government decided to increase the budget for 2010 by 6 trillion won at the emergency economic meeting held in September 9. The decision was made so that all of budgets for social welfare, defense, and infrastructure section would increase. Thus, the finance investment spending on infrastructure sector is expected to increase approximately 2 trillion Korean Won.

But construction investment is forecasted to record around 2% growth rate in 2010, lower than the initial forecast (2.3%), as the sluggishness in building construction of private residential sector, even though the increase in investment in public works owing to the increased government expenditure[2]

[2] KDI, *Economic Outlook*, 2009.9.

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Part 2: Theme Paper

Integration of Value Chain in the Construction Industry

Revisit Prework

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Executive Summary

The construction project is fragmented by nature. In most cases, planning, design, construction, and maintenance are separated by disciplines and executed in phases. To overcome fragmented process in construction project, both managerial and technical approaches have been attempted. As one of these approaches to integrate fragmented process, a prework has various advantages against traditional way of doing design and construction in terms of not only integrating design and construction process but also construction cost, time, quality, productivity and safety. However, some barriers exist. The main aim of this paper is to provide an overview of benefits, barriers, and application of prework in the construction industry. Through this paper, a case study of automatic digitalized rebar supply management system in Korea was introduced as an example of successful application of prework. At the end of this paper, several suggestions for successful application of prework are provided.

1. Introduction

1) Fragmented Construction Process

In most cases, planning, design, construction, and operation and maintenance are separated by disciplines and executed in phases, in an adversary environment and with little interaction between phases and disciplines. The vertical and horizontal fragmentation of the construction industry reduces quality of final product and increases the life cycle costs of the final product. Originally, the construction was not separated when the project was done by master builder. As technologies for construction developed, segregation between design and construction functions occurred slowly. The segregation was reinforced artificially through legislation that required separate contracts for design and construction services. In addition, these services were procured on a separate basis, again reinforcing segregation. Educational system reinforced the segregation through separate degree programs in architecture, engineering, construction management, etc. Industry associations also reinforced the artificial segregation by restricting membership to individuals with specific degrees or certifications, or employment with certain types of firms (FMI 2007).

2) Efforts to Bridge the Gap between Phase

Bridging the gap between phases through the use of design/build and program management techniques is occurring. Government allows using alternative-delivery-systems such as design-build, and construction management. Leaders of educational institutions are designing joint-degree programs to reflect and respond to industry drivers. In the past, IT systems have created "islands of automation" and are far from achieving an acceptable level of integration across disciplines and across the design and construction processes. It is recognized that greater benefits can be achieved if these systems are integrated. Thus, numerous studies have been carried out with the aim of integrating the various project life-cycle phases through IT solutions. There is an urgent need to transfer a major proportion of the assembly and fixing operation from the site to the more favorable environment of the factory where, subject to a substantial degree of standardization, automatic or semi-automatic numerically controlled machinery can be put into service to produce prefabricated assemblies for delivery on a first-in-time basis before simple installation in the structure.

3) Prework

Partly because modularization, prefabrication, and preassembly are ill-defined and mix-used, they are often collectively referred to in the industry as prework[3]. There is subtle difference among these terminologies. "*Prefabrication*" can be defined as "a

[3] Some countries use the term "off-site".

manufacturing process, generally taking place at a specialized facility, in which various materials are joined to form a component part of a final installation" (Tatum 1987). These prefabricated components often only involve the work of a single craft. A common definition for *"Preassembly"* is "a process by which various materials, prefabricated components, and/or equipment are joined together at a remote location for subsequent installation as a unit" (Tatum 1987). The preassembly may be completed at the job site in a location other than the place of final installation. A preassembly often contains only portions of systems, and work from a variety of crafts is typically necessary. *"Modularization"* is generally referred to as the preconstruction of a complete system away from the job site that is then transported to the site. The modules are large in size and possibly may need to be broken down into several smaller pieces for transport. Usually more than one trade is involved in the assembly of a module. "Off-site" and "Industrialization" is used to attempt to describe and encompass all three aspects of offsite construction work: modularization, prefabrication, and preassembly. The industrialization process can be defined as an investment in equipment, facilities, and technology with the intent of increasing output, decreasing manual labor, and improving quality (Warszawski 1990).

2. Why Prework

Prework has various advantages against traditional way of doing design and construction. There benefits for the use of prework have been recognized through several reports (Hass et al. (2000), Wong et al. The traditional project factors driving desired benefits also apply prominently when considering prework. Cost, schedule, quality, productivity and safety are main drivers. Prework has the potential to positively affect the project in each of these areas (Gibb 2001). Lack of availability of skilled, on-site labor may also play a factor into the decision to use prework. Shortages of skilled labor could be a strong driving force.

Productivity & Cost

The overall cost for a project that uses prework can be less than a traditional method. Cost savings can be caused by various factors. Cost savings mostly consist of the differences between fieldwork and shop fabrication productivity. Shop productivity is often better than field because of controlled conditions, closer supervision, and easier access to tools. Controlled conditions such as ground level work, climate control and consistent lighting directly impact productivity. Weather is less of a factor for prework, providing an additional advantage over stick-build sitework. The prework shops take advantage of controlled environments that are not affected by harsh weather. Work is not interrupted and productivity can remain at a high level. In addition cost savings from increased productivity, prework can decrease costs associated with fieldwork. Since some or all of the work is relocated to an offsite location, costs associated with site infrastructure and overhead can be reduced. Fewer workers on site translate into fewer costs for accommodations in remote locations, scheduling onsite work, and other onsite logistics.

Time

The construction duration can be shortened through the use of prework. Activity desequencing along with increased productivity is a typical way of improving schedule with prework. Instead of performing tasks in a strictly linear sequence onsite, construction activities can be broken up and completed simultaneously at multiple locations. Fabrication may continue offsite while permitting delays activities at the project location. More work for a project can be completed before going to the site so that the construction schedule is decreased.

Safety

Overall project safety can be improved through the use of offsite work. With prework, workers face less exposure and companies receive more opportunities for decreasing

safety risk. Prework may reduce exposure to weather, heights, hazardous operations and neighboring construction activities. Workers at a fabrication shop are not affected as much as workers on site by temperature, wind and precipitation extremes. Since much of the prework is done at ground level, fewer safety harnesses are required and workers can focus more on the work.

Quality

Quality can also be improved through the use of prework. Controlled factory and production conditions and repetitive procedures and activities, along with automated machinery can lead to a higher level of quality than can be attained onsite.

Environmental Impact

Environmental impact of the project can be potentially decreased by use of prework. This is partly due to reduced amount of work on jobsite and jobsite construction duration and a decrease in field labor requirements. Additionally, prework may reduce material waste, pollution associated with dust and noise.

3. Barriers

While the benefits of prework help to enhance the use of prework, the decision to implement is influenced by the balance between the potential benefits and barriers. Common challenges faced by projects include increased engineering requirements, extensive transportation planning, decreased flexibility of scope, and high use of advanced technologies.

Increased Engineering Effort

Design work and extensive planning must be completed before prework can begin. Depending on the extent of prework, it may be necessary to complete 90% of engineering design prior to construction, as opposed to the 40% generally necessary for conventionally built projects (Tatum et al.. 1987). Interference analysis is required and lift planning must be completed well in advance. Interface management and transportation requirements may not only increase degree of completion requirements, but also account for a large portion of the estimated 15% increase in design cost. Since components are fabricated in the shop and shipped to the installation location, additional engineering is required to insure compliance. Due to increased engineering and planning effort engineering costs can increase as much as 15% and home office costs 5-15% per unit of prework.

High Use of Advanced Technologies

Prework requires various advanced technologies. 3D modeling is widely used to check interferences, to connect to component information, and to improve visualization. Prework also requires information technologies to aid in the coordination efforts required for prework projects. Advances in computer-controlled equipment have also provided enablers for the prework industry. Prework facilitates the application of productivity enhancing automation such as robotics much easier than site work. Prework may also benefit from advances in tracking technologies. Prework should make materials management easier and make applications such as radio frequency tagging and bar coding more economical, since fewer expensive tags would be required.

Extensive Transportation Planning

Transportation logistics play a large role in determining prework feasibility. Size and weight limitations, route restrictions, permitting and the availability of lifting equipment are among the considerations to be made for the coordination of construction. This is especially true for large modularized sections that must be transported over a long distance. Size constraints and limitations exist, based on the method of travel, which directly leads into cost and schedule considerations. Roadways, railroads and water transport all have limitations. The availability of these methods may dictate the type of prework selected.

Once the components reach the site, additional lift planning may be required, especially for heavier lifts. Key considerations for heavy lifting include lifting points, rigging and early involvement of the lift contractor (Gibb 2001).

Decreased Flexibility of Scope

Since prework requires a well-defined scope early in the project planning stages, scope flexibility may decrease. This is due to the increased engineering and transportation requirements. The scope must be set early to insure adequate design and integration upon construction and final assembly.

Extensive Coordination

It is necessary to understand the extensive coordination required prior to and during construction operations. In addition to the transportation and design issues, scheduling may also have to be coordinated (Tatum et al.. 1987). Further coordination may be required for materials management and supply chain scheduling. The complexity of assemblies, integration, and delivery provide opportunities for computer control.

Given the increases in coordination for projects utilizing prework, effective communication is necessary. Effective communication between project participants includes distribution of information regarding decisions, designs, transportation requirements, and schedules. In order to coordinate between multiple sites with critical scheduling, open communication must exist between owners, engineers, suppliers and contractors.

Local Economy and Condition

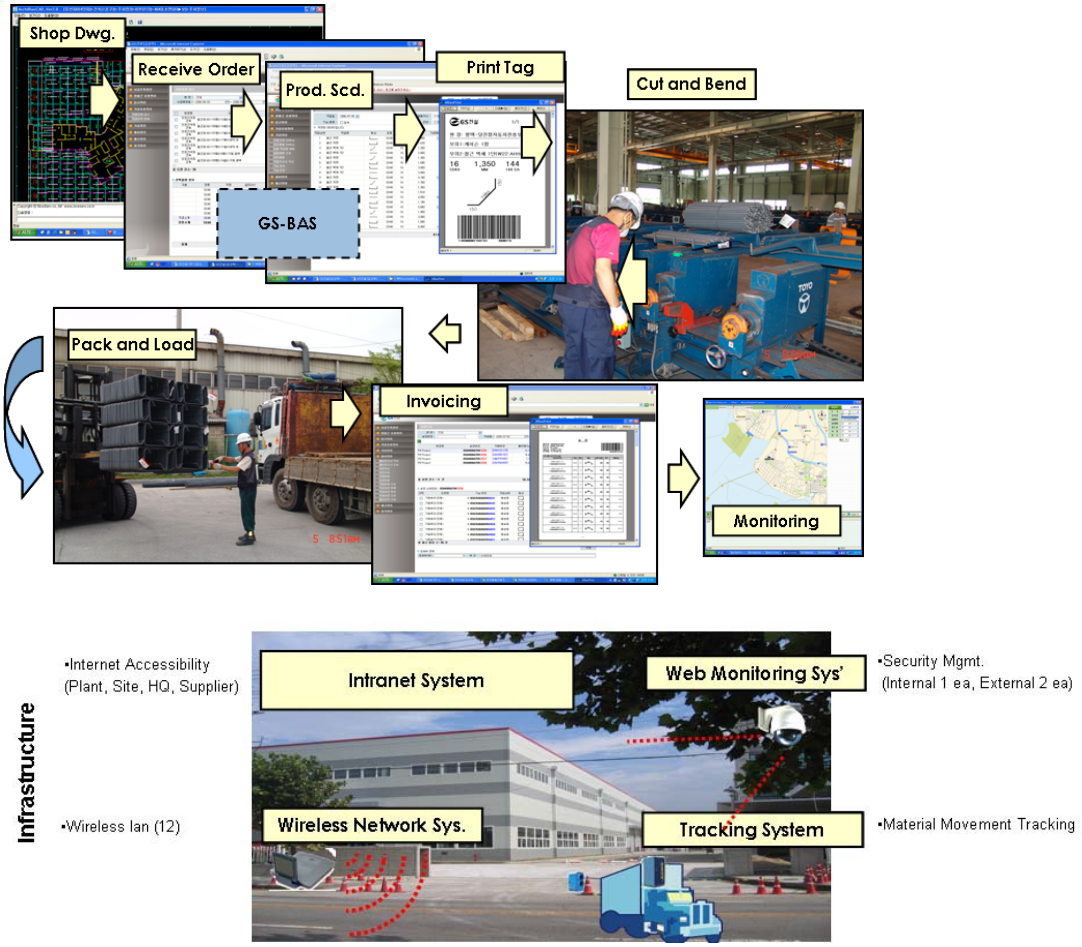
Other factors affecting the use of prework include the local economy. In areas where the cost of labor is low, prework may not provide an economic advantage. Another concern is the knowledge base of designers concerning prework components. Engineers may not have experience with such construction projects and therefore prefer traditional methods.

4. Case study

Previously, in Korea, it was impossible for a construction company accurately estimate the quantity of rebar needed on-site work using only manual work and experience. Additionally cutting and bending rebar on-site left the excessive rebar stock and needed extensive area for fabricating and storing rebar causing inefficient use of on-site space. To resolve these problems, GS Engineering and Construction, Korea's premier construction company, developed automatic digitalized rebar design system (GS BAS[4]) that can integrate management bar bending design and installation. Through successful application of this system, the company can integrate entire rebar design, shop drawing, output calculation, supply chain, transportation, and installation process.

Through successful use of this system, the company could save 9.7M compared to on site fabrication resulted from reduced production loss from 8~10% to 3%. Construction duration was also reduced by 2 weeks, unnecessary relocation and movement was reduced and material inventory also could be minimized.

[4] Bar Banding Automation System



5. Suggestions for Successful Implementation

Early Decision during Pre-planning

The companies involved in prework stress the importance of early decisions during pre-planning when using prework. In cases with a lesser degree of prework, decisions could often be delayed until later in the project during detailed design. Regardless of the type of prework, the importance of coordination of all involved parties through regular meetings to coordinate various design disciplines should be stressed.

Careful Analysis of Labor Differentials

Careful analysis of labor differentials is a common factor in determining prework feasibility. Moving work off-site takes advantage of lower wages available in shops and potentially lower costs related to equipment and overhead. The company which wants to employ prework should carefully evaluate the differences in wage rates, productivity, overall risks, equipments and overhead costs associated with labor.

Extensive Transportation Planning and Expediting

For adequate use of prework, extensive transportation planning is required. Careful analysis of shipping options and routes often dictated size and extent of prework.

Integrate Project Team

There does not seem to be much leadership for prework in design company. Many architects appear to reject prework out of hand, often referring to the limitations of previous generation's applications. Many current construction processes do not encourage more innovation from designers. There are some good examples where project teams have stimulated and encouraged the increased use of prework. However, it is important that the whole project team must be committed for effective implementation and this is made easier in vertically integrated teams.

Enhance Information and Communications Technology Use
Because of the way that much of the prework supply chain is organized, ICT play an important role in prework to control supply chain information flows and to enhance the visualization of design alternatives.

6. Conclusion

Prework can not only integrate design and construction process but also can provide various benefits in term of cost, time, qualify, and worker's safety. One of the key principles of prework is that the benefits are often realized elsewhere in the construction process. In other words the actual elements being preworked may be more expensive than the site assembled alternative. However, issues such as reduced site labor, less disruption and better quality control can produce savings that outweigh the additional first cost of the items. What this means is that the client and their advisors need to recognize this aspect in order to promote the increased use of prework. Overcoming lack of industry knowledge is another key factor in successful use of prework. Along with various benefits of prework, sustainability will be a good driver for increased prework, in particular less waste, noise, disruption etc resulting from factory-based activities.

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