First International Conference on Construction in the 21st Century (CITC2002)
"Challenges and Opportunities in Management and Technology"
25-26 April, 2002, Miami, Florida, USA

CURRENT LEVEL OF SATISFACTION WITH CONSTRUCTION MATERIAL LOGISTICS TASKS

HyounSeung Jang
Research Assistant, Construction Engineering and Management,
University of Wisconsin, Madison, Winsconsin, USA

Jeffrey S. Russell
Professor, Construciton Engineering and Management,
University of Wisconsin, Madison, Winsconsin, USA

ABSTRACT
Construction management researchers have only recently highlighted the relationship between the contractors and the ultimate customers. To improve understanding of the significance of customer satisfaction regarding construction logistics tasks, a pilot study has been undertaken. Customer satisfaction and continuous improvement are the fundamental goals of construction logistics tasks. Therefore the logistics manager who coordinates these operations with all parties to a contract is very important to the successful completion of a construction project. This paper examines how construction logistics affects a senior project manager's level of satisfaction and also defines through the use of a survey which logistics factors correlate the most with customer satisfaction. Two hundred twenty three logistics managers provided valuable data to the study. Five important factors related to satisfaction were found by interviews with logistics managers and a literature review. Those are personnel, material flow, schedule adherence, contractor's organization and information flow. The study results suggest that material flow and information flow are worthy of the most attention.

KEYWORDS
Construction Logistics, Customer Satisfaction

1. INTRODUCTION

Efficient management of construction material logistics tasks requires an integrated approach towards various logistical functions. In particular, the fundamental construction operations of facilities, inventory control and communication planning need to be closely coordinated. Thus the logistics manager who coordinates these operations with all parties to a contract is very important to the successful completion of a construction project.

A senior level manager briefs the Project Manager (PM) on the project so that the PM can understand where it fits in the general scheme of things in the parent organization, and its priority relative to other projects on the system and to the routine work of the organization. The PM must also get to know the client, to make sure that the proper facilities are available, ensure that any supplies required early in the project life are available when needed, and take care of the routine details necessary to get the project moving (Meredith, J.R. and Mantel, S.J. 1995). While customer satisfaction studies have not been undertaken in the constuction industry, the housing industry has conducted such studies. In traditional construction management studies of housing refurbishment (Ahonen, 1993; Holm and

Brochner,1999) and home-buyer (Zeljko M. Torbica and Robert C. Stroh, 1999) concentration has been focused on the customer relationship. These studies have been undertaken to characterize the relationship between landlords and construction companies. As a pointed contrast to this scarcity of investigations concerning customer satisfaction in the field of housing, a rapidly growing number of studies of customer satisfaction and service quality in the service industries have been published over the last few years, showing the correlation between customer satisfaction, or service quality, and economic returns (Holm, M.G. 2000). However, logistics management and Total Quality Management (TQM) in general appear to have many characteristics in common with operational sevice expectations. To establish the postive impact of customer satisfaction on the construction logistics tasks, operational service management is reviewed here in an attempt to identify principles with strong potential for application to construction logistics. This investigation offers practical implications for the logistics, based on operational management compiled from a review of the construction material logistics.

2. LOGISTICS CONCEPTUAL FRAMEWORK

The theory of "if the customer is happy, your business will prosper," has been around for a long time. This theroy has come to be known as not only total quality management (Imai M. kaizen, 1986), but also logistics management and has been credited with turning around the economies of entire industries. This may or may not be current, but there is no doubt that its concept can be very useful when applied properly. The Council of Logistics Management (CLM 1999) gives the most recent definition of logistics as "*The process of planning, implementing and controlling the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements.*" In construction terms, logistics can be understood as a multidisciplinary process that seeks to guarantee the right thing, at the right time, and in the right place.

2.1 Construction Logistics

Logistics management research can be classified into three broad perspectives: competitive strategy, firm focused tactics, and operational efficiencies. Competitive strategy issues have a long range impact on the firm. Firm focused tactical issues operate in a shorter time frame and operational efficeiencies involve day to day decisions that can be altered quickly (Ganeshan, et al. 1999). Typically, operational decisions reflect day to day operations up to two weeks ahead. The construction industry is concerned with the daily operation of a facility that is achieved through planning, organizataional, directing and controlling activities before and during the construction activities. In terms of construction logistics, multidisciplinary processes are categorized as follows: (1) Material supply, storage, processing and handling; (2) Manpower supply; (3) Schedule control; (4) Site infrastructure and equipment location; (5) Site physical flow management; and (6) Management of information related to all physical and services flow. Although construction logistics includes implementation and operational service management aspects that affect day-to-day operations, one must not lose sight of the fact that logistics is rooted in senior level decision-making.

Logistics Functions

Logistics functions in a construction firm can be divided into supply logistics and site logistics. Figure 1 illustrates the construction logistics tasks.

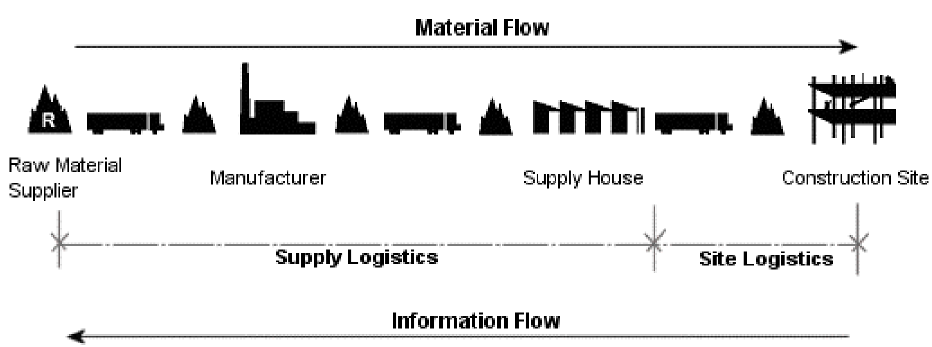

Figure 1: Construction Material Logistics Tasks

Supply logistics are related to activities that are cyclic in the production process. These activities are basically supply resources (materials, equipment and manpower) specification, supply planning, acquisition of resources, transport to site and delivery, and storage control. Site logistics are related to physical flow planning, organizing, directing and controlling on-site. This means, management of handling systems, safety equipment, site layout, definition of activity sequence and resolution of interference among production teams' activities on-site (Fred and Francisco 1999). The most appropriate system to describe the material logistic tasks is developed at structural levels on the multi-item joint replenishment problem at the point of interaction between internal and external systems. The main objective of a logistics process is to meet the customer's requirements.

Customer Service Level

Customer service level can be considered based on external relations between a construction company and its final clients, on external relations between a construction company and its suppliers, and on internal relations between a company and its internal clients on-site. This paper focuses on the second (company-suppliers relations) and third case (internal relations), and service level. It is determined by the company's capacity for providing resources to internal agents on site at the right time and place, and attaining the correct specification.

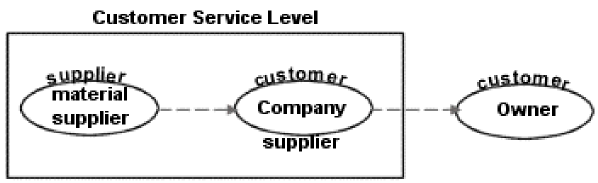

Figure 2: Customer Service Level

The issues of customer satisfaction and service quality generally dominate theories of customer service management. If we consider the whole body of research in the field of service management, it is a fundamental and recurring observation that high customer satisfaction leads to better economic returns. This can be explained by key concepts such as customer reliability and a positive reputation for the firm.

2.2 Customer Satisfaction

The function of the construction industry is to provide customers with facilities that meet their needs. A principle of logistics is a management philosophy that effectively determines the needs of the customer. By ensuring operational quality at each stage in the construction process, the quality of the final product should satisfy the final customer.

Juran's Triple Role & Construction Logistics Process

Every party in a process has three roles: supplier, processor, and customer. Juran (1988) defines this as the "triple role" concept. These three roles are carried out at every level of the construction process – corporate, division, department, and individual. This concept is illustrated by the right side of Figure 3. The designer is a customer of the owner. The former processes the design and supplies plans and specifications to the constructor. The constructor is the designer's customer, who uses the designer's plans and specifications, processes the construction, and supplies the completed facility to the owner. The roles of the three parties have not traditionally been viewed this way, but this clearly illustrates that construction is a process, and the logistics principles that have been applied to other processes are potentially adaptable to the construction industry.

How to Achieve Customer Satisfaction

There is no general consensus on the relationship between logistics and customer satisfaction, but the thrust of the logistics research has been focused in operations service management areas (Ganeshan, et al. 1999). However, Parasuraman, et al. (1994) have proposed a model where the customers' overall satisfaction in a transaction is thought to be a function of operation service quality, product quality and price. That service quality leads to customer satisfaction is an opinion held by other researchers also (e.g. Woodside, et al. 1989; Reidenbach, and Sandifer-Smallwook, 1990; Adersson, et al, 1994). Furthermore, Cronin and Taylor (1992) state that an antecedent of consumer satisfaction is operation service quality. Therefore, there is strong empirical support for the hypothesis that a satisfied customer, or a customer with a positive perception of logistics operational service management, gives the firm a positive reputation.

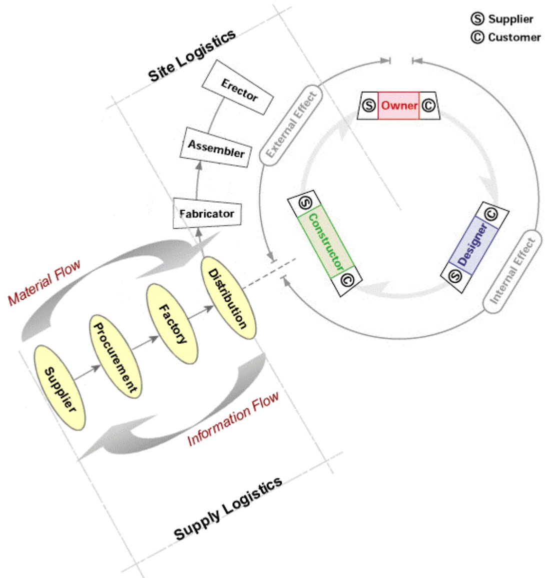

Figure 3: Juran's Triple Role & Construction Logistics Process

3. SURVEY

This paper reports on a questionnaire survey to collect customer satisfaction data on material operational logisistics in the construction industry. The aim of this survey is to define how construction logistics affects customer satisfaction and to define which logistics factors correlate the most with customer satisfaction. Then the result of this study can indicate which areas should be given attention to improve the satisfaction of their logistics managers. To gain a better understanding of the relationship between logistics and customer satisfaction, and to know which aspect of logistics has the greatest impact on customer satisfaction, exhaustive logistics literature reviews and interviews were conducted. To gather the necessary data, the survey was divided into two parts. These are the logistics survey and customer satisfaction survey.

3.1 Survey Instrument

The survey instrument consisted of 48 questions and addressed many facets of logistics processes and customer satisfaction such as personnel, material flow, schedule adherence, characterization of contractor's organization, and information flow. Most respondents completed the survey by mail, although several faxed or e-mailed their responses. The survey was distributed October 31, 2001.

3.2 Survey Population

1080 surveys were sent to construction companies that included design/engineering firms, general contractors, mechanical/electrical firms, heavy construction firms, and construction management firms. Respondents were senior level managers such as owner/vice president, project manager, project engineer, or superintendent.

3.3 Number of Respondents

227 surveys (returned rate: 21%) from 180 different organizations were returned in the survey distribution. Figure 4 shows the characteristics of the respondents. Respondent firms were General Construction (GC), Construction Management (CM), Heavy Construction (HC), and Mechanical and Electrical Construction (M). The majority of respondents firms were GC and CM firms.

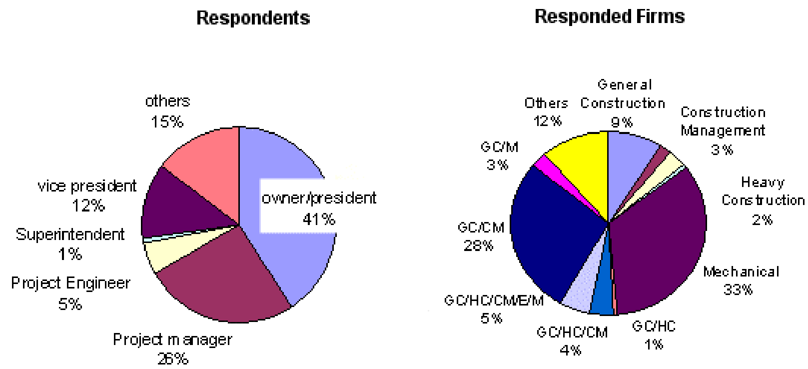

Figure 4: Characteristics of the Respondents and Firms

3.4 Key Factors of the Construction Material Logistics

Based on operational management in the logistics process, five critical areas of managerial planning and action that must be practiced to achieve effective logistics management in a company have been identified. Table 1 shows the five critical factors: (1) personnel, (2) material flow, (3) schedule adherence, (4) contractor's organization, and (5) information flow and description.

Table 1: Logistics Factors

Factor	Description
Personnel (COOP)	Level of cooperation with skilled workers and subcontractors for successful completion of projects
Material Flow (MAT)	Required materials maintained to prosecute the work
Schedule Adherence (SCH)	Schedule changing and updating procedures
Contractor's Organization (PAR)	Team building, or "partnering," is considered to be a commitment between two organizations for the purpose of achieving specific business objectives for the length of a project. The relationship is based upon trust, dedication to common goals, and understanding of each other's individual expectations and values.
Information Flow (INF)	Sufficient information flow to prosecute the project by manual or computer.
Personnel Satisfaction (PERSA)	How satisfied are you with the performance of personnel you deal with?
Material Flow Satisfaction (MATSA)	How satisfied are you with the quality of raw materials (right things)? How satisfied are you with material positioning of temporary facilities on job site? How satisfied are you with unnecessary movement of materials and equipment?
Schedule Adherence Satisfaction (SCHSA)	How satisfied are you with order cycle time? How satisfied are you with on time material delivery?
Contractor's Organization Satisfaction (PARSA)	How satisfied are you with meeting and communications procedures?
Information Flow Satisfaction (INFSA)	How satisfied are you with management of material logistics tasks by manual means? How satisfied are you with management of material logistics tasks by computer?

Besides explanatory independent variables, several control variables are used for analysis such as specific work (AREA), types of construction (TYPE), volume of project (VOL), value of work performed (DOL), self-perform (SP), self-manage (CM), and year of current position (TEN).

3.5 Measure Customer Satisfaction

The instrument contains several operational measures for each of the logistics factors. Each dependent variable measures the level of satisfaction of logistics managers that corresponds to each of five logistics factors. 17 questions were asked to measure the level of satisfaction of senior level logistics managers. Each dependent variable was rated from –5 to 5 including 0. The scale of overall satisfaction (ALLSA) was constructed such that each dependent variable was summed up and divided by the number of items. The correlation of factors are also examined. Table 2 shows the correlation of each factor and satisfaction.

Table 2: Descriptive Statistics

	Mean	Std. Dev	COOP	MAT	SCH	PAR	INF	PERSA	MATSA	SCHSA	CONSA	INFSA
COOP	1.103	2.426	1.000									
MAT	1.497	1.757	0.469	1.000								
SCH	1.056	2.656	0.281	0.311	1.000							
PAR	1.226	2.516	0.325	0.191	0.439	1.000						
INF	1.231	2.079	0.380	0.697	0.470	0.244	1.000					
PERSA	1.758	1.207	0.536	0.532	0.385	0.354	0.519	1.000				
MATSA	1.508	1.557	0.340	0.435	0.474	0.324	0.445	0.418	1.000			
SCHSA	1.221	2.031	0.425	0.725	0.140	0.160	0.524	0.461	0.379	1.000		
CONSA	1.631	2.212	0.318	0.325	0.689	0.481	0.513	0.414	0.532	0.185	1.000	
INFSA	1.887	1.934	0.330	0.372	0.292	0.111	0.406	0.402	0.464	0.320	0.278	1.000

3.6 Data Analyses

This section outlines the results from several analyses that were conducted on empirical data obtained from the survey. The data were analyzed with the aid of the Quantitative Micro Software (Eview 3.1_student version). With two goals in mind, the first is to determine the relative importance of each of the five factors of logistics manager satisfaction. It will be accomplished by developing a regression model for overall logistics manager satisfaction (ALLSA). The second goal is to test the interaction effect of using manual and computer methods for logistics processes with each of the five factors of ALLSA. To determine whether the interaction effect between the five logistics factors and the usage of computers affect the level of satisfaction of logistics manager. A multiple regression model was performed.

Relationship Between Construction Logistics and Senior Level of Manger Satisfaction

To determine the influence of the five factors of construction logistics on logistics manager's ratings of overall satisfaction, multiple regression was applied, with overall satisfaction (ALLSA) as the dependent variable and the five dimensions of logistic manager (COOP, MAT, SCH, PAR, and INF) as explanatory independent variables with seven control variables (AREA, TYPE, VOL, DOL, SP, CM, and TEN).

Table 3: Statistics Result of Overall Satisfaction (*$\alpha < .05$, ** $\alpha < .01$)

Dependent Variable: ALLSA
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COOP	0.107327	0.045200	2.374495	0.0201*
MAT	0.219740	0.073377	2.994684	0.0037**
SCH	0.180781	0.042418	4.261870	0.0001**
PAR	0.095426	0.036807	2.592573	0.0114*
INF	0.233752	0.051028	4.580840	0.0000**
AREA	-0.206786	0.402880	-0.513269	0.6093
TYPE	0.233022	0.221738	1.050889	0.2967
VOL	-0.041043	0.074639	-0.549879	0.5840
DOL	-0.007842	0.103694	-0.075629	0.9399
SP	-0.030467	0.087953	-0.346403	0.7300
CM	-0.102824	0.089857	-1.144311	0.2561
TEN	0.038705	0.087595	0.441860	0.6599
C	1.113978	0.619495	1.798202	0.0762
R-squared	0.695146	Mean dependent var		1.604396

The result of the analysis is presented in Table 3. The R-squared value was found to equal 0.695, implying that approximately 70% of the variation in the overall logistic manager satisfaction can be explained by the variability in the COOP, MAT, SCH, PAR, and INF. This analysis indicates that Schedule Adherence and Information Flows are the most significant dimensions for overall logistics manager satisfaction. This suggests that, to be most effective, logistics manager should have the potential of simultaneously influencing all five dimensions especially schedule and information flows. However, although these five variables are very significant to the logistic manager's satisfaction, the other seven variables are not found to be significant to logistic managers satisfaction. In other words, specific work, types of construction, volume of project, value of work performed, self-perform, self-manage, or year of current position are not significant predictors of overall logistics manager satisfaction when the five logistic variables are controlled.

Variation in each satisfaction Varialbe

Information about the relative importance of each of the five factors of logistics manager satisfaction can be very helpful in determining analytical areas in which to focus improvement efforts. Table 4 shows independent and dependent predictor variables in accounting for the variation in the variables.

Table 4: Variation of Each of the Predictor Variables

Dependent Variable	Independent Variable
Personnel	Personnel, Material Flow
Material Flow	Volume of project, Material Flow, Schedule Adherent
Schedule Adherent	Material Flow, Schedule Adherent
Contractor's Organization	Schedule Adherent, Contractor's Organization, Information Flow
Information Flow	Schedule Adherent, Information Flow

The implication is that addressing each of the five factors appears to be the best strategy for logistics managers to improve the level of material flow, schedule adherence, and information flow of construction logistics.

Interaction Effect of Using Manual and Computer Methods for Logistics Process

It is predicted that whether a computer or manual method is used will have an interaction effect on the satisfaction variable. Specifically, a cooperation with skilled workers and subcontractors (COOP) has a greater positive effect on satisfaction when a computer method is used. As shown in Table 5, the COOP*COM interaction effect is significant (and positive) at a .01 level of significance. It implies that when a computer method is used for logistics processes, the level of cooperation with skilled workers and subcontractors for successful completion is more effective. Material flow (MAT) has a greater positive effect on satisfaction when manual methods are used. As shown in Table 5, MAT*COM interaction effect is significant (and positive) at a .01 level of significance. It shows that using a manual method is more effective than using a computer method for material flows, because most logistics managers keep records relating to material flows at the job site.

Table 5: Statistics Result of Interaction Effect (* $\alpha < .05$, ** $\alpha < .01$)

Dependent Variable: ALLSA
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COOP	0.037209	0.023969	1.552399	0.1222
MAT	0.265802	0.054835	4.847318	0.0000
SCH	0.110646	0.034595	3.198321	0.0016
PAR	0.084117	0.031039	2.710020	0.0073
INF	0.233752	0.051028	4.580840	0.0000
COOP*COM	0.336948	0.059221	5.689720	0.0000**
MAT*COM	-0.165788	0.075215	-2.204187	0.0287*
SCH*COM	-0.005717	0.044432	-0.128674	0.8977
PAR*COM	-0.024579	0.041400	-0.593684	0.5534
INF*COM	-0.097405	0.069388	-1.403771	0.1620
C	0.614713	0.070950	8.664044	0.0000
R-squared	0.738609	Mean dependent var		1.647528

4. CONCLUSIONS

This study has resulted in new insights regarding the construction logistics process and senior level manager satisfaction. The research results found a significant relationship between the construction logistics process and senior level manager satisfaction. Also this paper has presented statistical regression results to predict overall logistics manager satisfaction, and the relative importance of each of the five variables of logistics manager satisfaction. It was found that all five variables of logistics manager satisfaction (COOP, MAT, SCH, PAR, and INF) are significant predictors of overall satisfaction for the construction logistics process. This suggests that, to be most effective, logistics manager should have the potential of simultaneously influencing all five variables, but most importantly schedule and information flows. Interaction effect predicted that when a computer method is used for logistics processes, the level of cooperation with skilled workers and subcontractors for successful completion is more effective. It shows that using a manual method is more effective than using a computer method for material flows, because most logistics managers keep construction records relating to material flows at the job site.

5. REFERENCES

Adersson, E.W., Fornell, C. and Lehman, D.R. (1994), Customer satisfaction, market share, and profitability: findings from Sweden. *Journal of Marketing*, 58 (July), pp.53-66.

Ahonen, A. (1993). Customer-oriented renovation and modernization process for multistory apartment buildings, dissertation, Tampere University of Technology (Publication, 123).

CLM. (1999), 21st Century Logistics: Making Supply Chain Integration A Reality: Council of Logistics Management.

Cronin Jr, J.J., and Taylor, S.A. (1992), Measuring service quality: a reexamination and extension. *Journal of Marketing*, 56 (July), pp. 55-68

EViews 3.1 Student Version, Quantitative Micro Software, www.eviews.com

Fred B. S., and Francisco F. C., (1999). “Applicability of Logistics Management in Lean Construction”. Proceedings IGLC-7. University of California, Berkeley, CA, USA.

Ganeshan. R, Jack. E, Magazine. M.J.,and Stephens. P. (1999). “A Taxonomic Review of Supply Chain Management Research”, QAOM Department, The Univesity of Cincinati.

Holm, M.G. and Brochner, J. (1999). Satisfying the ultimate customer in housing refurbishment, in *Facilities Management and Maintenance: The Way Ahead into the Millennium*, Quah I. K. (ed.), McGraw-Hill, Singapore, pp. 205-212.

Holm, M.G. (2000), “Service Management in Housing refurbishment: a theoretical approach”, Construction Management and Economics 18, pp. 525-533.

Imai, M. Kaizen. (1986) the key to Japan’s Competitive Success. New York: Random House, Inc.,

Juran. J. M. (1988), *Juran on planning for quality*. The Free Press, New York, N. Y.

Meredith, J.R. and Mantel, S.J. (1995). *Project Management*, Third Edition, University of Cincinnati, John Wiley & Sons, Ins., New York, Chi Chester, Brisbane, Toronto, Singapore.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1994), Reassessment of expectations as a comparison standard in measuring service quality: implications for further research. *Journal of Marketing*, 58 (January), pp. 111-124.

Reidenbach, R.E. and Sandifer-Smallwook, B. (1990), Exploring perceptions of hospital operations by a modified SERVQUAL approach. *Journal of Health Care Marketing*, 10(4), pp. 47-55.

Woodside, A.G., Frey, L.L. and Daly, R.T. (1989), Linking service quality, customer satisfaction, and behavioral intention. *Journal of health Care Marketing*. 9(4), pp. 5-17.

Zeljko M. Torbica and Robert C. Stroh. (1999). “Impact of Total Quality Management on home-Buyer Satisfaction”, *Journal of Construction Engineering and Management*, Vol. 125, No. 3, May/June. pp. 198-203.