STRATEGIC LEVEL THREE-STAGE PRODUCTION DISTRIBUTION PLANNING WITH CAPACITY EXPANSION

by
PINAR YILMAZ

Submitted to the Graduate School of Engineering and Natural Sciences
in partial fulfillment of
the requirements for the degree of
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ACKNOWLEDGMENTS

First, I would like to extend my sincere gratitude to Asst. Professor Bülent Çatay for his patience, guidance and encouragement throughout this past year. I owe many thanks to my parents for always being there when I need them. To my sister and brother, thank you for the joy and fun you bring to my life. And finally, I thank to my fiancé, S. Birgi Martin for his invaluable support and guidance that made this thesis possible in the first place.

ABSTRACT

In this thesis, we address a strategic planning problem for a three-stage production-distribution network. The problem under consideration is a single-item, multi-supplier, multi-producer and multi-distributor production-distribution network with deterministic demand. The objective is to minimize the costs associated with production, transportation and inventory as well as capacity expansion costs over a given time horizon. The limitations are the production capacities of the suppliers and producers, and transportation capacities of the corresponding transportation network. On the other hand, all capacities may be increased at a fixed cost. The problem is formulated as a 0-1 mixed integer programming model. Since the problem is intractable for real life cases efficient relaxation-based heuristics are considered to obtain a good feasible solution.

ÖZET

Bu tezde 3 aşamalı üretim-dağıtım ağı için stratejik planlama problemi gözönüne alınmıştır. İncelenen problem tek ürünlü, çok tedarikçili, çok üreticili ve çok dağıtıcılı deterministik bir üretim-dağıtım ağıdır. Amaç sistemin üretim, dağıtım, taşıma ve kapasite artırma sabit maliyetlerini minimize etmektir. Problemin kısıtları tedarikçiler ve üreticilerin üretim, tedarikçi-üretici, üretici-dağıtıcı ağındaki taşıma kapasite sınırlamalarıdır. Bunun yanısıra kapasiteler çeşitli yatırımlar yapılarak, belli bir sabit maliyetle artırılabilmektedir. Problem karışık tamsayı doğrusal programlama modeli olarak formule edilmiştir. Modelin gerçek hayattaki planlama problemleri için çözülmesi imkansız ya da çok zor olduğundan tamsayı kısıtlamaları kaldırılarak elde edilen sonuçtan özel bir algoritma geliştirilmiştir.

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CHAPTER 1

INTRODUCTION

In the last decades, competitive pressures pose the challenge of simultaneously prioritizing the dimensions of competition: flexibility, cost, quality and delivery. In addition to these dimensions, other factors such as the speed with which products are designed, manufactured and distributed, as well as the need for higher efficiency and lower operational costs, are forcing companies to continuously search for ways to improve their operations. Firms are using optimization models and algorithms, decision support systems and computerized analysis tools to improve their operational performance and remain competitive under the threat of increasing competition.

A production-distribution system is referred to as an integrated system consisting of various entities that work together in an effort to acquire raw materials, convert these raw materials into specified final products and deliver these final products to markets (Beamon, 1998). Production part of these systems includes design and management of the entire manufacturing process. Distribution and logistics part determines how the products are retrieved and transported from warehouses to retailers.

For years, research focus has been on improving and optimizing individual processes in a production-distribution system until the global competition urged firms to sustain and gain competitive advantage. Main motivation for research in production distribution systems is the importance of such systems. Firms from Fortune 500, have experienced big losses because of flaws in their production distribution systems and damaged their brand image remarkably. To name a few, Boeing has lost 2.6 billion dollar-worth contracts due to supply failure of some critical components. Shortage of Sony Playstation 2 caused 50% less shipment than planned and a huge amount of lost sales for Sony. For this reason, the ultimate success of a firm depends on the managerial ability to integrate and coordinate the intricate business relationships among production-distribution system members (Min and Zhon, 2002). One of the recent approaches to respond to competitive pressures of the era is to integrate the decisions of different

functions, such as supply process, distribution, inventory management, production planning and facilities location into a single optimization model (Nagi and Sarmiento, 2004). Many research came into the scene in the last decade concerning the simultaneous optimization instead of sequential optimization of decision variables.

In this thesis, a single-item, multi-supplier, multi-producer and multi-distributor production-distribution network is formulated as a mixed integer programming model. Main limitations of the problem are capacity constraints on the supplier and producer; however these capacities can be expanded with a fixed cost. The objective is to minimize the costs associated with production, transportation and inventory as well as capacity expansion costs over a given time horizon. The problem is formulated as a 0-1 mixed integer programming model and three common sense heuristics are developed in an attempt to obtain have good solutions in a reasonable amount of time.

The organization of the thesis is as follows: in chapter 2, a brief review of the existing literature on production-distribution systems is presented. Chapter 3 identifies assumptions, notation and the mathematical representation of the model. Chapter 4 provides basis for solution methodology and explains heuristics. The design of experiments, computational tests, results and analysis are presented in Chapter 5. Chapter 6 concludes the thesis with a discussion of results and future research directions.

CHAPTER 2

LITERATURE REVIEW

Production-distribution planning is one of the most important activities in supply chain management (SCM). To implement SCM in real logistic world, supply chains have been modeled in analytically ways using deterministic or stochastic methods. Production-distribution in supply chains may take on many forms. In general, there are two distinctive models: production models and distribution models, designed to be linked together and considered as a production-distribution model in supply chain (Lee and Kime, 2000).

There is a vast amount of articles on the integrated production-distribution literature. Although classification of related literature is hard due to the wide variety of assumptions and multiplicity in objective functions, a general classification is possible. The design of the distribution system and production planning processes may be classified as strategic level work, as the optimization problems on a given production-distribution system is considered as tactical level work. Additionally a classification is possible based on the solution methodology of the problem. Mathematical programming model, simulation, and hybrid approaches are common, while analytical models are rare and a direction for future research. In line with the scope of the thesis, the literature review presented here contains mathematical programming models on integrated production-distribution. However, interested readers may refer to Vidal and Goetschalckx (1997), Beamon (1998), Erengüç *et al.* (1999), for detailed literature review on models and methods for integrated production-distributions systems.

One of the early works on the topic dates back to the work of Geoffrion and Graves (1974), which presents an algorithm based on Benders Decomposition to solve a multi-commodity single-period production-distribution problem. The authors apply their algorithm to a 17 commodity class, 14-plant and 45-distribution center problem modeled as a mixed integer programming problem. Fixed and variable costs, production

costs and linear costs are included in the objective function. The contribution of the paper is the method of solution, which converges to the solution in a few iterations for a specified difference between upper and lower bounds.

Geoffrion *et al.* (1978) present a status report in strategic distribution system planning based on decomposition techniques. The difference of this paper from Geoffrion and Graves (1974) is its new ideas, created by new applications and customer requirements. Geoffrion *et al.* (1982) present a final version of this paper with a more thorough description of the system and more managerial emphasis, but with the same model as in their former research.

Williams (1981) proposes seven heuristics for a joint production-distribution scheduling problem. The demand is assumed to be deterministic. The objective of each heuristic is to determine the production-distribution schedule which satisfies final demand while minimizing the average inventory holding and fixed costs associated with ordering and processing.

Hodder and Dinçer (1986) are first to include financial considerations caused by the international facility location decisions. Exchange rates, subsidized financing, preferential tax treatments, market prices and international interest rates are implicitly included in the objective function. The authors use a multifactor approach in order to transform large-scale quadratic MIP into a more tractable model. They report solutions for 1600 continuous and 20 integer variables based on two approaches. Major drawback of this model is its deficiency of including inventory and transportation costs, and exclusion of the suppliers.

Another MIP formulation, provided by Brown *et al*. (1987), is a multi-commodity model, which determines both opening and closing plans and quantities to be produced and transported for Nabisco. Variable production and shipping costs as well as fixed costs associated with the opening and operating the plants are included in the objective function. The model is solved by a decomposition method similar to that of Geoffrion and Graves (1974). The difference is the production goal constraints added to the master problem. That is the authors impose that initially all plants produce exactly the same amounts regardless of their joint production capacity. These constraints can be violated at a small linear penalty cost. According to the authors, using goals has a significant impact on the performance of the decomposition method.

Cohen and Lee (1988) present a comprehensive model on linking the decisions between different entities of the supply chain and improving their performance. They use stochastic demand and their network consisted of suppliers, final production plants and distribution centers. The objective is the maximization of after-tax profit. The structure of the model consists of several sub-models each representing different part of a supply chain. The sub-models are material control, production control, finished goods stockpile and distribution network control. The outcome of this research study is a software package which includes a heuristic embedded in it.

Cohen and Moon (1991) present a MIP model to determine product line assignments as well as determining raw material requirements, production volumes and shipments. They apply an algorithm and report solutions for the small problems with 60 binary variables and 204 continuous variables in 49 seconds of CPU time.

Arntzen *et al*. (1995) include multinational considerations in their optimization problem. This multi-period, multi-item production distribution network includes production, inventory and shipping costs. The objective is to optimize the global supply chain of Digital Equipment Corporation. Some limitations are demand satisfaction, bill-of-material constraints, throughput limits in each facility and production capacity limits. They report solutions to problems of 6000 constraints, few hundreds of binary variables by non-traditional methods. However exact solution method is not provided in the paper.

A real life application is presented by Brown *et al*. (2001). The problem is the multi-item, multi-facility, multi-period production-distribution-inventory network of Kellogg Company. The authors propose two approaches to the problem. First approach is solving the model in weekly detail to determine the levels of finished and in-process products shipped between the plants and distribution centers. Second approach is planning the production-distribution network in monthly time periods in order to make capacity expansion and consolidation decisions. The tactical version of the problem is solved with a heuristic called sliding time window, by splitting the time period into 5-week periods and fixing the solutions on a rolling basis.

Barbarosoğlu and Özgür (1999) propose a Lagrangean relaxation based solution procedure to a multi-item, multi-producer, multi-supplier, multi-period integrated production-distribution problem. They attempt to decouple the system with relaxation

and use subgradient optimization to facilitate the information flow between sub-problems. The main contribution of this study is the forward algorithm applied to distribution sub-problem. The authors present computational results for 120 problems which are categorized into ten data sets. Each data set is uniquely characterized by the number of customers, number of products, number of depots and planning horizon. Lagrangean heuristic is shown to perform well.

Jang *et al*. (2002) present a supply network design and production-distribution planning problem and attempt to solve it by splitting it into modules. Production-distribution planning module is modeled as a multi-item, multi-period, multi-facility mixed integer programming model. The authors aim to determine real time production plans subject to capacity and bill-of-material (BOM) constraints while minimizing total system costs. Since the problem is very difficult or impossible to solve for large number of integer and binary variables, genetic algorithm (GA) is used as solution methodology. Small-scale examples with 6 suppliers, 4 plants, and 3 distribution centers are solved using CPLEX 6.5 for comparison. The authors report 0.2% gap between the GA solutions and solutions from CPLEX.

Yan *et al*. (2003) add logical constraints to the production-distribution problem and their problem setting is a multi-supplier, multi-producer, multi-item production distribution system. The challenge is to determine the number, location, capacity and type of producers and distribution centers to use so as to minimize the total cost. The authors attempt to present strategic analysis model of the production–distribution system with consideration of BOM. Their main contribution is adding BOM limitations as logical constraints to the mixed integer representation of the problem. One small-scale problem result is presented. However the solution quality is not compared to other solution methods, neither is the efficiency investigated.

The aim of this thesis is to model the strategic level production-inventory-transportation planning problem of a three stage system as a 0-1 MIP problem and to propose three linear programming relaxation based heuristics to obtain good solutions fast. In the next chapter, the mathematical model is presented.

CHAPTER 3

MODEL FORMULATION

In this thesis, an integrated production-distribution system is investigated. Our case represents a system consisting of first-tier suppliers, main production plants and distribution centers. Deterministic demand is considered and demand points are distribution centers. The model is designed as a capacitated, multi-facility, single-item production-distribution system.

From an overall perspective, the production and distribution network comprises of three distinct stages. The first stage is the supply network consisting of M $(i=1;...;M)$ suppliers providing goods and services to several plants. This part of the network consists of all suppliers of raw materials, fabricated parts, service parts and any other supplies to the plants. The second stage includes N plants $(j=1;...;N)$, where the actual transformation process occurs and the product/service is created. The third and final stage is the distribution network consisting of K distributors $(k= 1;...;K)$ and this stage generates the demand for the product or service.

Capacity limitation on suppliers, producers and corresponding transportation network can be expanded with a fixed cost. After capacity expansion, due to contractual costs, variable production costs also changes. Inventory holding is allowed only at the producer stage. Figure 3.1 shows network representation of the model.

Linear programming is chosen to formulate the problem for some reasons. One of the reasons is its ability to capture links between levels, such as link between supplier and producer, producer and distributor. Similarly, in problems with long planning horizons, linear programming can capture the links between time periods very well. To incorporate capacity expansion costs into the problem, some variables are restricted to be binary.

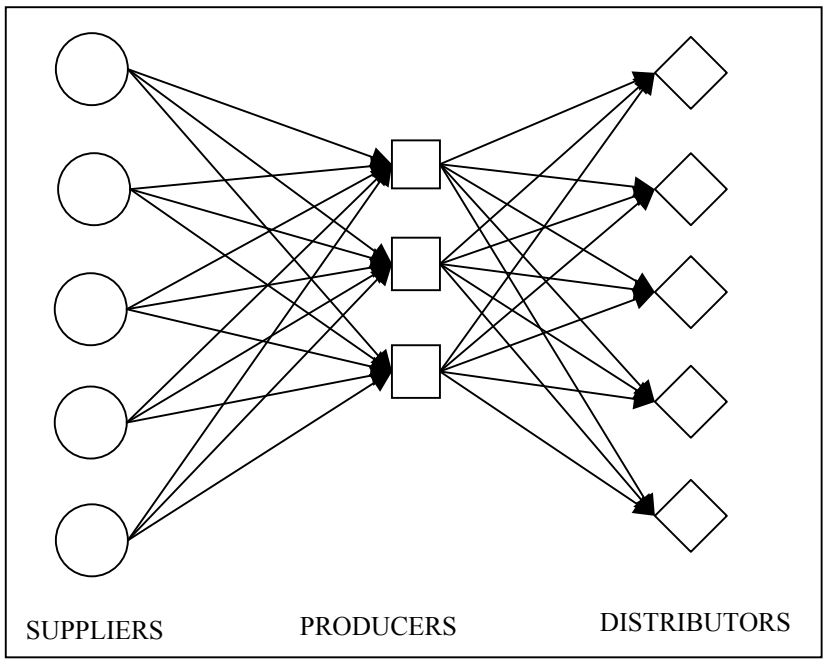

Figure 3.1 Network Representation of Problem

3.1. Assumptions

In the design of model, the following assumptions are imposed.

- Demand is deterministic.
- Backlogging is not allowed.
- There is a variable transportation cost between the supplier and producer, and the producer and distribution center.
- Production capacities at the supplier and producer are limited but can be expanded with a fixed cost and increased variable cost per unit.
- Transportation capacities between the supplier and producer and the producer and distributor are limited but can be expanded with a fixed cost and variable cost per unit of increased capacity.
- Investment decisions to increase the capacity are made at the beginning of each period and are not carried to next periods.
- Distribution and manufacturing lead times are negligible.
- Only the producer may hold inventory without any capacity limitation.

- Fixed costs are associated with the outsourcing of transportation, like contractual costs arising from carrying additional quantities.
- Demand at every stage is satisfied on just-in-time basis (JIT).
- There is a 1:1 ratio between raw materials and finished goods.

3.2. Notation

The parameters of the model are as follows. All cost parameters are discounted with 0.2% interest rate per period.

p_{it}: Amount of raw material cost per unit at supplier i in period t

m_{jt}: Amount of production cost per unit at producer j in period t

R_t: Available total transportation capacity from suppliers to producers in period t

S_t: Available total transportation capacity from producers to distributor k in period t

G_i: Available production capacity at supplier i

C_j: Available production capacity at producer j

A_{ijt}: Fixed cost for transportation capacity increase between supplier i and producer j in period t

B_{jkt}: Fixed cost for transportation capacity increase between producer j and distributor k in period t

E_{it}: Fixed cost for production capacity increase in supplier i in period t

e_{it}: Variable cost for per unit production capacity increase in supplier i in period t

F_{jt}: Fixed cost for production capacity increase in producer j in period t

f_{jt}: Variable cost per unit production capacity increase in producer j in period t

trs_{ijt}: Transportation cost per unit between supplier i and producer j in period t

trp_{jkt}: Transportation cost per unit between producer j and distributor k in period t

h_{jt}: Unit inventory cost in producer j in period t

d_{kt}: Demand at distributor k in period t in period t

α: Discount rate (0.2 %)

The decision variables are as follows:

x_{ijt}: Raw material shipped from supplier i to producer j in period t

y_{jkt}: Product shipped from producer j to distributor k in period t

I_{jt} : Inventory at producer j at the end of period t

u_{ijt}: Added transportation capacity from supplier i to producer j in period t

n_{jt}: Added production capacity at producer j in period t

w_{it}: Added supply capacity of supplier i in period t

v_{jkt}: Added transportation capacity from producer j to distributor k in period t

$$U_{ijt} = \begin{cases} 1 \text{ if } u_{ijt} > 0 \\ 0 \text{ otherwise,} \end{cases}$$

$$V_{jkt} = \begin{cases} 1 \text{ if } \mathrm{v}_{jkt} > 0 \\ 0 \text{ otherwise,} \end{cases}$$

$$W_{it} = \begin{cases} 1 \text{ if } \mathrm{w}_{it} > 0 \\ 0 \text{ otherwise,} \end{cases}$$

$$N_{jt} = \begin{cases} 1 \text{ if } \mathrm{n}_{jt} > 0 \\ 0 \text{ otherwise.} \end{cases}$$

3.3. Mathematical Model

The system under consideration consists of multi-suppliers, which provide raw materials to multiple production plants producing a single item distributed to several distribution centers. Here, the distribution centers are operated by wholesale companies operating independently. Depending on the case, the model can be interpreted as integrating intra-company production-distribution system or integrating inter-company production-distribution activities. Although the production plants have the inventory holding capability, a JIT perspective is implemented in the demand process, which enforces a JIT delivery of products without backlogging. The multi-echelon nature with fixed costs both in the production and transportation activities complicates the problem and it becomes difficult to find an efficient procedure to solve the resulting formulation to optimality.

Min $$\sum_{t\in T}\sum_{i\in S}\sum_{j\in P} p_{it}x_{ijt} + \sum_{t\in T}\sum_{j\in P}\sum_{k\in D} m_{jt}y_{jkt} + \sum_{t\in T}\sum_{i\in S}(e_{it}w_{it} + E_{it}W_{it}) + \sum_{t\in T}\sum_{j\in P}(f_{jt}n_{jt} + F_{jt}N_{jt})$$
$$+\sum_{t\in T}\sum_{i\in S}\sum_{j\in P}(trs_{ijt}u_{ijt} + A_{ijt}U_{ijt}) + \sum_{t\in T}\sum_{j\in P}\sum_{k\in D}(trp_{jkt}v_{jkt} + B_{jkt}V_{jkt}) + \sum_{t\in T}\sum_{j\in P} I_{jt}h_{jt}$$
$$+\sum_{t\in T}\sum_{i\in S}\sum_{j\in P} trs_{ijt}x_{ijt} + \sum_{t\in T}\sum_{j\in P}\sum_{k\in D} trp_{jkt}y_{jkt} \qquad (1)$$

s.t.

$$\sum_{i\in S}\sum_{j\in P} x_{ijt} - \sum_{i\in S}\sum_{j\in P} u_{ijt} \le R_t \qquad \forall\, i,\, j,\, t \qquad (2)$$

$$\sum_{j\in P}\sum_{k\in D} y_{jkt} - \sum_{j\in P}\sum_{k\in D} v_{jkt} \le S_t \qquad \forall\, j,\, k,\, t \qquad (3)$$

$$\sum_{j\in P} x_{ijt} \le G_i + w_{it} \qquad \forall\, i,t \qquad (4)$$

$$\sum_{i\in S} x_{ijt} \le C_j + n_{jt} \qquad \forall\, j,t \qquad (5)$$

$$I_{jt-1} + \sum_{i\in S} x_{ijt} - I_{jt} = \sum_{k\in D} y_{jkt} \qquad \forall\, j,\, t \qquad (6)$$

$$\sum_{j\in P} y_{jkt} = d_{kt} \qquad \forall\, k,\, t \qquad (7)$$

$$u_{ijt} \le Z_{ij}^{r} U_{ijt} \qquad \forall\, i,\, j,\, t \qquad (8)$$

$$v_{jkt} \le Z_{jk}^{s} V_{jkt} \qquad \forall\, j,\, k,\, t \qquad (9)$$

$$w_{it} \le Z_{i}^{g} W_{it} \qquad \forall\, i,\, t \qquad (10)$$

$$n_{jt} \le Z_{j}^{p} N_{jt} \qquad \forall\, j,\, t \qquad (11)$$

$$U_{ijt}, V_{jkt}, W_{it}, N_{jt} \in \{0,1\}$$

The objective (1) is to minimize costs associated with the production, transportation, inventory holding and capacity expansion. Constraints (2) are the transportation capacity constraints ensuring that the total raw materials shipped from supplier *i* to producer *j* in period *t* does not exceed the total available capacity and the expanded capacity of routes (*i-j*). Constraints (3) are the similar transportation capacity constraints for the routes between producers and distributors. Constraints (4) are the supply capacity constraints for supplier *i* and provide that raw materials shipped from supplier *i* to producer *j* in period *t* should not exceed the supply capacity of supplier *i* and its expanded capacity. Constraints (5) are the production capacity constraint at the producer. The inventory balance constraints are expressed in constraints (6). Constraints (7) are demand constraints which state that total products shipped from all producers to distributor *k* in period *t* should exactly match the demand of distributor *k* in period *t*. Constraints (8-11) are binary constraints for capacity expansions. Constraints (8) and (9) are for transportation capacity expansion between supplier *i* and producer *j* in period

and between producer j and distributor k in period t, respectively. Constraints (9) and (10) are additional supply and production capacity constraints, respectively. All Zs are sufficiently large scalars satisfying the capacity increases.

CHAPTER 4

SOLUTION METHODOLOGY

Integrated models with centralized planning naturally lead to complex, large-scale models which are difficult to solve optimally in most real-life cases. Hence, it becomes a necessity to develop alternative solution techniques which are able to provide near optimal solutions for all organizational divisions in the integrated model (Barbarosoğlu and Özgür, 1999). Among many methods used for solving this kind of intractable problems, decomposition and heuristics are shown to perform well.

There are two basic kinds of heuristic approaches that can be designed. First is heuristics that are based on optimization theory and aims to accelerate or truncate optimization method, such as partial branch and bound method used in Maes *et al* (1991). Other heuristics are common sense heuristics based on intuition or common rules applied to a problem (Maes *et al.*, 1991).

For this reason, the focus of the thesis is directed towards designing an efficient heuristic. This thesis proposes three simple linear programming (LP)-based heuristics to obtain good solutions in a reasonable time. Common sense heuristics proposed in this study, try to achieve cost savings by eliminating fixed costs. Also, they include steps to ensure feasibility. Unlike other common sense heuristics, our heuristics do not perturb the result of heuristics in order to make additional savings. In what follows is the description of each heuristic approach.

4.1. LP Heuristic 1

LP Heuristic 1 (LPH1) starts with the LP relaxation solution of the problem. After obtaining the relaxation solution, it finds the largest non-integer binary variable, forces it to 1 by adding a constraint and resolves the problem. This process continues until all binary variables are equal to 1 or 0. LPH1 is depicted in Figure 4.1.

LPH1

Step 0: Solve LP Relaxation.

Step 1: Select the largest non-integer capacity expansion binary variable and round it to 1.

Step 2: Resolve the LP. If solution is all integer STOP, else go to Step 1.

Figure 4.1 Description of LP Heuristic 1

4.2. LP Heuristic 2

LP Heuristic 2 (LPH2) which is also based on LP-relaxation aims to achieve cost reductions by evaluating the trade-off between holding inventory instead of expanding capacity and incurring the fixed cost. Since holding inventory is possible at only producer stage, heuristic starts with first two production binary variables of the highest fixed cost producer. The algorithm first checks two consecutive time period capacity expansion variables together. If the sum of consecutive binary variables equals 1, second binary variable is forced to 0 and the other is forced to 1 by adding two constraints to the problem, that is next period's demand is produced in the current period and carried in inventory for one period. After resolving this LP, there can be two consequences; new solution can be infeasible or objective function does not improve. In this case last two constraints are deleted from the problem, largest variable is forced to 1 and the problem is resolved. Otherwise, if there is an improvement in the objective function, heuristic continues with checking the next two consecutive binaries.

If, at the beginning, there are no two variables such that their sum is, first non-integer variable is forced to 1 or 0 depending on whether it is greater or less than 0.5. The heuristic stops when all binary variables are 1 or 0. The detailed description is provided in Figure 4.2.

4.3. LP Heuristic 3

LP Heuristic 3 (LPH3) is based on LPH2. Contribution is heuristic's ability to check the tightest capacity level and improving solution based on that capacitated stage. In our case, most capacitated level is the largest fixed cost and the minimum capacity producer. By this prescreening feature, the heuristic tries to make big improvements at the beginning and aim to save time.

LPH2

Step 0: Solve LP relaxation.

Step 1: From the production capacity expansion non-integer variables of the most expensive producer, check if there exists two consecutive j_1 and j_2 such that $j_1+j_2=1$ and j_1 and j_2 are as small as possible. If exists go to Step 2, otherwise go to Step 4.

Step 2: Force N_{j1} to 1 and N_{j2} to 0. Resolve LP.

Step 3: If LP solution is infeasible or if there is no improvement in objective function, then delete the most recently added constraint which forced N_{j2} to 0 and resolve LP. Go to Step 1.

Step 4: If $j_1>0.5$ force N_{j1} to 1, otherwise to 0. Resolve LP.

Step 5: If infeasible, replace the most recent added constraint to 1 and resolve LP. Go to Step 1.

Figure 4.2 Description of LP Heuristic 2

CHAPTER 5

COMPUTATIONAL STUDY

5.1. Design of Experiments

Small-scale examples with 534 continuous and 282 binary variables and large-scale examples with 2976 continuous and 1536 binary variables are considered for experimental tests. These data sets are characterized by the number of suppliers, producers, distributors and the length of time horizon. For exact comparison, first run of experiments are conducted with a small example consisting of 5 suppliers, 3 producers and 8 distributors over a planning horizon of 6 months. The small-scale examples may be solved to optimality within a reasonable computational time using ILOG CPLEX Concert Technology 2.0 and allow us to make a sound comparison. Still, a time limit of 300 seconds is imposed for the sake of time management in case of tight capacity examples which may require longer computational time. Other data set consists of 8 suppliers, 5 producers, 15 distributors and analysis horizon is 12 months.

To accurately reflect the effect of capacity, fixed and variable costs, different cases are evaluated in the data sets. First of all, production and transportation capacities are set to 60% of total demand in tight capacity case. In loose capacity case capacities are set to 90% of total demand. Raw material cost is set to 10, and production cost is determined as 5% and 20% of raw material cost and interpreted as added value at the production plant. Extra supply and production costs are set to 10% of production cost, which is total raw material cost and manufacturing value added. Inventory cost per item/day is 2% of production cost. Transportation cost between the supplier and producer is different from that of producer and distributor and low transportation cost between the supplier-producer is matched with low transportation cost between the producer and distributor.

All data is generated according to uniform distribution. The demand data comes from U(50,500). Transportation costs between the supplier and producer are generated using U(0.5, 1.5) and U(0.5, 3.5) for low and high transportation costs, respectively.

Transportation costs between producer and distributor comes from U(0.6, 1.80) and U(0.6, 4.20) for low and high transportation costs, respectively.

In computational tests, the effect of fixed cost is investigated by choosing fixed cost 10 times and 100 times greater than the average production costs. Transportation fixed cost is chosen to be the 100 times and 500 times the average transportation cost. As a result 1024 sample problems from the each data set is generated with C++. For each set of parameters 5 problems of small type and 3 problems of large type are solved. In total, 8192 problems are solved. Detailed parameter setting can be found in Table 5.1.

	Set 1	Set 2
Suppliers	5	8
Producers	3	5
Distributors	8	15
Time Period	6	12
Demand	U(50,500)	
Production Capacity	60% and 90% of demand	
Supplier Capacity	60% and 90% of demand	
Transportation Capacity	60% and 90% of demand	
Raw Material Cost	10	
Producers Cost	5% and 20% of raw material cost	
Transportation Cost *i-j*	U(0.5,3.50)	U(0.5,1.50)
Transportation Cost *j-k*	U(0.6,1.80)	U(0.6,4.20)
Inventory Holding Cost	2% of raw material cost+manufacturing value added (producer's cost)	
Extra Production Cost	10% of raw material cost+manufacturing value added (producer's cost)	
Fixed Supplier Cost	x10 of raw material cost	x100 of raw material cost
Fixed Producer Cost	x10 of raw material cost+ producer's cost	x100 raw material cost+ producer's cost
Fixed Transportation (*i-j)* Cost	x100 of average transportation cost *i-j*	x500 of average transportation cost *i-j*
Fixed Transportation (*j-k)* Cost	x100 of average transportation cost *j-k*	x500 of average transportation cost *j-k*

Table 5.1 Detailed Parameter Setting

5.2 Results and Analysis

All three of the heuristics are coded in C++ and solved on a PC with 2.00 GHz Xeon processor. Branch-and-cut method of CPLEX Concert Technology 2.0 is used for benchmarking. Detailed results are reported in Appendix A for small data sets and

Appendix B for large data sets. The results in the tables are grouped into four categories with respect to their transportation cost combination (high-low) and production cost combination (high-low). The legend can be found in Table 5.2.

JKT	IJT	PT	ST	TH
Tight transportation capacity between producer and distributor	Tight transportation capacity between supplier and producer	Tight capacity in producer	Tight supply capacity	High Transportation cost
JKL	IJL	PL	SL	TL
Loose transportation capacity between producer and distributor	Loose transportation capacity between supplier and producer	Loose capacity in producer	Loose supply capacity	Low Transportation cost
FKH	FIH	FPH	FSH	PH
High fixed cost for transportation between producer and distributor	High fixed cost for transportation between supplier and producer	High fixed cost for producer	High fixed cost for supplier	High production cost
FKL	FIL	FPL	FSL	PL
Low fixed cost for transportation between producer and distributor	Low fixed cost for transportation between supplier and producer	Low fixed cost for producer	Low fixed cost for supplier	Low production cost

Table 5.2 Legend

Some general observations may be made regarding the small problem setting. First of all, when more than two of capacity restrictions are tight, CPLEX may not solve the problem to optimality in 300 seconds. However, heuristics provide very close solutions compared to the optimal (only good feasible in some cases) solutions obtained by CPLEX in a few seconds using LPH1 or LPH2. It is worth noting that as the capacities become looser solution quality of heuristics deteriorate and CPLEX can reach the optimal solution in a few seconds. The problems with tight capacity and high fixed costs for all entities (i.e. supplier, producer, transportation network between supplier-producer and producer-distributor) cannot be solved to optimality in 300 seconds. In total, 91.5% of 5120 small problems are solved to optimality.

Specifically, if low transportation cost alternative is chosen, LPH2 performs better than other heuristics. Solution time of LPH2 is less than that of LPH3 and more than that of LPH1. Another observation is that, regardless of the production and fixed costs,

the solution quality of LPH2 gradually decreases as capacity constraints loosen, thus heuristics have no advantages over CPLEX. The reason is that; there is generally no need for capacity expansion in problems with two or more loose capacity in entities, which means there are only a few non-integer variables in the LP relaxation solution. The improvements obtained using the heuristics which are based on rounding non-integer variables will become insignificant in such cases. Average errors in solutions for low transportation-low production cost and low transportation-high production cost cases may be found in Figure 5.1 and Figure 5.2, respectively.

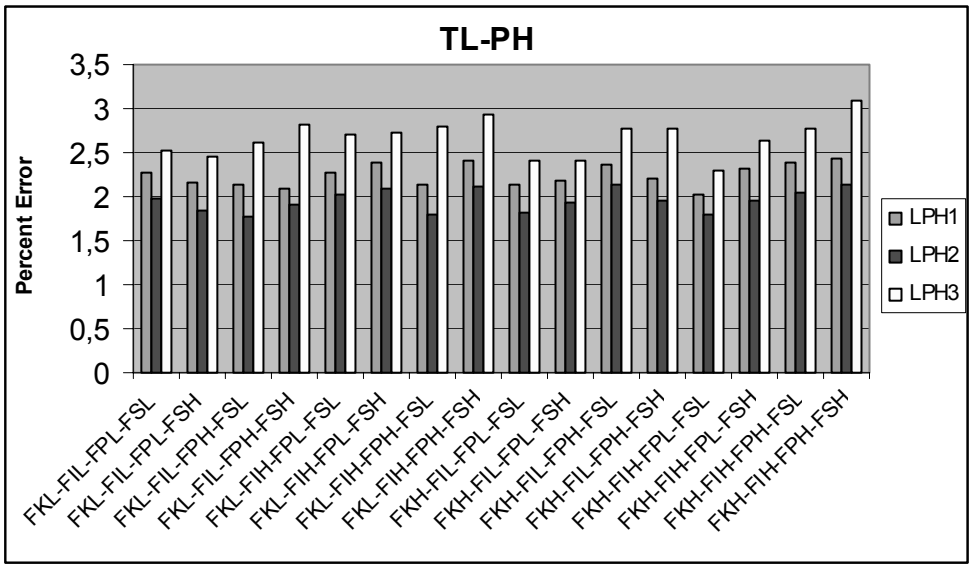

Figure 5.1 Percent Errors for TL-PH case for small problems

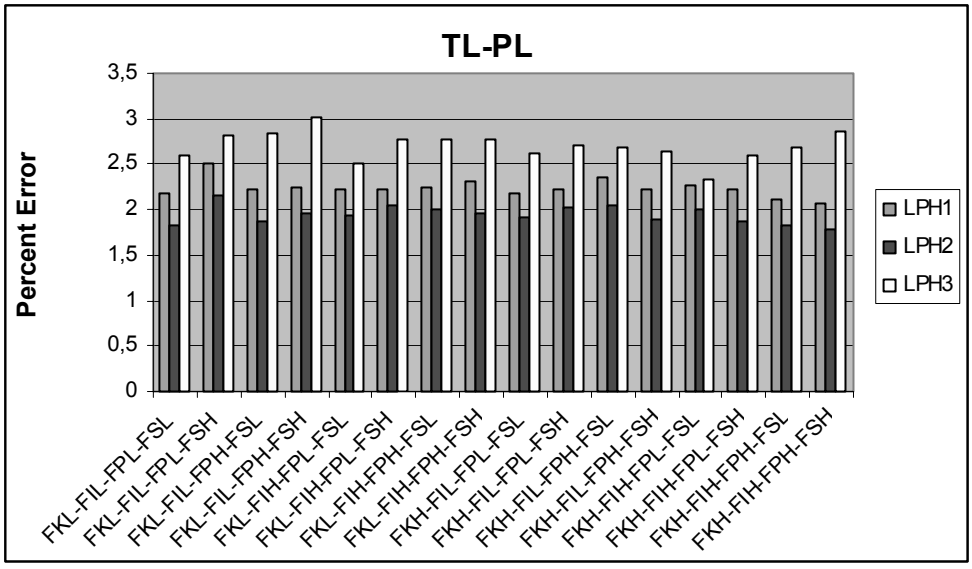

Figure 5.2 Percent Errors for TL-PL case for small problems

When the transportation cost is high, LPH2 still gives better solutions regardless of the level of production cost (Refer to Figures 5.3 and 5.4).

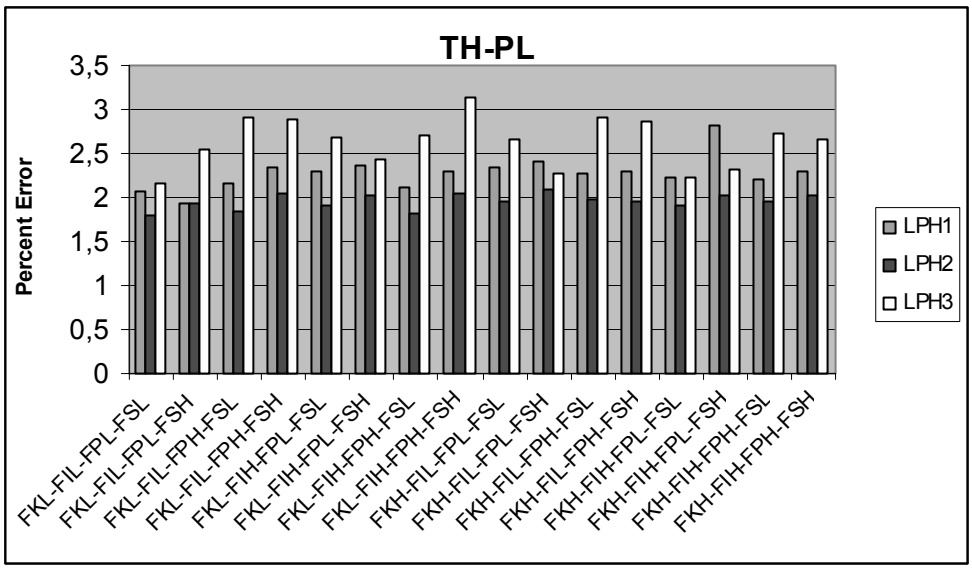

Figure 5.3 Percent Errors for TH-PL case for small problems

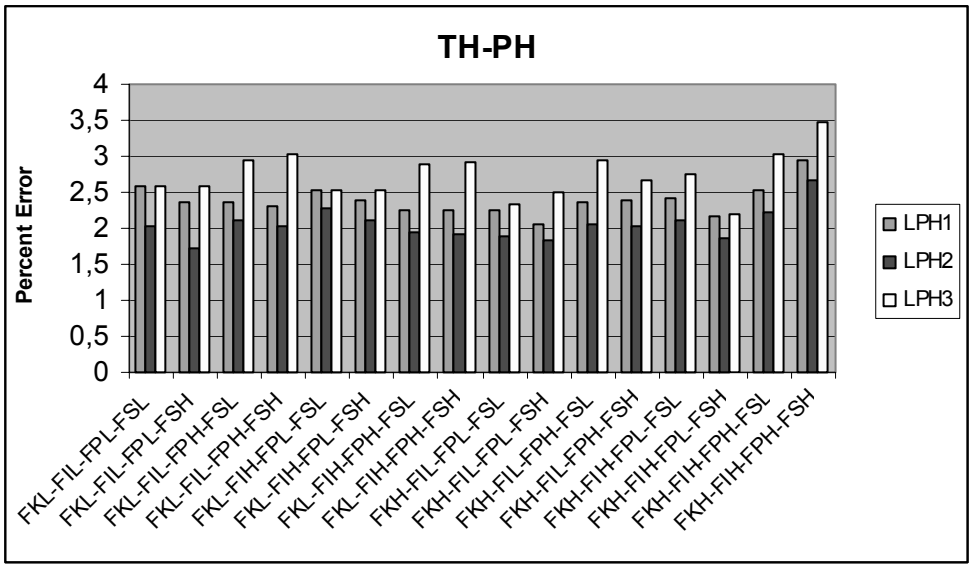

Figure 5.4 Percent Errors for TH-PH case for small problems

For large-scale examples, a time limit of 150 seconds is imposed in CPLEX. It is observed that LPH1 performs better than other heuristics. In low transportation cost and low production cost case LPH1 produces good results except for two problem sets: FKH-FIL-FPH-FSH and FKL-FIH-FPH-FSH. Percent errors vary between 0.4-0.6 % of CPLEX solutions (Note that CPLEX was able to find the optimal solution in 3 problem instances out of 3072 problems). For LPH1, solution times are 7.15 seconds on the average, 6.97 seconds in the best and 7.36 seconds in the worst case. Solution times for

LPH2 are 12.90 seconds on the average, 12.64 in the best and 13.3 in the worst case. Solution times for LPH3 are 12.74 in the average, 12.12 in the best and 13.10 in the worst case. Even when the transportation cost is high LPH1 performs better than other heuristics with all fixed cost cases and 0.51% deviation in the average is achieved compared to CPLEX solutions. CPLEX solutions are obtained in 159.38 seconds in the average. Detailed results for TL-PL and TH-PL cases may be found in Figure 5.5 and Figure 5.6, respectively.

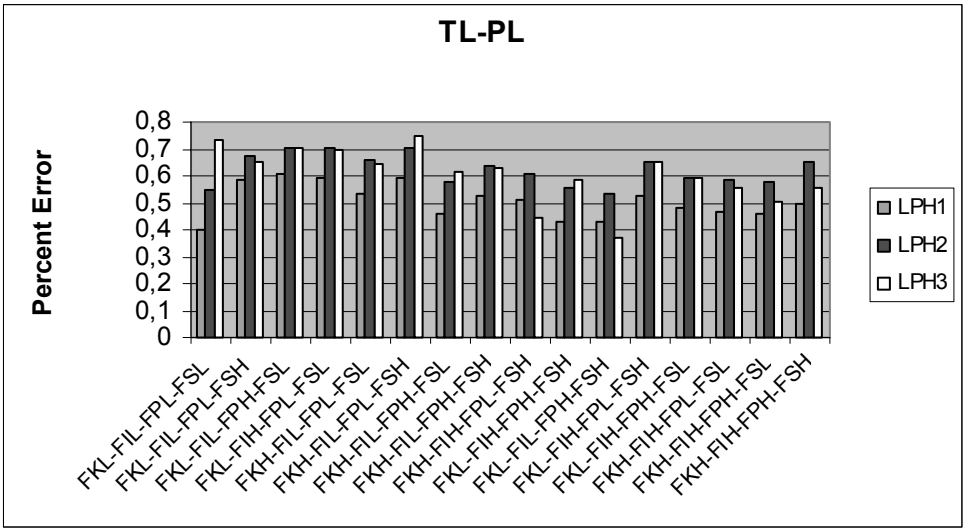

Figure 5.5 Percent Errors for TL-PL case for large problems

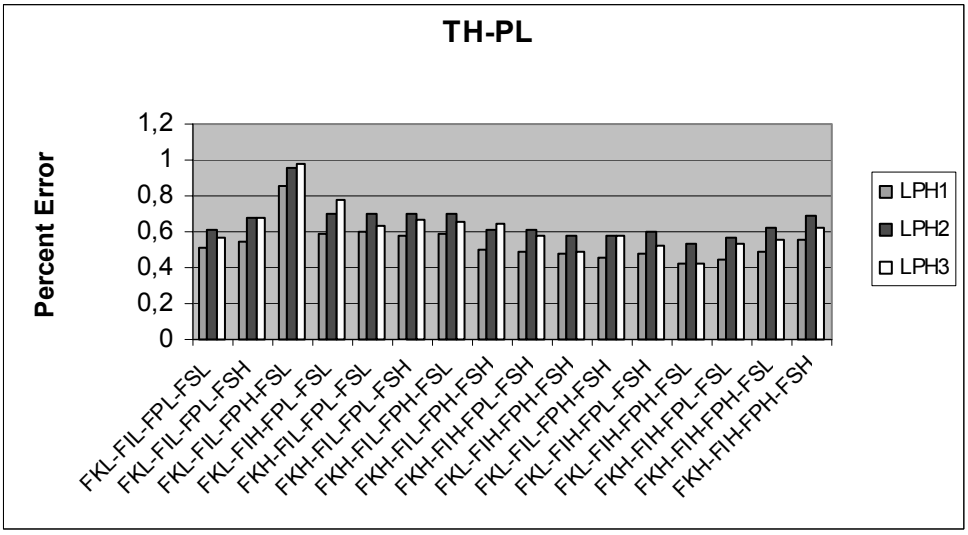

Figure 5.6 Percent Errors for TH-PL case for large problems

Same performance is observed with the high production cost problems regardless of the transportation cost. LPH1 gives good feasible solutions in 7.17 seconds in the

average, 6.97 in the best and 7.36 in the worst case. However, it should be noted that CPLEX takes much larger time to give a feasible solution (158.86 seconds in the average, 150 seconds in the best and 291.11 seconds in the worst case). As the capacity restrictions loosen solution times for heuristics increase, solution times for CPLEX decrease. Detailed results may be found in Figure 5.7 and Figure 5.8.

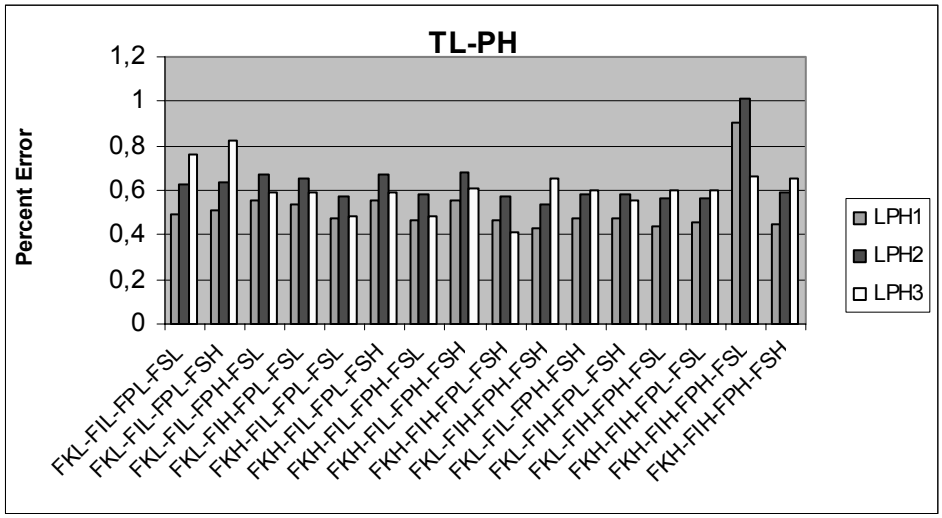

Figure 5.7 Percent Errors for TL-PH case for large problems

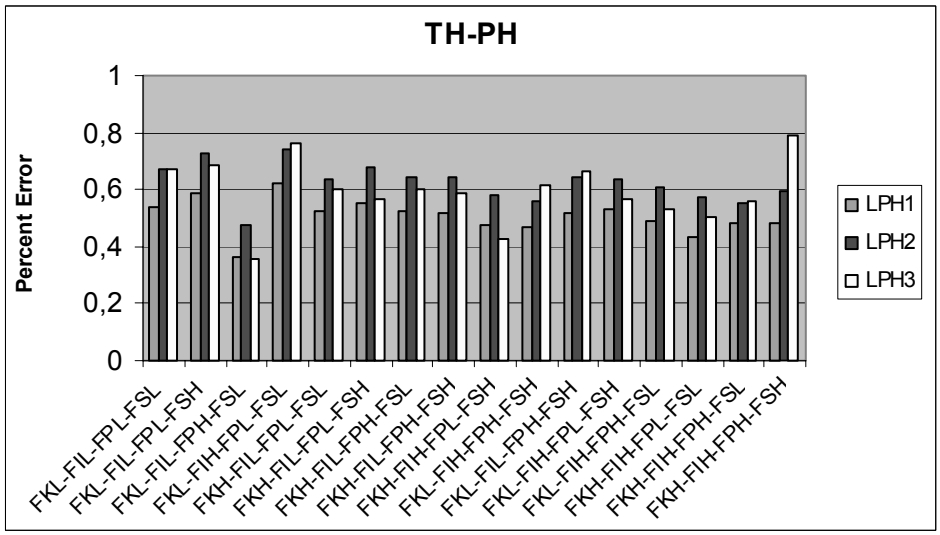

Figure 5.8 Percent Errors for TH-PH case for large problems

CHAPTER 6

CONCLUSION AND FUTURE WORK

This thesis proposes a mathematical formulation of a multi-period three-stage strategic production-distribution planning problem and presents a simple and fast methodology to solve this problem. The proposed model includes the links between entities and this integrated approach provides an understanding of the minimization of system-wide costs which include production, inventory and transportation costs as well as costs associated with the increase in production and transportation capacities and in supply quantities.

Three heuristics are developed based on the LP relaxation solution of the problem. The efficiency of the heuristics is tested with an extensive computational study. We conclude that heuristics provide good feasible solutions for complex problems with little computational effort compared to the feasible solutions obtained using CPLEX with significantly longer computational times. Even if CPLEX provides optimal solutions in a reasonable time (which is the case in only 3 problem instances in a total of 3072 large-scale problems), heuristic codes may still be preferable since they are easy to use generic codes and accessible to everyone while CPLEX is a licensed program which requires skills to use.

The proposed heuristics are simple common sense procedures which are based on rounding the non-integer decision variables. As a future research direction, a more extensive study may be conducted to develop a more sophisticated heuristic to improve the solution quality.

The model presented assumes that the capacity increases are contract based and does not allow carrying the additional capacities to the subsequent periods. However, the increase in capacities may be permanent in the case of one-time investments for acquisition of land, building, machinery and/or logistics components. Thus, the performance of the heuristics for this case may be explored in the future.

Since demand fluctuations are more common in real life situations, a stochastic modeling approach may also be addressed. Service level requirements may be incorporated within the stochastic demand case.

Additionally, performance of CPLEX solutions may be observed by setting heuristics' solution as initial feasible solution. For problems that should be solved to optimality, starting from initial feasible solutions and starting from scratch may be compared to understand the heuristics' efficiency to reach optimality.

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APPENDIX A

RESULTS FOR SMALL PROBLEMS

FKL-FIL-FPL-FSL

Table 1					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time[1]	LPH1		LPH2		LPH3		CPLEX Solution Time[1]
Capacity					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	0,16	2,11	0,17	1,99	0,09	5,02	17,74	1,30	0,88	1,11	1,56	1,65	1,90	272,31
				SL	0,91	0,63	0,61	1,09	1,00	1,21	201,08	0,92	0,63	0,90	1,12	0,79	1,27	63,46
			PL	ST	1,91	0,52	1,63	1,00	2,46	1,14	1,18	2,17	0,55	1,68	1,01	2,59	1,22	15,27
				SL	1,51	0,52	1,08	0,88	1,89	1,09	5,38	1,78	0,55	1,45	0,99	2,46	1,26	14,03
		IJL	PT	ST	2,63	0,54	2,22	0,87	3,62	1,14	6,55	2,69	0,55	2,18	0,83	2,14	0,99	7,33
				SL	2,44	0,50	2,06	0,79	2,33	0,94	4,51	2,02	0,50	1,56	0,80	3,07	1,11	8,03
			PL	ST	2,95	0,56	2,68	0,88	3,05	1,09	7,38	3,04	0,56	2,53	0,96	2,80	1,04	6,91
				SL	1,93	0,70	1,64	0,89	2,58	1,14	5,77	2,19	0,60	1,87	0,99	2,08	1,08	8,16
	JKL	IJT	PT	ST	1,73	0,49	1,43	0,86	2,32	1,10	7,35	2,72	0,49	2,41	0,87	2,81	1,08	2,27
				SL	2,80	0,53	2,41	0,85	2,92	1,02	2,40	2,37	0,53	2,11	0,79	2,73	0,93	2,22
			PL	ST	1,80	0,42	1,60	0,64	2,66	0,91	2,65	2,36	0,55	1,96	0,92	2,82	1,15	3,17
				SL	3,09	0,42	2,75	0,86	3,18	1,10	2,15	2,69	0,42	2,45	1,04	2,10	1,19	1,86
		IJL	PT	ST	2,03	0,56	1,59	0,82	3,06	1,08	1,62	2,72	0,56	2,77	1,15	3,44	1,41	1,70
				SL	3,26	0,70	2,81	1,22	3,63	1,51	1,97	2,95	0,70	2,63	1,28	3,07	1,49	1,79
			PL	ST	3,23	0,67	2,80	1,18	3,83	1,55	2,44	2,79	0,66	2,55	1,11	3,07	1,37	0,65
				SL	2,32	0,66	1,79	1,12	2,99	1,53	1,87	1,72	0,62	1,30	0,99	2,90	1,36	0,83
PH	JKT	IJT	PT	ST	0,23	1,36	0,66	1,92	0,17	4,54	3,30	1,29	0,89	1,09	1,54	1,10	1,79	276,81
				SL	0,52	0,61	0,86	1,10	0,74	1,29	164,87	1,53	0,62	1,37	1,15	1,58	1,34	173,37
			PL	ST	1,60	0,49	1,16	0,90	1,86	1,16	1,92	2,49	0,55	1,72	0,98	1,59	1,12	21,19
				SL	2,40	0,53	1,20	0,95	1,45	1,16	6,82	3,37	0,53	1,47	0,97	2,34	1,30	6,81
		IJL	PT	ST	2,12	0,50	1,85	0,83	2,85	1,12	5,77	1,83	0,49	1,80	0,79	1,38	0,92	5,18
				SL	3,88	0,52	2,38	0,82	1,90	0,92	6,12	0,93	0,52	2,16	0,80	2,30	0,98	5,91
			PL	ST	3,20	0,52	2,16	0,89	3,01	1,12	23,14	3,65	0,52	2,16	0,87	3,13	1,20	7,60
				SL	1,32	0,70	1,86	0,91	2,23	1,08	4,38	3,38	0,62	2,78	0,95	3,56	1,28	3,40
	JKL	IJT	PT	ST	2,07	0,51	1,96	0,87	2,85	1,17	4,38	1,93	0,45	2,05	0,77	2,15	0,96	6,57
				SL	2,89	0,47	2,54	0,82	2,33	0,88	1,76	4,11	0,47	2,74	0,97	3,13	1,13	1,31
			PL	ST	1,21	0,46	1,68	0,69	2,91	1,05	0,65	3,56	0,48	1,98	0,77	3,67	1,14	0,96
				SL	1,84	0,46	2,53	1,04	1,79	1,01	0,87	2,47	0,46	1,96	0,92	3,25	1,29	0,90
		IJL	PT	ST	2,77	0,52	2,31	1,02	3,11	1,30	1,94	4,26	0,52	2,16	1,01	3,23	1,38	1,55
				SL	2,76	0,70	1,67	0,96	1,84	1,17	1,43	1,85	0,70	3,19	1,24	2,71	1,38	1,63
			PL	ST	2,26	0,58	1,17	1,03	1,83	1,29	3,81	3,78	0,69	2,69	1,28	3,15	1,63	1,46
				SL	2,08	0,75	2,61	1,28	3,48	1,63	0,66	1,11	0,62	1,28	1,01	2,90	1,46	1,67

[1] Some of the CPLEX solution times exceed the 300 seconds time limit imposed. The reason is that CPLEX is allowed to conclude its last iteration of the branch-and-cut and total computational time is reported.

FKL-FIL-FPL-FSH

Table 2

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,88	2,66	0,54	2,06	0,58	4,22	145,32	1,45	0,90	1,29	1,58	1,64	1,75	300,55
				SL	1,10	0,63	0,74	1,04	1,00	1,30	140,59	1,29	0,64	0,95	1,13	1,23	1,33	200,08
			PL	ST	2,07	0,53	1,66	0,96	2,34	1,10	3,80	1,46	0,50	1,05	0,92	2,01	1,13	15,80
				SL	2,10	0,57	1,61	1,02	2,99	1,26	9,00	1,82	0,56	1,46	1,08	2,21	1,18	3,07
		IJL	PT	ST	3,60	0,58	3,03	0,93	3,64	1,08	1,23	2,73	0,52	2,53	0,94	3,11	1,01	3,71
				SL	2,94	0,56	2,50	0,94	2,67	1,04	4,95	2,64	0,53	2,17	0,83	3,25	1,06	3,12
			PL	ST	2,51	0,55	2,06	0,92	3,61	1,25	3,54	1,87	0,55	1,67	0,78	1,79	0,98	4,01
				SL	2,36	0,57	2,43	0,94	2,75	1,11	3,15	2,08	0,59	1,70	0,96	2,77	1,19	8,46
	JKL	IJT	PT	ST	3,01	0,56	2,85	1,02	2,88	1,06	2,80	2,56	0,46	2,53	0,82	2,96	0,96	2,92
				SL	3,25	0,57	2,80	0,94	3,07	1,00	3,83	2,26	0,46	1,90	0,83	2,92	1,00	2,41
			PL	ST	2,31	0,46	2,09	0,78	3,19	1,03	2,61	2,56	0,53	2,13	0,89	2,88	1,05	2,59
				SL	3,34	0,56	2,93	0,98	3,95	1,14	2,94	2,42	0,49	1,92	0,87	1,09	0,84	2,63
		IJL	PT	ST	2,26	0,53	1,87	0,86	3,18	1,23	4,68	2,02	0,52	1,97	0,87	2,52	1,05	2,60
				SL	3,21	0,49	2,77	1,10	3,17	1,30	3,00	2,76	0,66	2,42	1,15	3,28	1,31	1,87
			PL	ST	1,68	0,53	1,25	0,86	2,84	1,05	2,00	2,21	0,67	1,97	1,09	2,31	1,19	1,58
				SL	3,56	0,82	3,44	1,49	3,15	1,47	1,26	2,35	0,82	1,87	1,13	3,33	1,40	2,85
PH	JKT	IJT	PT	ST	0,87	1,94	0,67	2,71	0,65	2,03	272,07	0,48	0,84	1,03	1,44	1,61	1,51	300,52
				SL	1,08	0,61	0,73	1,14	0,98	1,17	157,12	0,97	0,64	1,43	1,17	1,34	1,19	184,01
			PL	ST	0,67	0,50	1,50	0,98	2,49	1,03	7,62	2,23	0,54	1,28	0,96	2,51	1,05	8,20
				SL	1,34	0,55	1,82	1,00	3,34	1,12	4,30	3,40	0,51	1,39	0,95	2,60	1,07	4,72
		IJL	PT	ST	3,13	0,53	2,41	0,95	3,08	1,01	2,38	1,41	0,50	1,29	0,75	2,62	0,93	4,28
				SL	1,67	0,49	1,43	0,72	1,17	0,75	4,14	3,36	0,54	2,00	0,90	1,95	0,83	2,47
			PL	ST	2,04	0,52	2,50	1,00	3,07	1,05	3,86	2,72	0,58	1,92	0,86	2,45	0,92	2,48
				SL	0,89	0,58	2,34	0,91	3,11	0,93	2,40	3,67	0,55	2,18	0,89	2,87	1,01	4,14
	JKL	IJT	PT	ST	0,96	0,49	1,77	0,89	3,15	0,99	3,74	4,51	0,50	2,30	0,86	3,36	0,94	3,21
				SL	2,06	0,51	2,58	0,87	2,89	0,86	3,14	3,34	0,49	2,49	0,81	3,53	0,88	3,06
			PL	ST	1,19	0,49	1,65	0,77	2,15	0,71	4,48	2,36	0,46	1,31	0,74	2,71	0,87	3,70
				SL	1,93	0,57	2,50	0,92	3,12	0,97	3,41	1,42	0,45	1,03	0,72	1,57	0,78	5,37
		IJL	PT	ST	3,80	0,45	2,18	1,08	2,87	1,12	4,51	3,47	0,59	2,10	1,03	3,02	1,09	2,99
				SL	2,21	0,53	1,86	0,91	3,65	1,06	3,03	1,41	0,57	1,45	0,98	3,04	1,18	3,45
			PL	ST	5,89	0,69	2,40	1,17	2,07	1,08	1,30	0,52	0,60	2,04	1,04	3,43	1,25	1,11
				SL	1,00	0,69	2,47	1,23	2,97	1,22	1,51	2,73	0,69	2,21	1,21	2,76	1,25	2,07

Table 3

FKL-FIL-FPH-FSL

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,93	1,85	0,75	2,70	0,55	2,06	271,85	1,13	0,85	0,89	1,49	0,61	1,42	300,60
				SL	1,02	0,59	0,75	1,09	1,00	1,13	248,19	1,39	0,65	1,25	1,14	1,25	1,13	134,95
			PL	ST	2,13	0,54	1,86	0,99	3,87	1,19	18,22	1,61	0,53	1,24	0,95	2,42	1,01	10,55
				SL	1,64	0,51	1,35	0,91	2,93	1,08	5,58	1,78	0,55	1,55	1,02	2,63	1,13	9,38
		IJL	PT	ST	2,64	0,58	2,41	0,88	3,83	0,98	2,79	2,35	0,49	1,98	0,79	2,52	0,84	3,36
				SL	2,30	0,53	1,84	0,83	3,18	0,95	4,56	1,79	0,53	1,49	0,76	2,53	0,85	2,92
			PL	ST	2,94	0,53	2,63	1,02	3,11	0,97	2,98	2,10	0,55	2,15	0,94	2,92	0,98	2,59
				SL	2,21	0,60	1,73	0,94	2,33	1,05	1,74	2,19	0,60	1,71	0,92	2,71	0,99	1,67
	JKL	IJT	PT	ST	2,83	0,60	2,59	1,14	3,79	1,21	1,55	2,43	0,42	1,94	0,74	2,95	0,85	1,08
				SL	2,47	0,50	2,03	0,79	2,59	0,89	1,36	2,59	0,51	2,24	0,72	3,60	0,90	1,18
			PL	ST	2,40	0,48	2,01	0,93	2,82	0,86	1,34	2,39	0,49	1,87	0,79	1,84	0,74	1,44
				SL	2,54	0,52	2,14	0,87	3,06	0,94	1,19	2,06	0,48	1,73	0,85	3,18	0,99	2,06
		IJL	PT	ST	2,67	0,58	2,30	1,00	3,63	1,14	1,62	2,16	0,58	1,82	0,88	2,72	0,92	1,62
				SL	2,53	0,60	2,07	1,05	3,44	1,22	2,36	2,91	0,65	2,45	1,10	3,40	1,26	1,72
			PL	ST	2,19	0,66	1,91	1,05	2,68	1,18	1,66	2,84	0,72	2,35	1,22	3,68	1,46	1,18
				SL	2,07	0,61	1,74	1,14	2,44	1,12	1,66	2,29	0,68	1,79	1,12	2,93	1,24	2,26
PH	JKT	IJT	PT	ST	0,54	1,38	0,98	1,77	0,85	1,79	301,95	1,13	0,85	0,95	1,48	0,80	1,41	300,35
				SL	0,74	0,61	0,85	1,14	1,17	1,20	182,69	0,86	0,63	1,04	1,18	1,00	1,13	56,97
			PL	ST	0,67	0,50	1,50	0,98	2,49	1,03	7,62	2,31	0,52	1,41	0,96	1,87	0,93	8,05
				SL	1,67	0,50	1,31	0,93	2,82	1,04	3,50	1,91	0,57	1,76	1,02	3,24	1,18	18,94
		IJL	PT	ST	1,18	0,50	1,18	0,95	2,64	1,05	19,11	1,41	0,50	1,29	0,75	2,62	0,93	4,28
				SL	4,74	0,55	2,30	0,97	3,55	1,13	2,93	3,44	0,46	2,38	0,83	3,19	0,88	4,90
			PL	ST	3,04	0,54	2,50	0,89	3,40	0,96	3,33	2,14	0,57	2,09	0,89	3,46	1,05	3,82
				SL	1,94	0,46	1,58	0,76	3,09	0,87	5,16	3,54	0,57	3,16	0,91	4,66	1,05	7,33
	JKL	IJT	PT	ST	3,22	0,46	2,79	0,82	3,49	0,89	4,76	2,35	0,42	3,07	0,90	3,85	1,03	4,71
				SL	1,84	0,39	1,49	0,58	3,17	0,70	3,42	2,59	0,53	2,40	0,86	2,18	0,93	3,34
			PL	ST	1,93	0,57	2,50	0,92	3,12	0,97	3,41	2,67	0,53	2,15	0,93	3,44	1,06	2,21
				SL	2,77	0,62	2,15	1,04	3,29	1,13	1,56	2,35	0,61	2,01	1,07	3,15	1,18	1,84
		IJL	PT	ST	2,85	0,58	2,46	1,04	3,60	1,11	3,12	2,69	0,58	2,54	1,16	3,38	1,23	3,21
				SL	2,59	0,54	2,20	0,91	3,64	1,03	2,61	2,61	0,61	2,27	0,98	3,04	1,08	4,84
			PL	ST	2,39	0,63	1,67	1,04	2,98	1,26	2,27	2,80	0,66	2,40	1,11	3,07	1,26	1,60
				SL	2,41	0,63	1,87	1,05	3,08	1,27	2,49	3,08	0,76	3,03	1,29	3,96	1,51	1,12

Table 4

Capacity					FKL-FIH-FPL-FSL													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	0,90	0,68	0,93	1,40	0,65	1,68	255,13	2,42	0,68	2,40	1,52	2,41	1,59	255,13
				SL	1,13	0,60	0,90	1,06	1,35	1,34	164,42	1,35	0,60	1,04	1,12	1,37	1,36	83,18
			PL	ST	1,99	0,52	1,53	0,97	2,07	1,13	17,79	1,82	0,52	1,38	0,97	3,08	1,29	10,00
				SL	2,09	0,55	1,79	0,99	2,66	1,24	5,84	1,76	0,55	1,54	1,01	2,19	1,24	13,46
		IJL	PT	ST	2,51	0,49	2,19	0,80	3,46	0,99	7,86	2,82	0,54	2,64	0,84	3,39	1,05	8,05
				SL	2,65	0,55	2,33	0,87	3,58	1,13	5,13	3,02	0,56	2,73	0,92	2,92	1,01	9,64
			PL	ST	2,42	0,52	2,08	0,92	2,94	1,10	6,21	2,03	0,52	1,72	0,84	2,89	1,10	5,68
				SL	3,02	0,62	2,81	0,96	3,65	1,22	4,74	2,48	0,59	2,20	0,92	3,41	1,22	5,41
	JKL	IJT	PT	ST	2,87	0,54	2,45	0,93	3,16	1,18	7,58	2,71	0,54	2,41	0,77	2,79	0,94	2,64
				SL	2,98	0,48	2,49	0,87	2,56	1,00	1,63	2,25	0,44	2,29	0,82	3,17	0,98	2,09
			PL	ST	3,19	0,56	2,91	1,05	3,10	1,14	3,21	2,12	0,44	1,89	0,87	3,24	1,09	3,20
				SL	2,17	0,56	1,82	0,87	2,25	0,98	1,91	2,11	0,50	1,83	0,86	2,65	1,07	4,05
		IJL	PT	ST	2,39	0,58	2,26	1,05	3,41	1,43	2,20	1,94	0,55	1,50	0,85	1,61	1,00	1,27
				SL	0,48	0,61	0,10	1,09	1,01	1,28	0,66	2,66	0,59	2,24	1,00	3,10	1,28	0,66
			PL	ST	1,55	0,61	1,51	0,92	1,79	1,14	1,67	2,36	0,66	2,02	1,23	3,30	1,59	1,62
				SL	3,09	0,71	2,82	1,29	2,59	1,36	1,30	2,68	0,72	2,66	1,38	1,67	1,31	1,74
PH	JKT	IJT	PT	ST	1,16	0,76	1,28	1,58	1,36	1,74	300,03	5,49	0,76	5,76	1,62	5,38	1,79	300,03
				SL	1,41	0,65	1,01	1,16	1,21	1,29	161,50	1,67	0,65	1,35	1,14	1,42	1,37	211,75
			PL	ST	2,10	0,53	1,47	0,93	1,70	1,10	6,74	1,63	0,54	1,29	0,93	2,04	1,15	9,36
				SL	1,65	0,54	1,43	0,98	2,67	1,30	12,17	2,08	0,60	1,83	1,08	2,33	1,35	17,50
		IJL	PT	ST	1,88	0,47	1,89	0,80	2,78	1,04	8,34	1,75	0,47	1,26	0,73	2,92	1,16	7,35
				SL	2,44	0,54	2,00	0,82	3,08	1,08	5,75	3,17	0,57	2,84	0,88	3,34	1,11	6,42
			PL	ST	2,32	0,57	1,96	0,86	3,68	1,18	5,25	2,72	0,63	2,42	1,01	1,18	0,93	3,37
				SL	2,10	0,58	1,72	0,92	2,43	1,20	2,50	2,46	0,60	2,02	0,99	1,53	1,08	5,12
	JKL	IJT	PT	ST	2,05	0,52	1,35	0,82	3,35	1,28	3,49	2,24	0,52	2,00	0,85	2,32	1,07	3,75
				SL	3,22	0,46	2,79	0,82	3,49	0,89	4,76	2,53	0,45	2,01	0,73	3,45	1,15	1,10
			PL	ST	3,33	0,55	2,61	0,92	2,13	1,07	0,92	3,07	0,45	3,00	0,98	2,69	1,07	1,04
				SL	2,99	0,55	2,76	0,94	3,10	1,13	1,82	2,40	0,54	2,18	0,98	2,67	1,23	2,55
		IJL	PT	ST	2,87	0,58	2,41	1,04	3,15	1,27	0,56	2,98	0,62	2,65	1,07	2,00	1,20	0,82
				SL	1,96	0,65	1,65	1,11	2,99	1,61	1,11	1,76	0,56	1,43	0,92	2,99	1,26	1,11
			PL	ST	1,85	0,53	1,39	0,84	2,82	1,30	1,31	2,55	0,71	1,99	1,09	2,33	1,33	1,73
				SL	3,36	0,71	2,94	1,24	3,11	1,40	1,27	1,93	0,69	2,48	1,25	1,72	1,29	2,08

Table 5

FKH-FIL-FPL-FSL

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,17	0,83	1,11	1,49	1,03	1,82	293,35	1,25	0,87	1,17	1,53	1,68	1,81	300,63
				SL	0,88	0,62	0,77	1,11	1,41	1,35	244,23	1,14	0,63	0,89	1,15	0,45	1,20	99,37
			PL	ST	1,16	0,47	1,00	0,90	1,58	1,07	4,03	2,04	0,56	1,63	1,00	1,47	1,03	24,11
				SL	1,86	0,57	1,50	1,02	1,29	1,02	21,21	1,78	0,54	1,43	1,00	2,00	1,28	12,70
		IJL	PT	ST	2,27	0,46	1,78	0,75	2,77	0,98	8,08	2,27	0,48	1,84	0,75	2,15	0,97	5,77
				SL	2,46	0,51	2,14	0,83	3,04	1,10	8,71	2,72	0,57	2,14	0,85	2,92	1,11	8,02
			PL	ST	2,09	0,58	1,66	0,83	2,60	0,97	7,42	1,82	0,54	1,51	0,92	2,34	1,10	5,54
				SL	2,93	0,64	2,74	1,01	2,97	1,17	6,07	2,85	0,61	2,52	1,00	3,80	1,41	6,00
	JKL	IJT	PT	ST	2,94	0,55	2,67	0,98	3,18	1,18	9,03	2,49	0,44	2,00	0,76	2,37	0,91	1,94
				SL	3,52	0,52	3,14	1,04	3,48	1,11	2,23	2,31	0,55	2,48	0,98	2,40	1,14	2,53
			PL	ST	1,76	0,48	1,43	0,75	3,25	1,06	2,10	2,18	0,49	1,73	0,85	2,47	0,94	1,92
				SL	2,29	0,50	2,13	0,92	3,25	1,11	2,49	2,15	0,50	1,92	0,86	3,31	1,10	2,75
		IJL	PT	ST	2,19	0,52	1,85	0,94	2,89	1,10	0,97	1,82	0,56	1,40	0,95	2,24	1,11	1,18
				SL	2,81	0,61	2,71	1,10	3,22	1,34	2,11	2,35	0,58	2,02	1,04	3,14	1,30	2,11
			PL	ST	2,59	0,61	2,29	1,08	2,58	1,25	2,99	2,56	0,61	2,27	1,17	2,50	1,36	1,20
				SL	2,12	0,63	1,65	1,03	3,26	1,48	0,79	2,51	0,73	2,22	1,23	3,31	1,60	1,01
PH	JKT	IJT	PT	ST	1,19	0,84	1,19	1,49	1,58	1,79	300,03	1,24	0,85	1,14	1,48	0,60	1,57	272,90
				SL	0,96	0,62	0,89	1,11	1,45	1,43	183,39	1,57	0,67	1,17	1,17	1,23	1,36	221,83
			PL	ST	2,17	0,53	1,69	0,93	1,54	1,08	12,51	2,05	0,54	1,41	0,95	1,52	1,10	6,17
				SL	1,92	0,56	1,74	1,00	2,27	1,27	11,47	1,72	0,57	1,97	1,09	2,43	1,38	8,62
		IJL	PT	ST	2,71	0,50	2,38	0,82	3,10	1,10	6,47	2,43	0,51	2,06	0,82	1,79	0,96	5,38
				SL	3,45	0,58	2,56	0,96	2,21	1,00	8,76	2,63	0,56	2,27	0,88	2,29	1,05	5,50
			PL	ST	2,32	0,57	1,96	0,86	3,68	1,18	3,75	0,58	2,68	0,92	3,56	1,30	2,58	3,37
				SL	2,75	0,61	2,09	1,00	3,57	1,33	3,27	1,65	0,62	1,17	0,91	1,81	1,21	4,79
	JKL	IJT	PT	ST	2,78	0,51	2,31	0,92	2,91	1,12	2,62	2,88	0,47	2,47	0,77	3,52	1,11	1,92
				SL	2,61	0,39	1,92	0,76	1,57	0,96	2,18	2,98	0,45	2,55	0,78	2,78	1,00	0,68
			PL	ST	3,00	0,51	2,73	0,88	3,58	1,25	1,42	3,34	0,53	2,43	0,86	3,48	1,22	0,64
				SL	2,26	0,53	2,39	0,92	3,27	1,24	2,37	2,53	0,54	1,98	0,95	2,78	1,22	1,46
		IJL	PT	ST	2,64	0,50	1,94	0,80	2,45	1,00	0,68	2,89	0,59	2,18	0,99	2,70	1,25	0,59
				SL	1,07	0,50	0,95	0,83	2,40	1,21	1,98	2,25	0,59	2,07	1,06	2,97	1,34	1,06
			PL	ST	2,86	0,59	2,26	1,09	3,24	1,43	0,88	2,58	0,62	2,01	1,09	2,61	1,38	1,51
				SL	2,83	0,69	2,32	1,17	3,60	1,55	1,64	2,81	0,69	2,50	1,28	3,72	1,67	0,90

FKH-FIL-FPL-FSH

Table 6					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,20	0,86	1,15	1,51	1,55	1,74	300,33	0,96	0,89	0,79	1,54	0,59	1,58	300,57
				SL	0,91	0,63	0,71	1,12	0,42	1,22	244,59	1,00	0,65	0,90	1,13	0,88	1,31	220,70
			PL	ST	2,27	0,54	1,85	1,02	2,73	1,30	63,48	2,54	0,55	2,03	0,97	2,65	1,15	10,88
				SL	0,04	0,56	1,58	1,01	1,98	1,20	8,90	1,67	0,56	1,38	0,99	2,20	1,14	18,88
		IJL	PT	ST	2,06	0,48	1,73	0,80	2,29	0,86	1,85	1,88	0,51	1,67	0,77	1,48	0,80	2,78
				SL	2,94	0,56	2,50	0,94	2,67	1,04	4,95	2,64	0,53	2,17	0,83	3,25	1,06	3,12
			PL	ST	2,51	0,55	2,06	0,92	3,61	1,25	3,54	1,87	0,55	1,67	0,78	1,79	0,98	4,01
				SL	2,62	0,61	2,29	0,94	2,35	1,08	5,26	2,26	0,64	2,33	1,09	3,22	1,34	4,48
	JKL	IJT	PT	ST	2,68	0,59	2,42	1,01	2,33	1,09	4,91	2,57	0,46	2,33	0,76	2,17	0,84	1,70
				SL	2,35	0,39	2,11	0,80	3,21	0,84	2,26	2,97	0,51	2,59	0,90	2,99	0,96	2,27
			PL	ST	2,82	0,52	2,61	0,96	3,58	1,10	4,32	2,58	0,49	2,36	0,83	3,57	1,08	2,72
				SL	3,09	0,57	2,63	1,02	3,35	1,21	1,71	2,75	0,57	2,52	1,00	2,64	1,20	3,36
		IJL	PT	ST	2,26	0,53	1,87	0,86	3,18	1,23	4,68	2,02	0,53	1,97	0,87	2,52	1,05	2,60
				SL	2,53	0,61	2,28	1,12	4,18	1,53	2,39	2,43	0,62	2,17	1,08	3,21	1,29	2,36
			PL	ST	1,68	0,53	1,25	0,86	2,84	1,05	2,00	2,21	0,67	1,97	1,09	2,31	1,19	1,58
				SL	3,56	0,82	3,44	1,49	3,15	1,47	1,26	2,59	0,66	2,19	1,13	2,95	1,24	1,10
PH	JKT	IJT	PT	ST	1,00	0,81	1,06	1,44	1,23	1,38	281,81	0,81	0,87	1,05	1,58	1,21	1,51	300,53
				SL	1,32	0,67	1,18	1,19	1,52	1,31	251,01	1,09	0,66	0,99	1,17	1,07	1,18	189,38
			PL	ST	2,10	0,55	1,81	1,02	2,25	1,06	3,36	1,77	0,53	1,70	1,00	2,93	1,12	4,86
				SL	1,92	0,56	1,74	1,00	2,27	1,27	11,47	1,95	0,56	1,56	1,02	2,55	1,13	4,85
		IJL	PT	ST	2,36	0,50	1,93	0,82	2,95	0,89	3,01	2,15	0,47	1,69	0,76	2,18	0,79	3,26
				SL	1,82	0,49	1,43	0,72	1,17	0,75	4,14	2,30	0,54	2,00	0,90	1,95	0,83	2,47
			PL	ST	2,58	0,52	2,50	1,00	3,07	1,05	3,86	2,30	0,58	1,92	0,86	2,45	0,92	2,48
				SL	3,44	0,63	2,78	0,99	2,99	0,99	1,72	1,71	0,56	1,28	0,91	2,53	1,07	3,27
	JKL	IJT	PT	ST	2,71	0,52	2,09	0,86	3,25	0,97	3,37	2,98	0,50	2,57	0,82	3,13	0,92	1,87
				SL	3,28	0,57	2,52	0,93	185,58	1,02	4,03	2,16	0,50	2,01	0,83	1,61	0,72	5,14
			PL	ST	2,92	0,51	2,54	0,90	3,78	1,06	3,83	2,38	0,53	2,51	0,98	3,15	1,04	4,80
				SL	2,50	0,57	2,67	1,02	2,83	1,01	4,71	2,83	0,57	2,40	0,99	3,80	1,12	3,28
		IJL	PT	ST	2,70	0,60	2,45	1,03	2,99	1,10	2,74	2,34	0,59	2,41	1,04	2,57	0,98	1,56
				SL	2,13	0,53	1,86	0,91	3,65	1,06	3,03	1,76	0,53	1,45	0,98	3,04	1,18	3,45
			PL	ST	3,21	0,69	2,40	1,17	2,07	1,08	1,30	2,41	0,60	2,04	1,04	3,43	1,25	1,11
				SL	2,72	0,69	2,47	1,23	2,97	1,22	1,51	1,96	0,67	1,57	1,18	2,39	1,19	1,50

Table 7

FKH-FIL-FPH-FSL

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**Solution**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,19	0,87	1,02	1,47	0,94	1,46	300,68	0,85	0,90	0,93	1,51	0,78	1,48	301,69
				SL	0,88	0,67	0,81	1,08	0,72	1,01	187,11	1,20	0,63	1,12	1,14	0,89	1,18	142,84
			PL	ST	2,14	0,53	1,50	0,95	2,29	1,02	9,22	1,20	0,51	1,32	0,96	2,44	1,04	3,07
				SL	2,24	0,56	1,77	0,97	2,58	1,06	10,37	2,30	0,57	1,88	1,07	1,78	1,03	16,89
		IJL	PT	ST	2,17	0,56	2,44	0,95	3,15	1,00	5,09	2,72	0,56	2,66	0,90	2,41	0,88	1,87
				SL	3,48	0,66	2,93	1,03	3,46	1,02	4,65	2,18	0,60	1,76	0,98	3,29	1,14	1,13
			PL	ST	2,95	0,53	2,61	0,83	3,25	0,90	3,63	3,37	0,53	2,81	0,87	3,24	0,93	3,84
				SL	2,27	0,51	2,28	0,83	1,85	0,80	2,94	3,24	0,61	2,72	0,90	3,11	0,92	1,94
	JKL	IJT	PT	ST	3,53	0,61	3,07	1,09	3,42	1,08	2,41	2,04	0,43	2,11	0,73	2,36	0,74	2,13
				SL	1,75	0,44	1,33	0,61	3,23	0,87	1,74	2,83	0,48	2,46	0,79	3,28	0,91	1,71
			PL	ST	2,58	0,52	2,50	0,99	2,97	0,92	1,41	2,06	0,48	1,81	0,88	3,21	0,93	1,25
				SL	3,30	0,59	2,64	0,95	3,07	0,97	1,63	3,27	0,62	3,06	1,10	4,13	1,21	1,75
		IJL	PT	ST	2,10	0,54	1,77	0,89	3,06	1,07	3,34	2,20	0,57	1,85	0,98	3,39	1,18	0,99
				SL	2,01	0,55	1,81	0,92	3,00	1,10	2,97	2,94	0,70	2,60	1,27	3,05	1,20	1,56
			PL	ST	2,10	0,64	1,64	0,99	2,56	1,13	1,36	3,14	0,72	2,68	1,22	3,92	1,33	2,38
				SL	2,96	0,67	2,50	1,13	3,27	1,20	1,22	2,33	0,71	2,45	1,37	2,91	1,34	2,28
PH	JKT	IJT	PT	ST	1,03	0,88	1,16	1,59	1,38	1,56	300,32	1,06	0,92	0,93	1,68	1,17	1,61	300,50
				SL	1,07	0,61	0,85	1,13	1,11	1,16	189,63	1,23	0,62	0,79	1,12	1,55	1,13	158,46
			PL	ST	1,73	0,51	1,88	1,01	2,36	0,99	1,63	1,91	0,52	1,19	0,93	2,91	1,08	2,26
				SL	2,24	0,55	1,79	1,03	2,88	1,15	6,00	1,56	0,53	1,44	1,01	2,44	1,09	1,70
		IJL	PT	ST	2,36	0,48	2,21	0,83	2,64	0,84	4,69	2,41	0,48	2,23	0,81	3,38	0,95	3,88
				SL	3,22	0,51	2,84	0,85	3,71	0,92	3,78	2,39	0,55	2,11	0,91	2,85	0,98	5,35
			PL	ST	1,61	0,52	1,61	0,82	3,76	1,01	5,98	3,75	0,64	3,01	1,05	3,65	1,05	4,28
				SL	2,29	0,59	1,82	0,94	3,17	1,11	6,78	2,14	0,57	1,65	0,87	3,05	1,02	3,57
	JKL	IJT	PT	ST	1,97	0,48	1,85	0,89	2,78	1,00	9,92	3,96	0,51	3,65	0,95	4,28	1,02	4,02
				SL	3,08	0,56	2,33	0,86	3,04	1,01	4,44	2,76	0,50	2,59	1,01	3,41	0,91	3,78
			PL	ST	2,33	0,44	2,09	0,82	3,01	0,84	3,78	3,04	0,53	2,79	0,94	3,60	1,13	3,50
				SL	2,43	0,49	1,92	0,84	2,91	0,97	4,54	2,18	0,51	1,85	0,92	2,53	0,93	2,76
		IJL	PT	ST	2,40	0,52	2,01	0,94	3,34	1,08	2,79	1,99	0,53	1,78	0,85	3,01	1,01	3,37
				SL	2,70	0,60	2,45	1,03	2,99	1,10	2,74	2,43	0,67	2,29	1,24	2,43	1,25	2,21
			PL	ST	3,40	0,73	2,85	1,28	3,89	1,46	2,33	2,77	0,72	2,43	1,21	3,17	1,39	2,23
				SL	2,52	0,68	2,02	1,13	3,61	1,32	2,02	2,31	0,75	2,33	1,28	3,54	1,50	4,13

Table 8

FKH-FIL-FPH-FSH

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,76	0,81	0,88	1,49	0,79	1,52	300,04	0,98	0,88	1,00	1,68	0,78	1,61	301,03
				SL	0,88	0,59	0,55	1,11	0,77	1,15	245,00	0,82	0,63	0,78	1,12	0,80	1,06	142,91
			PL	ST	2,34	0,55	1,90	1,04	1,57	0,97	13,04	2,42	0,57	2,30	1,08	2,82	1,15	6,70
				SL	1,63	0,52	1,48	1,04	2,79	1,17	27,58	1,77	0,53	1,28	0,99	3,14	1,14	2,43
		IJL	PT	ST	2,09	0,52	1,70	0,81	2,74	0,89	5,58	1,86	0,47	1,64	0,83	2,61	0,90	7,22
				SL	1,47	0,47	0,91	0,78	2,50	0,93	4,03	1,93	0,50	1,89	0,82	2,58	0,93	4,26
			PL	ST	2,12	0,60	1,72	0,80	2,70	0,94	3,66	2,32	0,52	1,83	0,79	3,33	0,96	5,03
				SL	2,46	0,59	2,26	0,97	2,97	1,08	3,17	2,51	0,61	2,36	1,05	2,93	1,05	1,67
	JKL	IJT	PT	ST	3,05	0,51	2,72	0,99	2,93	1,05	2,83	2,46	0,47	2,16	0,83	2,74	0,87	2,74
				SL	2,06	0,41	1,57	0,82	2,76	0,84	3,32	2,86	0,51	2,55	0,91	3,04	0,89	1,88
			PL	ST	2,89	0,47	2,43	0,85	3,97	0,99	1,59	3,19	0,54	2,76	0,96	3,97	1,12	1,90
				SL	1,55	0,44	1,26	0,77	3,25	1,01	1,79	2,01	0,51	1,93	0,96	3,21	1,07	2,43
		IJL	PT	ST	3,09	0,58	2,68	1,05	2,73	1,07	2,10	2,83	0,60	2,45	1,04	2,96	1,13	3,20
				SL	2,91	0,61	2,60	1,10	3,80	1,25	1,54	2,26	0,60	2,36	1,11	2,99	1,18	1,70
			PL	ST	2,68	0,68	2,35	1,14	3,05	1,20	2,61	3,08	0,69	2,54	1,30	3,44	1,41	2,16
				SL	3,50	0,77	3,13	1,34	2,92	1,37	2,55	1,94	0,58	1,41	0,98	3,05	1,22	2,80
PH	JKT	IJT	PT	ST	1,54	0,86	1,30	1,55	0,96	1,49	300,36	1,07	0,85	0,96	1,50	1,19	1,52	301,14
				SL	1,34	0,62	1,18	1,15	1,33	1,16	247,42	1,23	0,63	0,98	1,10	1,28	1,07	98,36
			PL	ST	1,92	0,52	1,73	0,92	2,31	1,02	6,05	2,88	0,57	2,37	1,05	2,72	1,09	10,58
				SL	2,21	0,56	1,80	0,99	3,05	1,16	13,50	1,78	0,54	1,75	1,01	2,29	1,09	4,38
		IJL	PT	ST	3,28	0,51	2,69	0,83	3,53	0,93	5,42	3,57	0,52	2,76	0,83	4,01	0,95	4,46
				SL	2,11	0,49	2,01	0,81	3,22	0,92	2,56	2,72	0,52	2,30	0,85	2,66	0,95	2,36
			PL	ST	1,68	0,53	1,86	0,88	2,76	0,99	2,87	3,77	0,62	3,39	1,06	2,75	0,92	2,31
				SL	2,55	0,59	2,15	0,95	3,25	1,05	3,88	2,81	0,62	2,37	1,01	3,09	1,15	3,03
	JKL	IJT	PT	ST	2,38	0,47	1,99	0,85	3,75	1,00	2,58	2,06	0,42	1,55	0,71	2,06	0,74	3,02
				SL	2,69	0,47	2,31	0,85	3,46	1,14	3,26	2,44	0,45	2,38	0,87	3,08	1,04	2,57
			PL	ST	2,45	0,49	2,10	0,93	3,25	1,12	3,43	1,85	0,47	1,56	0,84	3,21	0,99	2,51
				SL	2,99	0,56	2,25	0,95	3,21	1,19	2,74	2,18	0,51	1,85	0,92	2,53	0,93	2,76
		IJL	PT	ST	2,17	0,52	1,81	0,89	2,43	0,95	3,59	2,41	0,58	2,17	1,04	3,37	1,21	2,50
				SL	2,08	0,60	1,86	1,05	2,67	1,15	3,61	2,47	0,60	1,83	1,03	2,63	1,15	2,75
			PL	ST	2,46	0,66	2,06	1,07	3,08	1,24	3,49	2,68	0,72	2,41	1,19	2,94	1,25	5,28
				SL	2,70	0,67	2,31	1,10	3,60	1,24	2,47	2,45	0,68	1,74	1,17	2,96	1,41	3,59

Table 9 **FKH-FIH-FPL-FSH**

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,19	0,87	1,12	1,51	1,06	1,55	300,27	1,33	0,86	1,05	1,53	1,03	1,70	254,95
				SL	0,98	0,60	0,69	1,08	1,58	1,33	195,57	1,14	0,64	0,90	1,13	1,69	1,33	128,03
			PL	ST	2,46	0,54	2,37	1,04	2,76	1,24	5,54	2,34	0,55	1,90	0,97	2,77	1,13	8,84
				SL	1,81	0,54	1,47	1,01	2,38	1,25	5,58	2,73	0,60	2,14	1,10	1,99	1,15	2,43
		IJL	PT	ST	2,14	0,47	1,93	0,78	2,69	0,96	1,55	2,31	0,50	1,97	0,83	2,56	0,96	2,36
				SL	4,20	0,51	1,45	0,77	2,73	0,98	2,70	1,93	0,51	1,55	0,80	2,45	0,99	5,80
			PL	ST	2,18	0,55	1,85	0,90	2,75	1,16	6,11	1,95	0,52	1,51	0,80	3,28	1,20	3,43
				SL	2,05	0,57	1,83	0,93	2,50	1,10	4,51	3,11	0,66	2,50	1,03	2,29	1,13	3,73
	JKL	IJT	PT	ST	2,58	0,41	2,17	0,71	3,02	0,85	2,06	2,14	0,43	1,95	0,79	2,38	0,91	5,48
				SL	1,93	0,40	1,78	0,79	3,08	0,90	2,83	2,67	0,48	2,27	0,78	3,15	1,01	2,67
			PL	ST	3,03	0,49	2,58	0,94	3,47	1,16	2,34	3,01	0,52	2,77	0,90	3,43	1,10	3,76
				SL	2,61	0,57	2,72	1,01	2,88	1,13	2,85	2,57	0,55	2,00	0,94	3,20	1,13	2,18
		IJL	PT	ST	2,28	0,52	2,28	1,07	2,83	1,21	2,43	1,95	0,55	1,76	0,85	3,21	1,25	2,07
				SL	1,69	0,58	1,30	0,93	2,62	1,14	1,79	2,63	0,63	2,18	1,06	2,93	1,21	1,47
			PL	ST	1,91	0,61	1,73	1,04	2,51	1,16	5,21	2,83	0,73	2,42	1,31	2,68	1,43	2,17
				SL	2,63	0,72	2,67	1,32	2,82	1,34	1,72	2,54	0,73	2,46	1,25	3,19	1,53	2,90
PH	JKT	IJT	PT	ST	1,54	0,86	1,30	1,55	0,96	1,49	300,36	0,97	0,83	0,85	1,53	0,68	1,57	300,20
				SL	1,15	0,60	1,04	1,14	0,99	1,05	181,89	1,00	0,63	0,98	1,17	0,73	1,20	162,33
			PL	ST	2,49	0,54	2,15	0,99	3,29	1,10	3,50	1,77	0,50	1,41	0,95	2,62	0,99	9,80
				SL	2,37	0,55	1,88	1,04	2,30	1,08	3,77	1,94	0,54	1,50	1,04	2,48	1,11	5,24
		IJL	PT	ST	3,28	0,54	2,89	0,86	2,50	0,82	2,31	2,41	0,52	2,10	0,83	2,25	0,84	2,11
				SL	9,39	0,51	1,96	0,84	2,54	0,88	3,98	2,60	0,50	2,18	0,90	2,47	0,90	3,38
			PL	ST	2,17	0,58	1,91	0,87	2,01	0,87	2,51	1,87	0,53	1,62	0,83	3,11	1,02	3,05
				SL	1,96	0,55	1,60	0,90	2,50	1,02	3,14	3,10	0,42	2,97	1,09	3,86	1,18	2,41
	JKL	IJT	PT	ST	2,48	0,47	2,10	0,79	2,81	0,87	2,83	2,15	0,43	1,66	0,81	2,28	0,74	3,18
				SL	2,77	0,51	2,32	0,81	2,26	0,93	5,95	1,84	0,44	1,53	0,79	2,97	0,85	3,56
			PL	ST	2,87	0,57	2,89	0,98	2,35	0,92	4,92	2,04	0,44	1,73	0,74	2,76	0,81	3,22
				SL	3,59	0,58	2,78	1,03	2,62	1,01	3,71	2,95	0,62	2,68	1,09	3,20	1,07	3,00
		IJL	PT	ST	2,10	0,53	1,82	0,88	2,09	0,86	3,02	1,95	0,53	1,48	0,82	3,38	1,07	5,19
				SL	2,08	0,60	1,86	1,05	2,67	1,15	3,61	3,54	0,71	2,97	1,29	3,03	1,29	1,39
			PL	ST	2,37	0,61	2,01	1,09	3,07	1,19	2,19	2,49	0,68	2,27	1,16	3,25	1,29	5,01
				SL	2,45	0,67	2,01	1,22	2,22	1,26	2,87	2,29	0,74	2,07	1,13	4,05	1,41	1,70

Table 10

FKL-FIH-FPH-FSH

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,09	0,84	1,31	1,48	1,32	1,50	279,67	1,15	0,85	1,11	1,58	0,81	1,47	300,73
				SL	1,05	0,63	1,07	1,17	0,78	1,02	132,44	1,05	0,62	0,87	1,12	0,76	1,12	251,37
			PL	ST	2,22	0,53	1,78	0,97	2,55	1,07	10,96	1,80	0,53	1,46	0,96	2,84	1,12	8,62
				SL	1,99	0,56	1,63	1,04	2,57	1,09	5,98	1,85	0,56	1,64	1,05	2,35	1,12	31,81
		IJL	PT	ST	2,11	0,49	1,81	0,80	3,31	0,96	4,55	3,21	0,53	2,84	0,83	3,42	0,93	5,11
				SL	2,29	0,49	1,90	0,80	3,13	0,94	5,83	3,44	0,56	2,92	0,92	3,68	0,95	2,69
			PL	ST	2,15	0,48	1,82	0,90	2,76	1,00	2,62	2,34	0,58	2,09	0,97	3,29	1,05	4,58
				SL	2,20	0,57	1,66	0,96	2,69	0,96	2,08	2,22	0,58	1,75	0,96	3,30	1,12	3,74
	JKL	IJT	PT	ST	2,98	0,61	2,65	1,09	3,23	1,19	1,28	3,73	0,52	3,12	0,95	3,57	0,96	1,99
				SL	3,18	0,49	2,70	0,80	4,01	0,91	2,43	2,29	0,47	1,88	0,87	3,39	0,98	2,53
			PL	ST	2,35	0,39	2,12	0,85	3,54	0,93	2,10	2,28	0,52	2,23	0,91	2,67	0,93	1,89
				SL	2,94	0,56	2,41	1,03	2,99	1,06	2,36	2,76	0,55	2,57	0,96	3,94	1,09	2,01
		IJL	PT	ST	2,08	0,52	1,78	0,84	2,64	0,89	1,61	2,69	0,60	2,57	1,10	3,31	1,19	3,18
				SL	3,05	0,62	2,40	1,07	3,68	1,26	2,17	2,57	0,65	2,32	1,15	3,57	1,36	2,62
			PL	ST	2,43	0,59	2,00	1,00	1,77	0,96	1,85	2,47	0,64	2,14	1,10	2,99	1,17	1,73
				SL	2,74	0,70	2,43	1,14	3,32	1,36	2,12	2,63	0,75	2,40	1,28	2,93	1,37	2,27
PH	JKT	IJT	PT	ST	1,04	0,84	1,25	1,90	1,46	1,53	300,03	1,06	0,85	1,00	1,52	0,82	1,47	300,31
				SL	1,11	0,62	0,89	1,12	1,40	1,09	231,27	1,18	0,64	0,91	1,10	0,83	1,06	222,65
			PL	ST	2,18	0,53	1,86	0,96	3,01	1,07	15,43	1,38	0,50	1,13	0,88	2,76	1,03	15,28
				SL	1,78	0,53	1,40	0,93	2,94	1,09	24,63	2,20	0,57	1,76	1,02	2,29	1,08	5,68
		IJL	PT	ST	2,50	0,48	2,21	0,80	3,72	0,91	3,83	2,95	0,52	2,58	0,81	3,46	0,89	6,50
				SL	1,56	0,48	1,34	0,73	2,76	0,88	3,70	2,44	0,51	2,15	0,82	3,21	0,96	3,30
			PL	ST	2,64	0,54	2,38	0,77	3,70	1,01	2,97	2,42	0,54	2,22	0,96	3,88	1,14	1,98
				SL	2,20	0,62	2,05	0,92	3,32	1,09	3,01	2,91	0,64	2,09	0,96	2,97	1,12	3,65
	JKL	IJT	PT	ST	2,62	0,57	2,06	0,99	2,45	1,04	6,44	2,13	0,40	1,93	0,73	2,88	0,79	4,99
				SL	3,00	0,52	3,00	0,85	4,20	1,06	1,85	2,54	0,40	2,07	0,71	2,95	0,75	2,45
			PL	ST	2,82	0,46	2,36	0,80	3,80	0,96	3,14	2,38	0,54	2,12	0,96	3,70	1,15	2,90
				SL	2,54	0,53	2,30	0,92	2,68	0,99	5,73	3,07	0,65	2,53	1,07	4,39	1,37	3,11
		IJL	PT	ST	2,32	0,55	2,15	0,91	2,93	1,02	1,94	2,47	0,56	1,99	0,98	3,26	1,11	2,98
				SL	3,09	0,61	2,72	1,06	4,21	1,20	2,49	1,96	0,57	1,56	0,99	2,62	1,11	4,13
			PL	ST	2,11	0,59	1,68	0,98	3,83	1,26	6,38	2,58	0,67	2,35	1,18	3,40	1,42	3,09
				SL	3,22	0,78	2,95	1,43	3,75	1,46	5,69	2,53	0,70	2,34	1,12	3,10	1,30	3,67

Table 11

FKL-FIL-FPH-FSH

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,85	2,30	0,91	3,15	1,29	2,04	302,71	0,72	0,87	0,92	1,61	1,30	1,69	300,49
				SL	0,85	0,60	0,86	1,13	0,68	1,12	151,90	0,95	0,62	0,80	1,11	0,73	1,09	178,50
			PL	ST	1,53	0,50	1,29	0,92	2,94	1,07	4,98	1,80	0,53	1,71	1,00	2,57	1,03	6,56
				SL	1,72	0,52	1,42	0,98	2,36	1,00	9,40	2,23	0,57	1,89	1,04	2,21	1,05	8,55
		IJL	PT	ST	2,19	0,53	2,05	0,92	2,79	0,94	3,77	2,04	0,48	1,83	0,80	2,96	0,92	6,58
				SL	2,22	0,51	2,09	0,83	3,53	0,95	4,89	1,85	0,48	1,48	0,76	2,99	0,92	2,19
			PL	ST	1,71	0,56	1,61	0,87	2,12	0,90	4,42	2,30	0,53	1,69	0,94	2,73	1,00	3,99
				SL	2,69	0,59	2,13	0,95	3,16	1,13	2,88	2,52	0,63	2,19	0,97	3,73	1,09	1,27
	JKL	IJT	PT	ST	3,46	0,60	3,28	1,09	4,43	1,25	4,53	3,32	0,52	3,36	0,92	4,15	1,01	1,61
				SL	2,69	0,48	2,24	0,87	3,31	0,95	1,85	1,69	0,39	1,37	0,82	2,91	0,84	2,90
			PL	ST	2,97	0,49	2,54	0,96	3,50	1,01	1,62	2,73	0,56	2,49	1,01	3,13	1,02	1,65
				SL	1,85	0,49	1,54	0,85	3,35	1,07	1,95	2,04	0,53	1,80	0,87	3,23	1,06	2,83
		IJL	PT	ST	2,43	0,54	1,90	0,89	3,74	1,20	2,18	2,04	0,52	2,49	1,01	3,97	1,14	1,49
				SL	2,59	0,57	2,01	0,97	3,43	1,12	1,92	2,26	0,61	1,86	1,10	2,13	1,10	1,62
			PL	ST	2,68	0,70	2,26	1,23	3,09	1,26	2,93	2,78	0,64	2,75	1,21	3,34	1,26	2,07
				SL	3,31	0,73	3,06	1,16	4,52	1,48	1,37	2,27	0,61	1,97	1,07	3,03	1,23	2,00
PH	JKT	IJT	PT	ST	0,77	1,82	0,92	1,88	0,65	1,95	301,85	0,91	0,81	0,88	1,51	1,31	1,50	300,34
				SL	1,11	0,62	0,89	1,12	1,40	1,09	231,27	1,24	0,60	0,97	1,12	1,32	1,14	155,48
			PL	ST	2,29	0,53	1,84	0,95	2,50	0,99	10,44	2,52	0,54	2,00	0,97	2,26	1,00	11,77
				SL	1,89	0,52	1,67	0,96	2,66	1,04	8,20	1,91	0,53	1,62	1,00	2,12	1,02	40,64
		IJL	PT	ST	3,01	0,55	2,68	0,89	3,02	0,91	3,25	2,65	0,49	2,48	0,83	2,99	0,86	4,32
				SL	2,30	0,52	1,97	0,82	3,40	0,94	3,93	3,06	0,57	3,13	0,90	4,11	1,03	2,05
			PL	ST	2,48	0,54	2,02	0,87	3,35	1,03	4,52	2,77	0,58	2,42	0,83	3,06	1,01	3,06
				SL	2,19	0,60	2,01	0,89	2,83	1,00	2,93	1,85	0,52	1,72	0,81	3,81	1,08	2,65
	JKL	IJT	PT	ST	3,24	0,58	2,86	1,03	3,55	1,13	2,62	2,79	0,43	2,47	0,82	3,20	0,90	2,68
				SL	2,56	0,51	2,15	0,93	3,45	0,98	2,33	2,26	0,51	1,89	0,76	3,90	1,02	3,59
			PL	ST	2,70	0,50	2,39	0,80	3,09	0,86	6,50	3,28	0,55	3,21	1,02	3,64	1,07	2,44
				SL	3,35	0,57	2,89	1,02	2,94	1,06	5,73	1,85	0,52	1,63	0,80	3,23	1,02	2,02
		IJL	PT	ST	1,98	0,51	1,62	0,84	3,43	1,05	3,12	2,45	0,55	1,99	0,91	3,40	1,12	5,34
				SL	1,99	0,59	1,94	1,10	3,21	1,24	4,52	2,01	0,58	1,46	0,91	3,07	1,14	3,92
			PL	ST	3,63	0,74	3,19	1,28	3,79	1,35	2,99	2,54	0,65	2,19	1,14	3,13	1,30	3,23
				SL	2,12	0,61	1,79	1,07	2,90	1,20	3,60	2,72	0,71	2,49	1,24	3,87	1,41	6,22

Table 12

FKL-FIH-FPL-FSH

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,35	0,88	1,24	1,52	1,41	1,64	300,01	1,02	0,86	1,04	1,52	0,94	1,74	261,07
				SL	1,22	0,62	0,93	1,13	1,68	1,35	246,31	1,09	0,64	0,79	1,18	0,77	1,29	249,62
			PL	ST	1,89	0,52	1,67	1,00	2,91	1,28	8,53	1,55	0,53	1,01	0,93	1,82	1,19	62,22
				SL	2,60	0,59	2,64	1,09	3,86	1,38	4,79	1,85	0,56	1,83	1,05	2,24	1,21	3,88
		IJL	PT	ST	2,78	0,51	2,45	0,81	3,55	0,98	1,81	2,52	0,53	2,34	0,90	3,35	0,98	3,46
				SL	2,68	0,53	3,17	0,93	2,70	0,90	3,79	2,59	0,51	2,26	0,88	2,95	0,99	3,06
			PL	ST	2,95	0,53	2,64	0,94	1,85	0,93	3,08	2,58	0,62	2,27	0,98	3,29	1,23	5,04
				SL	2,81	0,55	2,49	0,96	3,10	1,10	4,81	2,73	0,62	2,28	0,97	2,85	1,21	5,07
	JKL	IJT	PT	ST	2,22	0,60	1,98	1,02	3,01	1,32	2,19	3,51	0,56	3,16	0,96	3,68	1,19	4,18
				SL	2,80	0,49	2,55	0,87	2,85	0,89	2,23	2,98	0,56	2,62	1,02	3,18	0,98	4,63
			PL	ST	2,12	0,42	1,82	0,75	3,55	1,02	2,38	3,26	0,56	2,87	0,96	2,54	0,98	3,35
				SL	2,36	0,55	2,07	0,96	3,14	1,16	2,71	2,04	0,53	1,57	0,91	2,36	1,07	3,57
		IJL	PT	ST	2,09	0,52	1,57	0,83	1,77	0,94	2,39	2,87	0,56	2,44	0,92	2,90	1,13	3,54
				SL	1,88	0,55	1,41	0,94	2,91	1,28	2,09	2,99	0,70	2,99	1,21	4,44	1,49	1,56
			PL	ST	2,26	0,62	1,93	1,10	3,25	1,49	1,72	2,16	0,68	1,92	1,21	3,06	1,35	1,72
				SL	1,62	0,61	2,09	1,13	2,69	1,35	1,16	2,56	0,69	2,13	1,16	3,24	1,44	1,90
PH	JKT	IJT	PT	ST	1,03	0,82	1,08	1,49	1,26	1,54	300,05	0,87	0,86	0,96	1,49	0,84	1,51	300,09
				SL	0,99	0,60	0,88	1,07	0,50	1,04	228,18	1,06	0,66	0,86	1,20	0,92	1,15	171,04
			PL	ST	1,84	0,52	1,48	0,96	1,48	0,95	11,54	1,81	0,53	1,45	0,93	2,98	1,07	19,92
				SL	2,47	0,56	2,06	1,03	1,74	0,99	5,02	2,27	0,57	2,13	1,05	3,64	1,22	37,49
		IJL	PT	ST	2,55	0,51	2,26	0,82	2,52	0,85	3,81	3,49	0,53	3,02	0,90	3,12	0,86	2,64
				SL	2,86	0,53	2,31	0,85	2,77	0,89	2,65	2,73	0,55	2,21	0,87	2,48	0,84	2,07
			PL	ST	2,18	0,62	1,70	0,91	3,58	1,19	2,25	2,33	0,58	2,10	0,88	1,39	0,78	2,07
				SL	2,96	0,56	2,56	0,98	3,08	1,03	2,08	2,81	0,63	2,37	1,02	1,52	0,93	3,75
	JKL	IJT	PT	ST	3,24	0,64	2,72	1,09	3,01	1,06	3,52	2,21	0,42	1,74	0,71	2,70	0,76	2,48
				SL	3,14	0,48	2,85	0,83	2,62	0,78	4,36	2,43	0,39	1,91	0,81	2,82	0,76	5,75
			PL	ST	2,43	0,46	2,10	0,78	2,02	0,74	4,13	2,51	0,49	2,20	0,82	2,09	0,80	4,59
				SL	2,09	0,49	1,68	0,83	2,50	0,88	4,57	2,77	0,53	2,27	0,95	3,37	1,05	4,10
		IJL	PT	ST	3,20	0,61	3,07	1,06	4,02	1,06	3,99	1,85	0,54	2,15	1,04	3,22	1,11	2,55
				SL	1,12	0,48	0,90	0,76	1,65	0,78	2,83	2,92	0,67	2,46	1,17	2,91	1,16	6,15
			PL	ST	3,63	0,74	3,19	1,28	3,79	1,35	2,99	3,66	0,63	3,67	1,07	3,52	0,99	3,31
				SL	2,22	0,66	1,58	1,16	2,39	1,20	1,66	2,62	0,70	2,36	1,18	3,09	1,37	1,28

Table 13

Capacity					FKL-FIH-FPH-FSL													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	1,32	0,90	1,25	1,51	1,06	1,52	256,82	1,19	0,84	1,16	1,51	1,62	1,59	300,27
				SL	1,11	0,62	1,05	1,13	0,96	1,15	214,38	0,92	0,64	0,75	1,11	1,52	1,27	177,92
			PL	ST	2,36	0,54	2,06	0,97	2,70	1,02	9,34	2,04	0,52	1,64	0,94	3,28	1,11	15,20
				SL	1,89	0,55	1,33	0,96	2,40	1,08	7,29	1,72	0,55	1,38	0,99	2,45	1,11	12,95
		IJL	PT	ST	1,84	0,47	1,89	0,80	2,61	0,87	5,87	2,63	0,52	2,20	0,86	2,94	0,90	4,13
				SL	2,40	0,53	2,25	0,83	3,37	0,94	5,47	2,80	0,58	2,52	0,86	3,59	0,96	2,13
			PL	ST	2,41	0,54	2,03	0,87	2,60	0,94	2,54	2,19	0,55	1,62	0,89	3,30	1,18	3,61
				SL	1,52	0,52	1,29	0,89	1,72	0,88	4,90	2,48	0,62	2,10	0,95	2,29	0,95	2,48
	JKL	IJT	PT	ST	2,58	0,56	2,13	0,87	3,45	0,98	2,08	1,54	0,38	1,22	0,63	2,75	0,83	1,08
				SL	2,08	0,43	1,69	0,79	3,57	0,97	1,74	2,34	0,50	1,70	0,68	2,06	0,68	2,06
			PL	ST	3,27	0,58	2,87	0,95	3,46	0,99	1,46	2,02	0,47	1,76	0,78	2,90	0,92	1,26
				SL	3,51	0,63	3,18	1,04	3,64	1,05	1,57	2,43	0,53	2,00	0,91	3,34	1,08	3,31
		IJL	PT	ST	2,99	0,63	2,89	1,13	4,21	1,27	1,43	1,91	0,51	1,68	0,84	3,43	1,01	1,52
				SL	1,98	0,59	1,78	0,96	2,38	1,01	1,73	2,76	0,60	2,23	1,08	2,75	1,10	2,15
			PL	ST	1,88	0,60	1,54	0,99	2,71	1,10	1,85	2,55	0,62	2,32	1,18	3,65	1,38	1,67
				SL	2,94	0,70	2,66	1,23	3,52	1,40	3,02	2,80	0,76	2,32	1,24	2,88	1,24	1,65
PH	JKT	IJT	PT	ST	1,05	0,97	1,14	1,53	1,44	1,43	250,30	1,02	0,90	1,09	1,50	1,20	1,58	301,13
				SL	1,07	0,59	0,83	1,12	1,41	1,18	216,94	1,43	0,61	1,04	1,16	0,72	1,14	232,76
			PL	ST	1,71	0,51	1,37	0,97	2,18	1,01	55,72	2,48	0,54	2,29	1,06	3,57	1,12	4,24
				SL	2,16	0,54	2,03	1,07	2,82	1,08	3,53	1,83	0,56	1,29	0,98	2,59	1,10	1,78
		IJL	PT	ST	2,36	0,50	1,95	0,79	2,60	0,86	5,42	1,65	0,48	1,33	0,77	2,75	0,91	4,30
				SL	2,66	0,53	2,33	0,86	3,18	0,91	3,28	3,08	0,54	2,85	0,88	3,52	0,97	5,58
			PL	ST	2,80	0,52	2,36	0,92	3,12	0,97	4,39	1,75	0,55	1,37	0,85	2,70	0,98	3,64
				SL	1,94	0,57	1,87	0,95	3,09	1,07	5,84	1,96	0,56	1,75	0,90	3,14	1,03	4,04
	JKL	IJT	PT	ST	2,21	0,54	1,85	0,96	2,75	1,07	5,65	2,93	0,49	2,36	0,86	4,22	1,03	3,25
				SL	2,86	0,53	2,26	0,87	3,23	0,96	3,82	2,55	0,50	2,28	0,88	3,02	0,90	4,70
			PL	ST	2,56	0,48	2,11	0,82	2,84	0,86	3,77	2,14	0,48	1,75	0,85	3,30	1,01	6,77
				SL	2,00	0,49	1,76	0,86	2,56	0,94	3,39	2,66	0,54	2,52	0,96	3,40	1,04	4,10
		IJL	PT	ST	1,63	0,52	1,42	0,90	2,57	1,05	7,54	2,17	0,61	1,85	1,02	3,00	1,11	3,19
				SL	2,55	0,62	2,30	1,17	2,96	1,18	1,24	3,69	0,71	3,20	1,28	3,57	1,32	2,19
			PL	ST	1,89	0,62	1,64	1,02	3,26	1,24	1,53	2,45	0,63	2,19	1,11	3,29	1,23	1,26
				SL	2,41	0,74	1,94	1,22	3,22	1,37	1,68	2,24	0,63	1,86	1,13	2,31	1,18	4,27

FKH-FIH-FPL-FSL

Table 14					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,23	0,86	1,11	1,52	1,21	1,80	297,04	0,76	0,87	0,80	1,51	0,38	1,63	300,62
				SL	0,86	0,64	0,63	1,09	0,64	1,30	242,82	1,37	0,64	1,05	1,15	0,96	1,30	162,76
			PL	ST	1,78	0,53	1,40	0,97	2,69	1,23	10,89	1,17	0,50	0,74	0,90	2,44	1,20	5,83
				SL	1,59	0,54	1,19	0,98	1,92	1,27	11,43	2,21	0,53	1,91	1,07	1,75	1,18	5,12
		IJL	PT	ST	2,34	0,52	2,05	0,85	1,94	0,91	7,11	2,46	0,53	2,23	0,86	2,89	1,10	7,39
				SL	2,08	0,52	1,99	0,82	3,41	1,11	5,41	2,09	0,51	1,86	0,86	2,70	1,05	8,68
			PL	ST	2,87	0,56	2,89	0,99	2,64	1,05	5,79	1,99	0,54	1,62	0,91	1,99	0,94	6,38
				SL	2,76	0,63	2,47	1,01	3,12	1,13	5,37	1,94	0,58	2,04	0,97	3,40	1,27	5,45
	JKL	IJT	PT	ST	2,34	0,45	2,08	0,82	2,47	0,93	2,69	2,42	0,45	2,02	0,75	3,36	1,06	3,01
				SL	2,35	0,46	1,87	0,80	2,51	0,94	1,88	2,34	0,47	2,61	0,83	3,08	1,07	1,81
			PL	ST	2,48	0,51	2,33	0,98	2,56	1,06	2,15	2,86	0,52	2,39	0,91	2,99	1,08	1,58
				SL	2,77	0,57	2,39	0,99	1,75	1,02	2,93	2,18	0,52	2,05	0,89	1,52	0,88	1,48
		IJL	PT	ST	2,89	0,57	2,54	1,06	2,50	1,13	1,41	0,94	0,49	0,59	0,80	1,74	1,02	1,77
				SL	2,28	0,60	1,88	1,09	2,13	1,19	2,59	3,01	0,64	2,75	1,09	3,15	1,38	1,33
			PL	ST	3,03	0,74	2,84	1,32	3,03	1,50	3,32	1,73	0,63	1,67	1,13	1,78	1,33	3,75
				SL	2,68	0,68	2,30	1,21	2,82	1,42	1,92	2,78	0,71	2,55	1,28	2,74	1,49	0,84
PH	JKT	IJT	PT	ST	0,96	0,84	0,87	1,49	0,84	1,73	300,36	1,09	0,87	1,00	1,49	0,98	1,94	300,95
				SL	0,86	0,64	0,54	1,11	0,97	1,32	244,48	1,23	0,65	0,98	1,14	0,75	1,35	114,83
			PL	ST	1,68	0,54	1,38	0,97	2,13	1,19	4,90	1,71	0,53	1,34	0,94	1,36	1,15	9,88
				SL	2,29	0,56	1,92	1,01	1,60	1,15	11,23	2,06	0,58	1,98	1,07	2,12	1,34	9,15
		IJL	PT	ST	2,46	0,51	1,91	0,82	2,53	1,09	4,08	2,36	0,51	2,68	0,87	3,76	1,25	6,22
				SL	2,72	0,54	2,41	0,93	2,63	1,08	7,67	2,38	0,53	1,84	0,83	2,49	1,10	5,52
			PL	ST	1,99	0,56	1,79	0,91	2,20	1,04	4,40	3,34	0,66	2,99	0,99	4,09	1,28	4,56
				SL	2,85	0,61	2,38	1,00	1,79	1,12	4,18	2,17	0,63	1,86	0,95	2,89	1,30	6,49
	JKL	IJT	PT	ST	2,96	0,50	2,59	0,86	3,83	1,22	3,89	2,50	0,46	2,08	0,77	2,99	1,07	2,80
				SL	2,14	0,41	1,56	0,79	3,17	1,10	3,02	2,71	0,47	2,44	0,82	3,70	1,05	1,24
			PL	ST	2,56	0,51	2,58	0,85	2,71	1,14	0,99	2,89	0,54	2,52	0,94	3,30	1,19	1,23
				SL	2,82	0,56	2,63	1,00	2,41	1,10	0,97	2,69	0,54	2,25	0,93	3,16	1,30	0,77
		IJL	PT	ST	2,05	0,56	1,56	0,97	1,48	1,08	3,21	2,82	0,65	2,45	1,09	2,95	1,35	1,49
				SL	2,54	0,60	2,29	0,98	2,52	1,23	2,03	3,69	0,71	3,20	1,28	3,57	1,32	2,19
			PL	ST	2,50	0,60	2,26	1,06	2,17	1,22	0,78	2,92	0,68	2,56	1,19	2,91	1,43	1,26
				SL	2,06	0,68	1,75	1,10	2,70	1,42	0,75	2,24	0,68	1,72	1,12	2,95	1,46	2,51

Table 15

Capacity					FKH-FIH-FPH-FSL													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					%E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	1,41	0,83	1,48	1,47	1,31	1,47	280,23	1,09	0,90	1,04	1,51	1,08	1,64	245,46
				SL	0,98	0,62	0,79	1,11	0,95	1,18	236,29	1,40	0,69	0,96	1,20	0,68	1,21	251,13
			PL	ST	1,99	0,54	2,04	1,00	1,41	0,92	28,35	2,58	0,57	2,40	1,06	2,97	1,07	28,35
				SL	1,74	0,53	1,43	0,91	3,43	1,11	7,12	1,63	0,53	1,29	1,00	2,15	1,05	4,09
		IJL	PT	ST	2,41	0,48	1,98	0,74	3,25	0,86	2,82	2,30	0,49	1,85	0,77	2,57	0,90	2,29
				SL	1,88	0,55	1,32	0,72	2,49	0,93	3,52	2,33	0,55	1,92	0,84	3,20	0,95	3,09
			PL	ST	2,46	0,49	2,22	0,92	3,27	1,03	2,01	3,28	0,59	2,81	0,97	4,27	1,13	3,52
				SL	2,71	0,60	2,28	0,93	3,21	1,04	2,25	4,84	0,59	4,32	0,93	4,54	0,97	2,25
	JKL	IJT	PT	ST	2,17	0,42	1,88	0,70	2,36	0,75	0,90	2,43	0,48	2,55	0,91	3,99	1,09	2,31
				SL	1,91	0,44	1,65	0,66	2,87	0,89	1,77	2,24	0,46	2,10	0,85	2,35	0,79	0,88
			PL	ST	2,30	0,48	1,84	0,79	3,01	0,90	0,90	1,89	0,48	1,76	0,82	2,40	0,84	1,24
				SL	1,97	0,52	1,68	0,83	2,36	0,92	1,28	2,36	0,53	1,77	0,91	2,44	0,87	4,09
		IJL	PT	ST	2,34	0,57	1,99	1,01	2,35	1,06	2,55	2,48	0,58	2,12	0,97	3,16	1,09	2,14
				SL	2,80	0,59	2,36	1,03	3,60	1,15	0,96	2,91	0,70	2,46	1,15	2,60	1,20	1,66
			PL	ST	2,84	0,69	2,61	1,10	4,07	1,26	1,82	1,63	0,58	1,28	0,93	2,50	1,10	1,85
				SL	1,97	0,64	1,63	1,10	3,02	1,22	1,51	2,78	0,69	2,23	1,15	3,64	1,35	1,34
PH	JKT	IJT	PT	ST	1,04	0,85	1,14	1,49	1,01	1,42	300,13	1,06	0,86	1,29	1,65	1,04	1,54	268,68
				SL	1,10	0,61	1,01	1,15	1,16	1,19	161,50	1,06	0,63	0,97	1,11	1,35	1,13	81,12
			PL	ST	2,40	0,55	2,04	1,03	2,74	1,03	3,22	1,82	0,56	1,20	1,04	1,97	1,08	3,22
				SL	1,68	0,52	1,37	0,99	2,47	1,04	4,75	2,23	0,59	2,12	1,11	3,41	1,29	7,25
		IJL	PT	ST	2,34	0,49	2,19	0,83	3,07	0,92	3,81	2,79	0,51	2,63	0,85	3,36	0,90	6,79
				SL	2,92	0,55	3,10	0,99	3,99	1,00	3,89	2,87	0,55	2,53	0,86	3,25	0,90	2,46
			PL	ST	2,24	0,51	1,84	0,91	2,55	0,96	4,23	3,16	0,57	2,75	0,94	3,55	1,06	4,18
				SL	1,71	0,55	1,44	0,90	2,44	0,93	2,79	4,06	0,61	3,49	1,01	3,51	0,98	2,79
	JKL	IJT	PT	ST	2,66	0,43	2,39	0,78	2,81	0,81	3,24	2,57	0,45	2,45	0,83	3,31	0,91	3,87
				SL	2,99	0,47	2,41	0,80	3,27	0,86	2,97	2,69	0,54	2,45	0,89	4,11	0,96	3,34
			PL	ST	1,72	0,41	1,55	0,72	2,90	0,94	5,06	3,61	0,59	3,25	1,00	3,85	1,09	3,84
				SL	2,30	0,50	2,08	0,89	3,34	1,00	2,65	2,97	0,59	2,37	1,02	3,39	1,14	6,16
		IJL	PT	ST	2,27	0,56	1,94	0,95	2,45	1,02	2,47	2,05	0,57	1,75	0,94	3,22	1,11	2,57
				SL	2,88	0,65	2,53	1,20	3,81	1,35	2,00	2,67	0,65	2,35	1,16	2,97	1,23	1,62
			PL	ST	2,25	0,61	1,81	1,04	3,35	1,19	1,30	3,05	0,71	2,53	1,20	3,49	1,34	1,36
				SL	2,67	0,72	2,31	1,16	2,14	1,13	0,81	1,94	0,63	1,60	1,06	2,74	1,22	1,97

FKH-FIH-FPH-FSH

Table 16

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,23	0,86	1,46	1,61	1,51	1,63	285,44	0,84	0,82	0,88	1,53	0,86	1,62	300,39
				SL	0,82	0,62	0,68	1,07	0,46	1,01	260,10	1,03	0,67	0,89	1,21	1,43	1,26	209,50
			PL	ST	1,38	0,50	0,81	0,88	2,85	1,07	5,34	3,85	0,54	3,42	0,98	4,76	1,10	5,34
				SL	2,13	0,58	1,77	1,04	2,54	1,12	45,51	1,56	0,53	1,27	0,98	1,92	1,08	3,43
		IJL	PT	ST	2,22	0,50	1,83	0,81	2,91	0,94	6,17	2,78	0,52	2,63	0,88	3,46	0,97	8,41
				SL	1,78	0,49	1,47	0,81	2,63	0,93	4,55	1,84	0,48	1,81	0,78	3,45	1,02	2,99
			PL	ST	2,00	0,55	1,69	0,90	2,87	0,97	3,71	2,66	0,56	2,56	0,88	3,29	0,96	2,84
				SL	2,94	0,60	2,82	1,02	3,88	1,14	3,28	2,46	0,61	2,12	1,03	3,36	1,18	2,94
	JKL	IJT	PT	ST	1,96	0,42	1,78	0,75	2,96	0,88	1,66	1,96	0,42	1,78	0,75	2,96	0,88	1,66
				SL	2,78	0,49	2,53	0,92	3,63	0,98	1,62	2,43	0,48	1,85	0,82	2,83	0,90	2,01
			PL	ST	3,00	0,51	2,53	0,90	3,97	1,08	1,29	2,43	0,54	2,14	0,97	3,00	1,08	2,05
				SL	2,40	0,56	2,08	0,99	2,79	1,07	1,94	3,74	0,55	3,20	0,93	4,29	1,09	1,94
		IJL	PT	ST	2,10	0,52	1,87	0,91	3,00	1,10	1,63	2,24	0,54	1,82	0,91	3,42	1,11	2,56
				SL	2,54	0,61	2,35	1,13	3,65	1,20	1,46	3,28	0,72	3,05	1,23	3,92	1,32	1,46
			PL	ST	2,00	0,56	1,56	0,95	3,65	1,14	2,54	2,37	0,64	1,91	1,16	2,83	1,32	2,16
				SL	1,80	0,63	1,41	1,03	2,39	1,14	2,07	3,56	0,82	2,87	1,40	3,76	1,51	1,48
PH	JKT	IJT	PT	ST	0,93	0,86	0,82	1,38	0,98	1,46	300,10	0,85	0,88	0,76	1,60	0,94	1,57	300,33
				SL	0,90	0,57	0,47	1,00	0,60	1,02	144,98	1,30	0,67	1,07	1,21	0,79	1,23	300,10
			PL	ST	2,28	0,53	1,83	0,97	3,13	1,08	15,71	10,58	0,53	10,46	0,98	11,14	1,00	15,71
				SL	1,96	0,55	1,68	1,00	2,86	1,12	13,06	2,31	0,57	1,89	1,03	2,89	1,16	4,39
		IJL	PT	ST	2,07	0,49	1,71	0,78	1,98	0,82	2,49	3,68	0,57	3,27	0,99	4,17	1,04	1,92
				SL	3,02	0,53	2,92	0,99	3,16	1,02	2,63	2,64	0,55	2,28	0,99	3,87	1,12	2,08
			PL	ST	3,21	0,50	2,89	0,82	3,50	0,90	3,59	2,32	0,48	2,19	0,75	2,98	0,84	2,64
				SL	2,41	0,56	2,05	0,86	2,26	0,87	3,05	2,07	0,61	1,67	0,86	2,45	0,99	1,92
	JKL	IJT	PT	ST	2,41	0,42	1,87	0,72	3,52	0,88	2,47	2,57	0,45	2,45	0,83	3,31	0,91	3,87
				SL	2,20	0,43	2,30	0,77	2,85	0,78	2,49	1,56	0,43	1,14	0,71	3,08	0,97	2,93
			PL	ST	2,96	0,50	2,76	0,97	3,03	0,98	3,64	2,32	0,52	2,26	0,97	2,23	0,98	2,94
				SL	2,30	0,48	2,37	0,92	3,55	1,06	2,45	0,46	0,57	0,08	1,00	1,11	1,11	2,45
		IJL	PT	ST	2,27	0,56	1,94	0,95	2,45	1,02	2,47	2,32	0,57	1,91	1,00	3,31	1,22	1,84
				SL	2,06	0,59	1,80	1,01	2,29	1,08	2,97	6,53	0,64	6,27	1,10	7,07	1,24	2,97
			PL	ST	2,62	0,65	2,17	1,11	3,15	1,26	4,06	3,16	0,70	2,71	1,23	3,42	1,29	2,96
				SL	3,23	0,74	2,64	1,34	3,19	1,37	3,33	2,52	0,75	2,25	1,29	2,84	1,30	3,63

APPENDIX B

RESULTS FOR LARGE PROBLEMS

FKL-FIL-FPL-FSL

Table 1					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time[2]**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time[2]**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,98	11,02	1,47	15,57	1,90	13,13	171,83	0,92	11,29	1,06	15,11	1,01	13,90	153,94
				SL	0,43	7,63	0,60	13,60	0,72	14,03	155,27	0,62	12,42	0,74	15,24	0,70	14,87	171,83
			PL	ST	0,28	7,73	0,50	13,84	0,30	14,72	154,52	0,16	7,49	0,27	13,54	0,33	13,98	175,56
				SL	0,14	7,44	0,60	13,49	0,50	14,41	157,21	1,40	7,57	1,16	12,94	1,97	13,70	164,44
		IJL	PT	ST	0,02	7,60	0,02	13,22	0,24	12,39	187,83	0,41	7,21	0,55	13,11	0,39	13,20	170,88
				SL	0,36	7,64	0,47	13,56	0,37	13,90	150,83	0,56	7,78	0,61	13,73	0,32	14,10	154,39
			PL	ST	0,37	7,20	0,45	12,43	3,56	12,86	192,24	0,37	7,56	0,48	13,84	0,25	13,41	153,22
				SL	0,37	7,66	0,54	13,86	0,34	13,30	154,64	0,16	7,10	0,37	12,84	0,17	12,86	162,11
	JKL	IJT	PT	ST	0,31	7,53	0,46	13,77	0,51	14,22	160,88	0,37	7,52	0,51	13,88	0,23	12,95	151,65
				SL	0,33	7,10	0,45	12,58	0,38	12,46	150,20	0,41	7,36	0,53	13,23	0,67	13,07	150,98
			PL	ST	0,36	7,13	0,49	13,37	0,41	12,49	150,81	0,26	7,23	0,32	13,11	0,15	10,97	150,86
				SL	0,39	7,32	0,54	13,22	0,88	13,90	150,08	0,27	7,17	0,40	12,97	0,17	12,18	150,07
		IJL	PT	ST	0,48	6,85	0,52	12,57	0,24	11,32	150,05	0,39	6,76	0,55	11,75	0,26	10,15	150,71
				SL	0,46	6,72	0,51	11,91	0,26	10,98	150,06	0,50	7,17	0,61	12,53	0,17	11,72	150,07
			PL	ST	0,95	5,56	0,99	9,91	0,84	10,06	150,05	0,75	5,58	0,83	9,82	0,92	10,01	150,44
				SL	0,19	5,75	0,23	10,00	0,27	11,31	107,40	0,61	3,14	0,80	6,10	1,30	6,68	150,04
PH	JKT	IJT	PT	ST	1,67	8,76	2,12	15,52	3,02	15,92	150,70	1,27	9,00	1,34	15,03	1,30	14,30	150,70
				SL	1,15	8,01	1,23	14,63	1,44	14,87	151,15	1,21	8,65	1,27	15,09	1,46	14,99	151,15
			PL	ST	0,13	7,19	0,27	13,06	0,32	13,25	151,67	0,73	7,44	0,86	13,80	0,57	13,39	150,35
				SL	1,53	7,29	1,78	13,66	1,40	11,91	155,42	0,32	7,81	0,46	14,16	0,36	13,49	150,38
		IJL	PT	ST	0,29	7,63	0,41	13,90	0,45	13,59	165,14	0,75	7,36	0,92	13,62	0,81	13,27	247,45
				SL	0,36	7,44	0,46	13,51	0,45	13,88	199,48	0,34	8,04	0,43	14,53	0,51	14,32	172,21
			PL	ST	0,32	7,38	0,46	13,97	2,37	12,95	150,86	0,15	6,97	0,30	12,16	0,11	11,88	153,78
				SL	0,45	7,75	0,55	13,81	0,91	14,08	151,94	0,45	7,44	0,55	14,11	0,44	12,95	151,81
	JKL	IJT	PT	ST	0,33	7,26	0,52	12,91	0,40	12,65	154,26	0,44	7,10	0,52	13,04	0,22	11,97	151,56
				SL	0,33	7,22	0,47	13,33	0,54	13,68	150,84	0,42	7,08	0,51	12,97	0,58	13,39	150,28
			PL	ST	0,33	6,99	0,47	13,03	0,17	11,92	150,81	0,38	7,50	0,51	13,04	0,60	13,88	150,08
				SL	0,40	7,22	0,54	13,36	0,53	13,20	150,07	0,38	7,07	0,46	13,14	0,64	12,93	150,22
		IJL	PT	ST	0,36	6,97	0,47	12,92	-0,20	10,62	150,26	0,55	7,18	0,64	12,82	0,16	11,38	150,06
				SL	0,60	6,85	0,68	12,20	1,05	13,13	150,05	0,47	6,75	0,51	12,03	0,47	12,42	150,30
			PL	ST	0,63	4,91	0,90	9,55	1,35	10,39	150,03	0,80	5,42	1,07	9,85	1,38	10,21	150,04
				SL	0,20	5,93	0,23	10,27	0,28	10,75	107,61	0,70	2,85	1,05	5,73	1,79	6,39	150,03

[2] Some of the CPLEX solution times exceed the 150 seconds time limit imposed. The reason is that CPLEX is allowed to conclude its last iteration of the branch-and-cut and total computational time is reported

FKL-FIL-FPL-FSH

Table 2					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,29	8,73	1,36	15,55	1,08	13,22	154,77	1,29	8,65	1,36	14,89	1,21	14,40	154,77
				SL	1,28	7,58	1,42	14,06	1,70	14,56	154,77	1,29	8,71	1,47	15,30	1,34	14,66	154,77
			PL	ST	1,05	8,09	1,10	14,84	1,48	13,35	159,69	0,90	7,56	1,12	13,78	0,91	13,33	154,77
				SL	0,12	7,64	0,29	14,31	0,33	14,87	164,66	-0,03	7,37	0,20	13,58	0,12	13,79	163,31
		IJL	PT	ST	0,37	7,19	0,44	13,60	0,52	13,18	180,24	0,47	7,42	0,57	13,66	0,62	12,78	193,92
				SL	0,38	7,68	0,48	14,00	0,13	12,94	157,56	0,50	7,33	0,56	13,65	0,76	13,03	176,82
			PL	ST	0,44	7,24	0,55	13,33	0,23	11,60	162,31	0,42	7,25	0,58	13,63	0,59	13,32	162,95
				SL	0,33	7,52	0,35	14,17	0,28	13,15	156,35	0,36	7,01	0,42	12,58	0,43	12,85	167,49
	JKL	IJT	PT	ST	0,50	7,28	0,64	13,61	0,67	13,18	164,12	0,33	7,13	0,44	12,73	0,38	12,23	150,92
				SL	0,52	7,28	0,60	13,66	0,23	12,20	150,32	0,30	6,90	0,41	12,84	0,65	12,58	150,63
			PL	ST	0,32	6,96	0,45	12,80	0,25	12,08	150,09	0,37	7,22	0,45	13,62	0,41	13,37	150,09
				SL	0,38	7,00	0,48	13,11	0,49	13,63	150,09	0,56	7,39	0,62	14,15	0,58	14,18	150,09
		IJL	PT	ST	0,56	7,26	0,60	13,47	0,60	14,01	150,04	0,40	7,12	0,54	13,03	0,45	13,87	150,09
				SL	0,54	6,92	0,60	12,62	0,62	13,06	150,06	0,35	6,77	0,51	12,71	0,40	12,92	150,04
			PL	ST	0,50	5,03	0,67	8,98	1,08	9,67	150,03	0,73	5,11	0,86	9,41	0,96	9,55	150,03
				SL	0,77	6,35	0,76	10,59	0,71	10,55	150,97	0,50	5,03	0,67	8,98	1,08	9,67	150,03
PH	JKT	IJT	PT	ST	1,27	8,90	1,37	15,21	1,77	16,26	188,39	0,40	8,66	0,55	15,43	0,43	16,94	188,39
				SL	0,64	7,88	0,72	13,91	0,26	12,85	188,39	1,08	9,49	1,22	14,49	1,06	15,27	188,39
			PL	ST	0,73	7,76	0,87	14,16	0,85	14,32	188,39	1,75	7,21	2,00	14,20	1,84	13,59	188,39
				SL	0,48	7,77	0,54	13,58	0,48	13,75	167,22	0,84	7,96	0,99	14,88	0,99	15,33	188,39
		IJL	PT	ST	0,23	7,27	0,35	13,75	0,12	12,70	168,48	0,37	7,56	0,44	13,78	0,34	13,14	166,97
				SL	0,26	7,40	0,39	13,22	0,16	12,20	153,05	0,33	7,53	0,39	13,68	0,27	13,34	152,13
			PL	ST	0,42	7,50	0,58	13,91	0,46	12,42	171,79	0,27	7,32	0,41	13,04	0,38	12,98	185,89
				SL	0,43	7,71	0,51	14,10	0,86	13,78	150,91	0,48	7,49	0,56	13,54	0,12	11,96	165,40
	JKL	IJT	PT	ST	0,43	7,22	0,50	13,28	-0,11	11,13	159,96	0,45	7,69	0,61	13,89	0,59	14,01	150,91
				SL	0,45	7,15	0,55	13,49	1,20	13,81	150,11	0,29	7,38	0,43	13,79	0,15	12,48	150,48
			PL	ST	0,42	7,21	0,47	12,85	0,69	13,33	150,08	0,44	7,28	0,61	13,77	0,61	13,78	150,11
				SL	0,56	7,39	0,67	13,81	0,35	12,52	150,13	0,45	7,34	0,57	13,49	0,52	12,98	150,06
		IJL	PT	ST	0,26	6,76	0,38	12,26	0,25	11,33	150,06	0,46	7,20	0,57	13,00	0,54	13,08	150,08
				SL	0,40	6,75	0,65	12,21	0,55	11,80	150,07	0,49	7,17	0,59	13,28	0,70	12,48	150,07
			PL	ST	0,66	5,46	0,84	9,68	1,04	9,76	150,04	0,64	5,12	0,88	9,73	1,33	10,16	150,05
				SL	0,48	5,38	0,83	8,57	4,18	11,47	127,04	0,66	5,46	0,84	9,68	1,04	9,76	150,04

FKL-FIL-FPH-FSL

Table 3					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,93	8,55	0,99	14,50	1,15	15,75	159,77	1,13	8,71	1,21	15,65	1,00	16,35	164,73
				SL	0,73	7,29	0,75	13,67	0,48	12,05	157,09	0,92	8,88	1,05	15,30	0,80	17,57	179,09
			PL	ST	0,79	7,69	0,93	14,37	0,53	13,27	172,72	0,78	7,74	0,94	14,33	1,15	15,48	156,17
				SL	0,06	7,46	0,16	13,12	0,45	13,81	174,17	0,07	7,26	0,19	12,98	0,11	13,41	187,01
		IJL	PT	ST	0,70	7,82	0,75	14,12	0,66	14,42	166,06	0,22	7,37	0,30	13,39	0,30	13,64	200,96
				SL	0,79	7,53	0,87	13,22	0,73	13,72	199,97	0,85	7,46	0,97	13,60	0,79	14,08	159,20
			PL	ST	1,25	7,51	1,27	13,12	1,17	12,07	161,54	0,49	7,39	0,59	13,23	0,01	10,72	174,96
				SL	0,58	7,68	0,74	13,72	0,72	14,75	151,83	0,36	7,29	0,48	13,44	0,50	14,42	162,32
	JKL	IJT	PT	ST	0,82	7,31	0,88	13,30	0,95	14,13	157,83	0,78	7,44	0,83	13,59	0,52	12,35	151,96
				SL	0,34	7,03	0,44	12,66	0,34	12,92	150,18	1,52	7,21	1,56	13,14	1,86	13,71	150,58
			PL	ST	0,32	7,02	0,43	12,46	0,36	12,48	150,10	0,67	7,10	0,75	12,91	0,75	13,36	150,08
				SL	0,46	6,90	0,56	12,56	0,36	12,56	150,11	0,56	7,23	0,69	13,23	1,04	13,73	150,06
		IJL	PT	ST	0,48	7,08	0,56	12,78	0,54	12,66	150,09	0,91	7,20	0,98	13,05	1,02	13,50	150,10
				SL	0,14	7,00	0,27	12,86	0,28	13,25	150,05	0,65	6,98	1,02	12,90	1,10	13,25	150,06
			PL	ST	0,81	5,16	1,06	9,66	1,17	9,86	150,03	0,99	5,29	1,08	10,10	1,50	10,51	150,04
				SL	0,58	4,61	0,65	8,35	1,38	9,65	151,12	2,81	3,54	2,73	6,36	3,15	7,08	150,03
PH	JKT	IJT	PT	ST	0,65	8,78	0,76	15,40	0,65	16,76	165,74	0,42	9,11	0,53	16,24	0,14	15,53	174,02
				SL	0,75	7,69	0,90	13,80	0,89	13,97	161,29	0,66	9,44	0,74	14,89	0,46	15,09	197,95
			PL	ST	0,69	7,48	0,81	13,39	0,83	13,58	159,85	0,28	7,98	0,44	14,20	0,48	14,64	159,75
				SL	0,22	7,19	0,36	12,62	0,29	13,44	176,39	0,25	7,56	0,43	13,39	0,16	13,49	180,43
		IJL	PT	ST	0,32	7,49	0,43	13,72	0,54	14,29	152,66	0,55	7,63	0,69	14,60	0,58	14,41	186,88
				SL	0,11	7,59	0,12	13,64	-0,22	12,79	155,75	0,32	7,60	0,51	14,14	0,17	12,65	165,98
			PL	ST	0,43	7,55	0,52	13,24	0,56	13,28	171,49	0,48	7,46	0,57	13,21	0,28	12,31	188,38
				SL	0,31	7,54	0,36	13,35	0,19	13,06	170,50	0,42	7,52	0,41	13,07	0,52	13,87	169,87
	JKL	IJT	PT	ST	0,32	7,21	0,40	12,40	0,24	12,83	159,43	0,48	7,61	0,57	13,86	0,24	12,86	155,09
				SL	0,48	7,47	0,56	13,36	0,38	12,74	150,23	0,41	7,36	0,45	12,94	0,41	12,75	150,23
			PL	ST	0,34	7,49	0,59	13,88	0,32	13,21	150,07	0,33	7,24	0,39	12,97	0,09	12,17	150,07
				SL	0,52	7,42	0,62	13,51	0,09	11,79	150,09	0,43	6,97	0,57	12,74	0,27	11,82	150,05
		IJL	PT	ST	0,43	6,89	0,59	12,23	0,55	13,09	150,06	0,41	6,87	0,59	12,87	0,68	12,87	150,08
				SL	2,42	7,10	2,51	12,10	1,96	9,96	150,06	0,12	7,00	0,30	12,60	0,16	12,74	150,09
			PL	ST	0,55	4,85	0,59	9,01	1,03	9,70	150,03	0,23	5,76	0,31	10,88	0,42	11,03	150,05
				SL	0,30	5,50	0,58	7,24	1,09	6,92	152,08	0,07	2,91	0,15	5,60	0,70	6,21	150,02

FKL-FIH-FPL-FSL

Table 4

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,45	10,58	0,61	15,80	0,38	15,53	170,55	0,73	10,25	0,83	15,20	1,08	15,40	164,89
				SL	0,96	7,69	1,09	14,11	0,63	13,06	169,65	0,59	11,41	0,82	15,69	0,82	15,19	207,92
			PL	ST	0,94	7,54	1,02	13,88	0,80	13,73	167,93	0,50	7,76	0,65	14,23	0,72	14,82	162,43
				SL	1,01	7,48	1,10	14,12	1,09	14,16	160,60	0,84	7,71	0,97	14,20	0,97	14,63	161,32
		IJL	PT	ST	0,73	7,63	0,82	14,05	0,74	13,55	160,54	0,56	7,28	0,68	13,44	0,67	13,88	160,56
				SL	0,43	7,49	0,48	13,95	0,09	12,96	158,93	1,02	7,32	1,07	13,36	1,12	13,63	159,06
			PL	ST	0,32	7,26	0,43	13,32	0,48	13,58	168,89	0,50	8,20	0,59	13,39	0,30	12,34	181,10
				SL	0,42	7,70	0,50	14,01	0,31	12,46	150,69	0,43	7,27	0,54	13,42	0,65	13,76	158,27
	JKL	IJT	PT	ST	0,38	7,30	0,48	13,04	0,28	13,38	159,95	0,41	7,61	0,40	13,29	0,29	13,87	172,00
				SL	0,35	7,32	0,53	13,73	0,74	13,93	150,21	0,49	7,44	0,58	13,39	0,60	13,53	151,29
			PL	ST	0,43	7,28	0,52	13,34	0,63	13,22	150,06	0,46	7,29	0,54	13,48	0,39	12,77	150,09
				SL	0,38	7,26	0,48	13,24	0,64	13,06	150,08	0,35	7,14	0,49	12,65	0,02	10,96	150,06
		IJL	PT	ST	0,34	6,93	0,46	12,68	0,43	13,01	150,07	0,42	6,83	0,52	12,25	0,73	13,21	150,07
				SL	0,54	7,00	0,69	12,67	0,65	13,47	150,07	0,38	6,67	0,54	12,21	0,61	12,51	150,05
			PL	ST	0,97	5,02	1,07	9,56	1,47	10,47	150,05	0,92	5,55	1,00	9,99	1,50	11,29	150,03
				SL	0,89	4,47	0,99	7,43	1,78	8,23	151,51	0,85	2,72	0,92	5,46	1,94	6,45	150,02
PH	JKT	IJT	PT	ST	0,79	8,84	0,87	15,75	0,80	15,08	192,29	1,45	8,56	1,63	15,12	1,53	14,88	193,14
				SL	0,03	7,72	0,13	14,30	0,25	13,84	192,42	1,16	9,76	1,27	15,91	1,07	14,76	291,11
			PL	ST	1,11	7,83	1,14	14,28	1,23	14,22	194,32	1,66	7,85	1,79	14,32	1,32	13,07	203,11
				SL	1,05	7,39	1,17	13,59	0,68	11,80	194,10	0,10	7,55	0,23	13,87	0,18	13,37	202,57
		IJL	PT	ST	0,50	7,38	0,70	13,61	0,36	12,93	173,17	0,01	7,53	0,13	13,44	0,04	13,96	188,27
				SL	0,39	7,59	0,51	13,86	0,36	13,77	159,06	0,48	7,36	0,65	13,18	0,93	13,92	155,70
			PL	ST	0,29	7,32	0,45	13,41	0,24	12,88	154,41	0,41	7,32	0,54	13,36	0,50	12,58	175,62
				SL	0,34	7,91	0,43	13,87	0,11	13,24	152,34	0,39	7,53	0,51	13,99	0,72	14,61	152,94
	JKL	IJT	PT	ST	0,37	7,22	0,50	13,17	0,00	12,46	161,20	0,31	7,20	0,45	12,82	0,23	12,13	157,11
				SL	0,40	7,23	0,47	13,03	0,17	12,00	150,17	0,40	7,25	0,49	13,12	0,37	12,83	150,68
			PL	ST	0,41	7,27	0,48	13,04	0,29	13,00	150,07	0,28	7,07	0,36	12,04	1,03	12,94	150,06
				SL	0,55	7,15	0,72	13,34	0,58	13,47	150,06	0,40	6,95	0,49	12,53	0,55	12,93	150,08
		IJL	PT	ST	0,56	6,77	0,66	12,03	0,80	11,55	150,07	0,42	6,89	0,59	12,45	0,15	11,48	150,08
				SL	0,47	6,90	0,52	12,42	0,65	12,57	144,84	0,45	6,92	0,61	13,00	0,66	13,33	150,06
			PL	ST	0,67	5,14	1,01	9,35	1,56	9,78	150,04	0,73	5,44	0,91	10,19	1,26	10,60	150,05
				SL	0,69	4,66	0,66	7,12	1,42	7,65	151,97	1,26	3,21	1,24	6,04	1,60	6,45	150,03

Table 5

FKH-FIL-FPL-FSL

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	1,456	10,73	1,6	14,83	1,7	15,05	151,594	1,2	10,92	1,3	15,05	1,3	15,47	151,59
				SL	0,92	7,74	1,05	13,89	0,78	15,09	151,59	0,81	11,35	0,88	16,03	0,55	13,67	151,59
			PL	ST	0,15	7,52	0,27	13,44	0,39	14,13	174,86	0,66	7,74	0,84	13,89	0,84	14,14	151,59
				SL	0,14	7,77	0,29	14,20	0,15	14,55	190,10	0,38	7,24	0,53	13,29	0,32	12,65	178,62
		IJL	PT	ST	0,31	7,60	0,40	13,43	0,33	13,44	169,08	0,26	7,67	0,42	14,10	0,76	15,25	162,49
				SL	0,37	7,36	0,50	12,74	0,37	13,05	182,20	0,30	7,49	0,42	13,09	0,17	12,65	153,56
			PL	ST	0,43	7,66	0,56	13,89	0,01	12,27	154,14	0,53	7,48	0,71	13,51	0,45	14,01	185,29
				SL	0,34	7,99	0,40	14,20	0,43	15,07	153,14	0,29	7,36	0,43	12,70	0,40	13,86	152,75
	JKL	IJT	PT	ST	0,37	7,03	0,48	12,41	0,43	12,29	162,04	0,35	7,33	0,48	13,69	0,12	13,11	159,46
				SL	0,41	7,02	0,56	12,86	0,52	12,72	150,20	0,47	7,13	0,58	13,07	0,23	11,52	150,59
			PL	ST	0,34	7,28	0,57	13,22	0,70	13,89	150,09	0,35	7,29	0,53	13,31	0,52	13,08	150,07
				SL	0,54	7,19	0,65	12,88	0,71	13,87	150,08	0,41	7,13	0,46	12,88	0,41	13,01	150,08
		IJL	PT	ST	0,48	7,43	0,58	13,15	0,27	12,24	150,06	0,62	7,22	0,64	13,29	0,66	13,14	150,08
				SL	0,34	6,90	0,53	12,57	0,52	12,85	150,04	0,48	6,95	0,62	13,04	0,48	11,88	150,05
			PL	ST	0,64	5,11	0,70	9,61	1,27	10,06	150,04	1,08	5,61	0,98	10,01	1,39	10,41	150,04
				SL	1,30	3,55	1,41	6,97	1,69	7,15	152,03	1,32	3,65	1,33	6,32	1,53	6,49	150,03
PH	JKT	IJT	PT	ST	0,665	9,209	0,8	16,52	0,7	16,24	162,37	0,4	8,934	0,6	15,65	0,2	14,34	173,03
				SL	0,228	7,437	0,4	14,32	0,1	14,49	150,995	0,3	9,132	0,5	15,2	0,2	14,58	177,3
			PL	ST	0,725	7,76	0,8	13,68	0	11,57	173,693	0,9	8,009	0,9	14,32	0,9	14,3	162,38
				SL	0,271	7,699	0,3	13,7	0,2	13,43	159,776	0,5	7,511	0,6	13,82	0,4	13,54	173,53
		IJL	PT	ST	0,378	7,506	0,5	13,58	0,1	11,44	157,641	0,4	7,573	0,6	14,06	0,4	13,45	176,27
				SL	0,383	7,641	0,5	14,17	0,5	13,99	163,682	0,3	7,505	0,5	13,8	0,2	12,57	161,78
			PL	ST	0,477	7,604	0,5	13,78	0,4	13,2	166,183	0,4	7,316	0,5	13,28	0,4	13,16	161,78
				SL	0,372	7,542	0,5	13,83	0,6	14,17	157,818	0,3	7,349	0,4	13,66	0,3	13,58	165,14
	JKL	IJT	PT	ST	0,39	7,353	0,5	13,57	0,1	13,35	159,797	0,4	7,595	0,5	13,95	0,5	14,18	151,52
				SL	0,525	7,18	0,6	13,31	0,6	13,1	150,208	0,6	7,506	0,7	14,03	0,5	13,04	151,96
			PL	ST	0,458	7,2	0,5	13,38	0,3	12,53	150,12	0,4	7,433	0,5	13,54	0,4	12,57	150,08
				SL	0,331	7,438	0,4	13,61	0,4	13,76	150,104	0,5	7,096	0,6	13,4	0,5	12,53	150,06
		IJL	PT	ST	0,409	7,325	0,5	13,25	0,4	13,22	150,12	0,6	7,221	0,6	13,58	0,7	14,35	150,08
				SL	0,443	6,787	0,6	12,58	0,4	11,65	150,068	0,6	6,928	0,6	12,84	0,4	12	150,04
			PL	ST	0,61	5,17	0,71	9,60	1,30	10,14	150,04	0,9	5,449	0,8	9,684	1,4	10,46	150,04
				SL	0,88	2,89	1,05	5,82	1,53	6,28	151,94	1,09	3,23	1,08	6,21	2,10	7,33	150,02

Table 6

Capacity					FKH-FIL-FPL-FSH													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	0,70	8,83	0,80	15,39	0,53	14,77	196,45	0,60	8,76	0,75	14,88	0,76	14,37	196,45
				SL	0,90	7,85	1,07	15,89	0,93	15,30	196,45	0,84	8,59	0,97	15,31	0,85	14,59	196,45
			PL	ST	0,77	7,91	0,81	14,57	0,92	13,82	196,45	1,29	7,88	1,43	14,86	1,00	13,74	196,45
				SL	1,02	7,34	1,18	13,27	0,84	11,31	157,37	0,17	7,68	0,30	13,87	0,58	14,19	161,63
		IJL	PT	ST	0,80	7,35	0,96	13,86	1,12	14,14	160,02	0,30	7,32	0,42	13,19	0,19	12,59	173,57
				SL	0,55	7,45	0,65	14,02	0,75	14,03	160,55	1,10	7,01	1,38	13,18	1,10	12,04	158,54
			PL	ST	0,38	7,19	0,61	13,29	0,40	11,70	161,73	0,57	7,19	0,68	13,17	0,48	12,61	157,60
				SL	0,35	7,19	0,41	12,95	0,14	11,80	158,45	0,41	7,15	0,55	13,29	0,60	13,72	158,84
	JKL	IJT	PT	ST	0,37	7,12	0,50	13,18	0,18	12,09	159,22	0,35	7,07	0,44	13,01	0,23	12,14	152,24
				SL	0,44	7,21	0,48	12,86	0,50	12,55	150,16	0,39	7,32	0,52	13,31	0,72	13,31	150,70
			PL	ST	0,41	7,20	0,46	13,14	0,51	13,50	150,09	0,36	6,72	0,44	12,16	0,13	11,55	150,10
				SL	0,39	7,01	0,48	12,90	0,76	12,77	150,13	0,47	7,47	0,56	13,61	0,27	13,05	150,09
		IJL	PT	ST	0,50	7,27	0,60	13,41	0,72	13,44	150,08	0,30	6,70	0,45	12,21	0,30	11,65	150,06
				SL	0,58	6,96	0,70	12,89	0,81	12,88	150,07	0,38	6,93	0,52	12,80	0,44	13,50	150,06
			PL	ST	0,68	5,18	0,72	9,27	1,10	9,90	150,05	0,46	4,98	0,59	9,30	1,43	10,30	150,05
				SL	0,68	2,98	0,83	5,64	1,71	6,53	152,06	1,17	3,22	1,15	6,31	1,52	6,78	150,03
PH	JKT	IJT	PT	ST	0,84	9,59	0,90	16,30	0,51	15,86	183,41	0,28	9,51	0,40	15,15	0,64	16,65	183,41
				SL	0,70	7,62	0,79	15,91	0,98	17,52	183,41	0,60	9,18	0,63	15,81	0,68	16,91	183,41
			PL	ST	1,28	7,68	1,39	13,45	0,96	12,70	183,41	1,31	7,72	1,52	14,44	0,86	11,62	183,41
				SL	0,45	7,73	0,56	14,06	0,37	13,00	157,95	0,72	7,45	0,83	13,15	0,96	12,86	155,85
		IJL	PT	ST	0,46	7,59	0,61	14,05	0,37	13,82	154,51	0,71	7,53	0,72	13,06	0,28	11,92	180,25
				SL	0,38	7,38	0,47	13,87	0,55	13,20	172,36	0,33	7,53	0,50	14,31	0,15	13,86	163,99
			PL	ST	0,47	7,77	0,59	13,82	0,40	13,79	178,16	0,43	7,95	0,50	14,60	0,53	14,17	194,26
				SL	0,44	7,68	0,51	14,22	0,41	13,66	159,47	0,33	7,21	0,50	13,61	0,35	12,81	153,99
	JKL	IJT	PT	ST	0,23	7,28	0,39	13,33	0,92	13,90	159,83	0,39	7,60	0,51	13,69	0,18	11,59	154,13
				SL	0,29	7,30	0,41	13,24	0,37	13,39	150,16	0,29	6,92	0,42	12,98	0,09	11,88	151,59
			PL	ST	0,23	7,38	0,38	13,77	0,22	13,45	150,10	0,43	7,39	0,50	13,48	0,27	12,41	150,12
				SL	0,43	7,43	0,50	13,26	0,56	12,99	150,07	0,37	6,95	0,54	12,41	0,27	12,40	150,07
		IJL	PT	ST	0,31	6,86	0,43	12,02	0,08	11,35	150,05	0,48	7,11	0,69	13,36	0,60	13,05	150,09
				SL	0,32	6,54	0,35	11,80	0,06	10,08	150,05	0,40	7,12	0,51	13,42	0,43	12,10	150,07
			PL	ST	0,77	5,37	0,92	9,94	0,75	9,46	150,05	0,58	5,21	0,73	9,60	1,25	9,71	150,05
				SL	1,31	3,41	1,50	6,80	1,93	7,07	151,95	1,20	3,20	1,31	6,26	1,55	6,60	150,03

Table 7

Capacity					FKH-FIL-FPH-FSL													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	0,39	8,70	0,50	15,58	0,13	14,38	174,49	0,71	9,03	0,80	16,06	0,73	16,95	174,49
				SL	0,34	7,50	0,41	15,85	0,33	18,10	159,77	0,46	8,72	0,55	15,32	0,22	16,01	159,77
			PL	ST	0,86	7,40	1,05	14,27	1,05	14,37	159,77	0,85	7,53	1,00	14,17	0,63	13,79	159,77
				SL	0,15	7,72	0,24	13,92	0,25	14,39	153,99	0,75	7,41	0,83	13,71	0,72	13,66	159,77
		IJL	PT	ST	0,27	7,65	0,37	13,84	0,67	14,39	151,41	0,77	7,52	0,89	13,85	0,83	13,83	151,14
				SL	0,27	7,58	0,32	13,48	0,86	14,43	163,69	0,33	7,50	0,50	13,24	0,77	14,20	151,04
			PL	ST	0,31	7,42	0,45	13,44	0,41	12,75	163,43	0,65	7,67	0,74	13,93	0,69	13,93	163,40
				SL	0,76	7,46	0,88	13,95	0,69	13,62	152,44	0,81	7,55	0,89	13,47	0,65	13,15	170,95
	JKL	IJT	PT	ST	0,66	7,38	0,72	13,15	0,59	12,41	155,47	0,76	7,25	0,83	13,07	0,80	12,61	154,63
				SL	0,18	6,90	0,34	12,71	0,18	13,12	159,07	0,34	6,89	0,51	12,94	0,34	11,42	155,70
			PL	ST	0,30	6,92	0,54	12,79	0,43	13,00	150,18	0,34	7,40	0,47	13,65	0,53	14,24	150,23
				SL	0,40	6,97	0,40	12,25	0,37	12,39	152,82	0,42	6,94	0,56	12,82	0,32	12,99	163,08
		IJL	PT	ST	0,50	6,84	0,60	12,72	0,31	11,97	150,09	0,38	7,09	0,55	13,34	0,50	13,20	160,14
				SL	0,41	6,87	0,55	12,85	0,52	12,92	150,09	0,32	6,73	0,48	12,25	0,49	12,02	150,09
			PL	ST	0,61	5,45	0,76	9,79	1,19	10,60	150,04	0,62	5,21	0,70	9,83	1,34	11,10	150,05
				SL	0,94	2,92	1,14	5,79	1,81	6,74	151,73	0,84	3,07	0,97	5,92	1,01	5,82	150,03
PH	JKT	IJT	PT	ST	0,25	9,11	0,45	15,90	0,37	17,67	161,77	0,43	8,84	0,52	15,50	0,57	17,23	161,77
				SL	0,32	7,99	0,39	14,89	0,37	16,44	161,77	0,79	9,24	0,87	15,50	0,33	15,98	161,77
			PL	ST	0,48	7,75	0,58	13,52	0,03	11,95	161,77	0,52	7,67	0,69	13,74	0,68	13,96	161,77
				SL	0,45	7,21	0,56	12,94	0,24	12,42	161,77	0,55	7,58	0,67	14,05	0,70	14,50	161,77
		IJL	PT	ST	0,48	7,84	0,62	13,95	0,58	14,11	161,89	0,41	7,72	0,57	14,13	0,26	11,78	161,77
				SL	0,48	7,70	0,62	13,70	0,41	14,04	183,65	0,26	7,76	0,37	13,74	0,52	14,00	168,52
			PL	ST	0,26	7,31	0,35	12,29	0,10	12,92	182,45	0,34	7,58	0,49	13,48	0,35	13,41	174,19
				SL	0,47	7,77	0,65	14,11	0,28	13,40	152,26	0,39	7,50	0,54	13,59	0,29	13,83	173,18
	JKL	IJT	PT	ST	0,27	7,12	0,43	12,84	0,24	13,40	163,47	0,31	7,43	0,40	13,59	0,34	13,44	151,39
				SL	0,43	7,07	0,52	13,06	0,59	13,40	150,18	0,34	7,64	0,48	13,72	0,70	13,92	152,94
			PL	ST	0,29	7,16	0,39	12,70	0,45	13,22	150,13	0,47	7,28	0,50	12,88	0,27	13,10	150,15
				SL	0,70	7,08	0,79	12,37	0,30	10,83	150,10	0,43	7,37	0,49	13,19	0,60	13,56	150,05
		IJL	PT	ST	0,52	7,16	0,66	12,74	0,59	13,33	150,05	0,35	6,92	0,55	12,46	0,60	12,87	150,14
				SL	0,38	6,87	0,47	12,64	0,40	12,96	150,07	0,51	7,18	0,61	13,01	0,54	12,66	150,04
			PL	ST	0,72	5,25	0,81	9,72	1,24	10,47	150,04	0,95	5,49	1,04	10,29	1,36	10,68	150,06
				SL	0,87	3,20	1,02	6,22	1,51	6,60	152,00	1,36	3,43	1,47	6,68	1,56	6,94	150,04

Table 8

Capacity					FKH-FIL-FPH-FSH													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	0,35	8,97	0,40	15,09	0,53	16,74	150,79	0,38	8,74	0,50	14,25	0,68	14,98	150,79
				SL	0,56	7,88	0,68	15,62	0,59	15,58	150,79	0,84	9,24	0,99	14,72	1,17	15,97	150,79
			PL	ST	0,56	7,69	0,65	13,77	0,56	14,45	150,79	0,37	7,76	0,43	13,51	0,62	13,65	150,79
				SL	0,45	7,83	0,59	13,69	0,43	13,59	150,79	0,67	7,66	0,79	13,75	0,59	12,92	150,79
		IJL	PT	ST	0,61	7,37	0,77	13,51	0,81	13,24	150,56	0,17	7,66	0,24	13,93	0,22	14,44	150,79
				SL	0,53	7,51	0,69	13,92	0,49	12,41	150,68	0,49	7,31	0,58	13,19	0,69	12,95	150,63
			PL	ST	0,51	7,22	0,61	13,24	0,72	12,67	154,35	0,55	7,38	0,64	13,58	0,68	13,16	150,66
				SL	0,41	7,52	0,51	13,63	0,30	12,30	151,82	0,42	7,67	0,64	14,07	0,52	13,53	164,84
	JKL	IJT	PT	ST	0,24	7,24	0,37	13,06	0,04	11,84	166,51	0,38	7,13	0,59	13,05	0,42	12,43	157,55
				SL	0,41	7,02	0,54	13,22	0,59	14,14	150,58	0,45	7,22	0,49	13,32	0,47	13,49	151,71
			PL	ST	0,37	7,21	0,47	13,35	0,49	13,61	150,14	0,27	7,17	0,40	13,15	0,34	13,10	150,14
				SL	0,47	7,15	0,60	12,32	0,31	11,10	150,09	0,39	7,28	0,47	13,30	0,53	13,14	150,06
		IJL	PT	ST	0,47	7,16	0,56	12,95	0,89	12,69	150,06	0,43	7,12	0,63	12,76	0,52	12,92	150,07
				SL	0,50	7,15	0,56	12,73	0,08	10,80	150,10	0,44	7,26	0,54	12,67	0,44	12,70	150,05
			PL	ST	1,11	5,59	1,08	10,26	1,53	10,65	150,04	0,73	5,14	0,87	9,31	0,99	9,28	150,05
				SL	0,88	3,05	1,13	6,00	1,70	6,37	152,09	0,96	3,30	1,02	6,30	1,40	6,54	150,03
PH	JKT	IJT	PT	ST	0,57	8,62	0,68	15,12	0,51	15,45	166,37	0,23	8,43	0,31	16,17	0,22	16,10	166,37
				SL	0,70	7,67	0,81	15,61	0,58	15,79	166,37	0,66	8,80	0,79	15,44	0,90	15,93	166,37
			PL	ST	0,58	7,39	0,64	13,18	0,68	12,95	166,37	0,54	7,58	0,64	14,28	0,29	12,87	166,37
				SL	1,13	7,11	1,26	12,30	1,16	12,94	166,37	0,92	7,75	1,01	14,29	0,54	12,24	166,37
		IJL	PT	ST	0,69	7,79	0,81	14,24	0,61	13,76	179,20	0,75	7,70	0,88	14,18	0,51	13,32	166,37
				SL	0,40	7,60	0,51	13,93	0,75	13,79	192,64	0,32	7,47	0,48	13,88	0,39	13,77	167,83
			PL	ST	0,37	7,70	0,45	13,89	0,15	13,00	186,66	0,35	7,35	0,49	13,38	0,50	13,12	183,70
				SL	0,24	7,80	0,42	14,01	0,55	14,49	164,33	0,37	7,19	0,50	12,67	0,66	13,89	163,49
	JKL	IJT	PT	ST	0,35	7,43	0,51	13,88	0,29	13,30	179,36	0,42	7,48	0,59	13,68	0,61	14,07	154,22
				SL	0,48	7,37	0,59	13,55	0,40	13,32	150,14	0,42	7,38	0,47	13,90	0,59	14,05	150,98
			PL	ST	0,50	7,41	0,58	13,27	0,76	14,30	150,08	0,36	7,39	0,49	13,28	0,12	13,18	150,12
				SL	0,44	7,46	0,51	13,75	0,37	14,30	150,08	0,40	7,00	0,51	12,68	0,42	11,82	150,06
		IJL	PT	ST	0,41	7,14	0,55	12,90	0,46	12,53	150,08	0,44	7,21	0,54	13,12	0,40	13,43	150,13
				SL	0,34	6,87	0,55	11,87	0,28	10,93	150,04	0,52	7,01	0,73	13,15	0,34	12,34	150,05
			PL	ST	0,54	5,20	0,81	9,83	1,17	10,37	150,03	0,84	5,53	0,84	10,58	1,37	10,82	150,04
				SL	1,13	3,21	1,19	6,02	1,07	6,04	151,64	0,80	2,97	1,02	5,93	1,50	6,41	150,03

FKH-FIH-FPL-FSH

Table 9					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,58	8,95	0,73	15,95	0,39	13,53	173,81	0,59	8,59	0,70	15,02	0,65	15,01	173,81
				SL	0,65	7,78	0,78	15,70	0,62	14,94	173,81	0,35	8,74	0,57	15,01	0,66	15,04	173,81
			PL	ST	0,49	7,65	0,65	13,66	0,90	14,26	173,81	0,37	7,70	0,46	14,22	0,55	13,23	173,81
				SL	0,61	7,61	0,70	13,53	0,25	11,70	165,36	0,78	7,35	0,90	13,14	0,48	10,88	165,36
		IJL	PT	ST	0,36	7,63	0,36	13,44	0,32	13,65	165,36	0,73	7,83	0,74	14,14	0,10	11,42	165,36
				SL	0,28	7,29	0,41	13,13	0,28	13,14	168,11	0,27	7,66	0,37	13,76	0,28	13,43	195,65
			PL	ST	0,37	7,53	0,44	13,65	0,05	13,08	163,80	0,28	7,17	0,43	12,88	0,68	13,30	162,41
				SL	0,32	7,51	0,47	13,56	0,46	13,63	151,17	0,32	7,37	0,52	13,52	0,62	13,76	159,73
	JKL	IJT	PT	ST	0,37	7,34	0,44	13,09	0,15	11,72	167,79	0,43	7,47	0,54	13,70	0,38	12,57	151,57
				SL	0,28	7,28	0,43	13,22	0,06	12,20	150,23	0,44	7,40	0,51	13,40	0,40	13,57	150,69
			PL	ST	0,49	7,03	0,62	13,48	0,62	13,96	150,07	0,34	7,43	0,47	13,96	0,25	13,19	150,09
				SL	0,44	7,27	0,53	13,22	0,21	11,91	150,11	0,32	7,19	0,51	13,30	0,40	12,64	150,07
		IJL	PT	ST	0,44	6,95	0,46	12,35	0,30	11,02	150,08	0,39	7,05	0,59	12,92	0,79	13,01	150,08
				SL	0,40	7,09	0,49	12,95	0,30	11,78	150,06	0,57	7,25	0,63	13,53	0,56	13,88	150,06
			PL	ST	0,87	5,61	0,96	10,46	0,88	10,41	150,07	0,83	5,34	0,94	9,66	0,97	9,78	150,06
				SL	1,25	3,42	1,30	6,49	1,37	6,63	151,60	0,80	3,07	0,87	5,78	1,38	6,39	150,04
PH	JKT	IJT	PT	ST	0,80	9,29	1,00	16,04	0,83	17,04	159,27	0,52	9,27	0,66	15,06	0,42	14,97	159,27
				SL	0,23	7,88	0,30	15,25	-0,42	19,09	159,27	0,51	8,92	0,67	15,13	0,64	16,83	159,27
			PL	ST	0,16	8,01	0,23	14,27	0,05	13,28	159,27	0,49	7,53	0,65	13,26	0,34	12,81	159,27
				SL	0,42	7,51	0,58	14,19	0,49	14,57	160,91	0,56	7,41	0,64	13,87	0,59	13,11	160,91
		IJL	PT	ST	0,24	7,83	0,32	14,64	0,20	14,65	160,91	0,16	7,39	0,26	13,61	0,08	13,65	160,91
				SL	0,46	7,49	0,60	13,82	0,31	12,98	174,09	0,37	7,68	0,48	13,77	0,21	12,95	165,92
			PL	ST	0,26	7,58	0,42	13,55	0,31	13,92	179,05	0,36	7,39	0,48	13,11	0,35	12,95	159,02
				SL	0,37	8,14	0,43	14,72	0,00	12,65	159,82	0,23	7,21	0,35	12,70	0,07	11,78	166,68
	JKL	IJT	PT	ST	0,46	7,77	0,55	13,72	0,19	13,12	160,53	0,37	7,20	0,49	12,82	0,55	12,74	151,23
				SL	0,39	7,36	0,49	13,72	0,27	12,65	150,15	0,42	7,41	0,48	13,27	0,06	12,11	150,94
			PL	ST	0,39	7,17	0,49	13,23	0,12	12,46	150,07	0,40	7,06	0,47	13,01	0,44	12,77	150,09
				SL	0,35	6,99	0,52	12,94	0,56	13,06	150,10	0,37	7,08	0,43	12,64	0,37	12,60	150,06
		IJL	PT	ST	0,40	6,81	0,48	12,33	0,34	11,60	150,04	0,48	7,31	0,55	12,72	0,18	11,62	150,06
				SL	0,64	7,16	0,74	13,17	0,60	12,91	150,06	0,52	7,28	0,63	13,12	0,74	13,37	150,05
			PL	ST	0,80	5,29	0,86	9,75	1,53	10,53	150,03	0,78	5,71	0,78	10,20	0,41	9,20	150,05
				SL	1,04	3,99	1,12	6,43	1,14	6,55	151,79	1,06	3,40	1,30	6,50	1,39	6,89	150,04

FKL-FIH-FPH-FSH

Table 10					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,36	8,94	0,50	15,73	0,62	16,13	174,37	0,73	9,07	0,81	14,78	0,39	13,57	174,37
				SL	0,32	7,67	0,43	13,83	0,58	14,54	174,37	0,60	8,93	0,67	15,16	0,79	15,77	174,37
			PL	ST	0,53	7,59	0,61	13,33	0,29	12,11	174,37	0,61	7,63	0,72	13,87	0,36	12,64	174,37
				SL	0,30	7,54	0,45	13,71	0,60	14,15	178,14	0,41	7,74	0,53	13,89	0,73	14,80	174,37
		IJL	PT	ST	0,42	7,42	0,60	13,91	0,69	13,79	187,19	0,32	7,42	0,53	13,63	0,18	12,05	217,10
				SL	0,34	7,17	0,49	13,01	0,55	12,79	163,00	0,37	7,59	0,37	13,57	0,23	12,80	182,68
			PL	ST	0,31	7,16	0,43	12,33	0,15	12,19	152,19	0,45	7,33	0,55	13,32	0,24	12,16	243,84
				SL	0,37	7,51	0,47	13,81	0,45	13,73	162,21	0,46	7,50	0,52	13,73	0,56	13,70	151,78
	JKL	IJT	PT	ST	0,24	7,48	0,37	13,22	0,30	13,09	166,93	0,39	7,56	0,55	13,45	0,29	12,76	150,84
				SL	0,35	7,36	0,49	13,34	0,29	13,41	150,32	0,30	7,50	0,47	13,11	0,62	13,53	151,09
			PL	ST	0,36	7,18	0,43	12,83	0,64	12,81	150,06	0,26	7,25	0,45	12,87	0,02	11,48	150,14
				SL	0,36	7,14	0,51	13,05	0,56	13,21	150,09	0,39	7,36	0,46	13,11	0,22	11,07	150,06
		IJL	PT	ST	0,36	7,00	0,43	12,42	0,46	12,73	150,13	0,44	6,89	0,58	12,73	0,64	12,78	150,12
				SL	0,21	6,83	0,42	12,50	0,46	12,52	150,06	0,38	7,01	0,47	12,55	0,31	12,03	150,06
			PL	ST	0,77	5,51	0,93	9,96	1,19	10,52	150,04	0,59	5,14	0,55	9,16	0,73	9,51	150,05
				SL	1,23	4,92	1,35	8,11	1,55	7,96	151,68	0,93	3,03	1,05	5,85	1,57	6,52	150,02
PH	JKT	IJT	PT	ST	0,44	8,80	0,56	14,62	1,13	16,24	162,57	0,14	9,03	0,24	14,70	0,33	13,58	162,57
				SL	0,26	8,01	0,39	14,57	1,36	14,49	162,57	0,81	9,41	0,86	15,06	1,08	13,07	162,57
			PL	ST	0,68	7,92	0,79	13,86	0,26	11,57	162,57	0,35	7,73	0,45	14,30	0,34	13,37	162,57
				SL	0,31	7,79	0,39	14,47	0,53	13,43	162,54	0,22	7,61	0,40	13,99	0,65	13,96	162,57
		IJL	PT	ST	0,19	7,39	0,30	13,36	0,60	11,44	154,23	0,86	7,60	0,92	14,09	0,87	14,58	162,46
				SL	0,31	7,42	0,44	12,68	0,89	13,55	151,16	0,58	7,26	0,67	13,49	0,48	14,3	150,45
			PL	ST	0,43	7,25	0,58	13,17	0,40	12,96	175,17	0,40	7,63	0,56	14,15	0,25	13,54	166,66
				SL	0,33	7,77	0,43	13,63	0,36	13,58	151,48	0,26	7,32	0,34	12,89	0,53	13,45	156,30
	JKL	IJT	PT	ST	0,36	7,32	0,45	12,95	0,92	12,46	169,71	0,54	7,49	0,56	13,26	0,45	12,57	151,76
				SL	0,26	7,26	0,42	13,15	0,35	13,38	150,17	0,35	7,47	0,44	13,77	0,70	13,56	154,17
			PL	ST	0,33	7,19	0,35	12,16	0,52	13,81	150,11	0,38	7,19	0,55	13,08	0,99	12,87	150,09
				SL	0,47	6,99	0,60	13,29	0,98	13,33	150,07	0,40	7,24	0,46	13,09	0,53	12,66	150,06
		IJL	PT	ST	0,39	6,93	0,47	12,29	0,77	12,52	150,06	0,31	7,04	0,45	12,66	0,76	9,96	150,08
				SL	0,47	7,19	0,53	13,03	1,09	11,33	150,08	0,32	6,75	0,42	11,83	0,45	9,70	150,05
			PL	ST	0,78	5,45	0,87	10,26	0,08	11,80	150,04	0,79	5,44	0,80	9,73	1,26	6,92	150,05
				SL	0,93	4,89	1,04	8,26	0,16	9,76	151,43	0,76	3,09	0,82	5,90	0,14	7,96	150,02

Table 11

Capacity					FKL-FIL-FPH-FSH													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	0,69	8,95	0,72	15,30	0,50	15,11	182,28	0,59	9,14	0,73	15,16	0,61	17,41	182,28
				SL	0,41	8,11	0,51	14,35	0,60	15,20	182,28	0,64	9,42	0,78	14,81	0,80	15,17	182,28
			PL	ST	0,28	7,55	0,46	12,89	0,07	11,85	182,28	0,39	7,60	0,46	13,43	0,19	13,05	182,28
				SL	0,07	7,46	0,23	14,22	0,03	13,03	184,36	0,32	7,26	0,41	12,63	0,06	11,59	183,67
		IJL	PT	ST	0,46	7,50	0,55	13,59	0,42	13,24	190,23	0,11	7,51	0,18	13,51	0,56	13,21	189,63
				SL	0,36	7,60	0,45	13,15	0,03	11,59	182,73	0,61	7,44	0,71	13,52	0,73	12,95	167,84
			PL	ST	0,25	7,43	0,44	13,55	0,02	11,92	190,52	0,48	7,28	0,70	13,46	0,43	12,69	152,54
				SL	0,24	7,41	0,32	13,11	0,26	12,92	155,01	0,28	7,60	0,35	13,87	0,25	13,66	162,38
	JKL	IJT	PT	ST	0,36	7,39	0,44	12,95	0,08	11,50	171,09	0,27	7,16	0,40	12,52	0,36	11,63	151,38
				SL	0,36	7,29	0,59	13,54	0,27	12,44	150,28	0,36	7,31	0,56	13,60	0,58	13,72	156,15
			PL	ST	0,42	7,06	0,53	13,03	0,10	11,97	150,07	0,46	7,24	0,55	12,97	0,41	12,94	150,09
				SL	0,42	7,10	0,48	12,86	0,36	13,05	150,06	0,47	7,29	0,58	13,55	0,49	13,41	150,05
		IJL	PT	ST	0,34	6,57	0,48	11,48	0,42	11,58	150,09	0,47	7,07	0,56	13,34	0,23	12,56	150,08
				SL	0,52	6,71	0,59	12,21	0,48	10,79	150,06	0,49	6,86	0,58	12,63	0,82	12,17	150,10
			PL	ST	0,77	5,44	0,89	9,70	1,32	9,82	150,04	0,65	5,36	0,90	9,87	1,35	10,23	150,03
				SL	0,89	7,31	0,89	9,55	1,01	7,99	151,45	0,74	2,88	0,81	5,40	1,38	5,91	150,04
PH	JKT	IJT	PT	ST	0,81	8,55	0,86	15,04	0,73	15,57	165,61	0,62	8,99	0,71	16,44	0,83	17,93	165,61
				SL	0,49	7,60	0,62	13,69	0,78	14,22	165,61	0,46	8,61	0,59	15,01	0,28	15,92	165,61
			PL	ST	0,07	7,35	0,16	13,76	0,11	13,77	165,61	0,36	7,81	0,57	14,19	0,56	14,11	165,61
				SL	0,46	7,60	0,58	14,07	0,42	13,05	158,83	0,36	7,59	0,45	13,78	0,52	14,10	158,34
		IJL	PT	ST	0,60	7,62	0,72	14,06	0,62	13,67	153,86	0,33	7,59	0,47	13,56	0,29	12,78	169,29
				SL	0,43	7,56	0,66	13,90	0,46	13,68	174,62	0,28	7,47	0,42	13,28	0,44	13,86	153,13
			PL	ST	0,23	7,24	0,38	13,46	0,33	13,57	158,90	1,65	7,48	1,65	13,68	1,85	14,43	153,52
				SL	0,26	7,60	0,36	13,21	0,49	13,51	153,00	0,30	7,34	0,45	13,27	0,86	13,66	162,77
	JKL	IJT	PT	ST	0,39	7,60	0,47	13,57	0,60	13,71	164,09	0,46	7,43	0,56	13,79	0,08	12,33	151,45
				SL	0,39	7,34	0,49	13,06	0,06	12,10	150,17	0,31	7,25	0,45	13,17	0,63	13,07	150,82
			PL	ST	0,51	7,00	0,62	12,79	0,83	13,41	150,10	0,22	7,04	0,33	12,36	0,23	11,77	150,12
				SL	0,39	7,53	0,49	13,53	0,32	13,28	150,09	0,35	7,04	0,47	12,76	0,42	13,31	150,05
		IJL	PT	ST	0,36	6,74	0,38	11,77	0,76	12,92	150,06	0,47	7,16	0,59	12,58	0,56	12,82	150,08
				SL	0,45	7,12	0,67	13,17	0,53	12,97	150,08	0,45	6,60	0,58	11,51	0,40	11,24	150,06
			PL	ST	0,92	5,49	0,89	9,89	1,16	10,32	150,05	0,78	5,23	0,97	9,54	1,11	9,58	150,04
				SL	0,87	5,92	0,90	7,64	1,44	8,67	152,03	0,88	3,17	1,04	6,28	1,52	6,67	150,03

Table 12

Capacity					FKL-FIH-FPL-FSH													
					Low Transportation Cost							High Transportation Cost						
					LPH1		LPH2		LPH3		CPLEX Solution Time	LPH1		LPH2		LPH3		CPLEX Solution Time
					% E	Time	% E	Time	% E	Time		% E	Time	% E	Time	% E	Time	
PL	JKT	IJT	PT	ST	0,80	8,69	0,94	15,12	0,94	15,23	175,70	0,69	9,02	0,74	14,78	0,61	13,16	175,70
				SL	0,84	7,43	0,93	13,17	1,02	13,35	175,70	0,65	9,17	0,81	15,48	0,57	14,05	175,70
			PL	ST	0,67	7,75	0,77	14,44	0,64	13,89	175,70	0,68	7,71	0,76	14,22	0,86	14,39	175,70
				SL	0,73	7,43	0,80	13,40	1,11	13,71	175,70	0,66	7,44	0,79	13,52	0,94	13,68	175,70
		IJL	PT	ST	0,36	7,30	0,55	13,76	0,19	11,99	168,33	0,27	7,75	0,41	14,16	0,06	13,19	158,26
				SL	0,08	7,31	0,17	13,00	0,35	13,34	162,85	0,35	7,70	0,55	14,08	0,67	14,56	158,08
			PL	ST	0,26	7,60	0,37	13,64	0,50	13,73	150,39	0,19	7,33	0,38	13,03	0,22	13,04	157,70
				SL	0,42	7,72	0,50	13,87	0,72	14,28	150,24	0,32	7,44	0,47	13,43	0,59	13,60	150,27
	JKL	IJT	PT	ST	0,45	7,36	0,59	13,39	0,47	12,85	159,96	0,41	7,30	0,53	13,60	0,23	13,03	150,45
				SL	0,47	7,45	0,51	13,62	0,39	13,14	150,14	0,40	7,43	0,54	13,88	0,64	13,86	150,45
			PL	ST	0,46	7,38	0,63	13,57	0,67	13,31	150,09	0,45	7,15	0,59	12,94	0,24	11,88	150,06
				SL	0,29	7,00	0,42	12,49	0,10	11,73	150,13	0,51	7,13	0,58	12,96	0,04	11,24	150,05
		IJL	PT	ST	0,57	7,28	0,91	12,77	0,07	10,77	150,08	0,37	7,25	0,49	13,34	0,63	13,28	150,08
				SL	0,33	6,68	0,45	11,55	0,48	11,36	150,04	0,31	6,77	0,46	12,45	0,49	12,79	150,05
			PL	ST	0,61	5,18	0,71	9,77	1,07	9,64	150,04	0,49	5,21	0,59	9,36	1,00	10,01	150,05
				SL	1,08	6,06	1,19	9,05	1,72	8,31	151,95	0,97	3,26	0,96	5,98	0,58	5,35	150,02
PH	JKT	IJT	PT	ST	0,10	8,83	0,16	15,38	0,07	16,79	166,46	0,15	8,94	0,21	15,45	0,13	16,19	166,46
				SL	0,61	7,95	0,67	14,03	0,35	12,64	166,46	0,71	9,27	0,80	15,30	0,59	16,13	166,46
			PL	ST	0,70	7,90	0,80	14,27	0,63	13,65	166,46	0,88	7,77	0,96	14,06	0,67	13,30	166,46
				SL	0,62	7,63	0,74	13,58	0,98	14,03	166,46	0,65	7,52	0,85	13,44	0,91	13,47	166,46
		IJL	PT	ST	0,45	7,74	0,62	14,35	0,36	15,34	155,96	0,21	7,65	0,38	13,50	0,25	13,58	171,66
				SL	0,36	7,38	0,48	13,26	0,53	14,32	183,07	0,72	7,50	0,91	13,92	0,22	10,98	159,59
			PL	ST	0,53	7,44	0,64	13,73	0,52	13,63	161,92	0,52	7,64	0,67	13,63	0,55	13,45	158,39
				SL	0,42	7,86	0,52	14,39	0,83	15,43	154,60	0,36	7,51	0,47	13,95	0,53	14,47	159,35
	JKL	IJT	PT	ST	0,46	7,16	0,59	13,02	0,91	13,38	169,32	0,28	7,28	0,41	13,52	0,23	12,76	157,80
				SL	0,35	7,22	0,40	13,29	0,11	13,19	150,45	0,54	7,17	0,67	13,09	0,71	13,07	151,60
			PL	ST	0,30	6,82	0,41	12,15	0,10	11,35	150,18	0,46	7,29	0,58	13,16	0,57	13,73	150,08
				SL	0,46	7,25	0,57	13,12	0,50	12,42	150,06	0,30	7,38	0,43	13,57	0,17	11,74	150,08
		IJL	PT	ST	0,39	7,11	0,49	12,77	0,21	11,51	150,08	0,29	7,07	0,47	12,31	0,96	11,05	150,08
				SL	0,43	6,60	0,56	12,17	0,31	12,26	150,07	0,47	7,10	0,52	12,39	0,31	11,64	150,05
			PL	ST	0,63	5,07	0,83	9,32	0,98	9,64	150,04	0,77	5,22	0,73	9,57	0,83	9,37	150,05
				SL	0,84	4,67	0,90	7,32	1,47	8,67	151,49	1,20	3,15	1,15	5,97	1,40	6,39	150,04

FKL-FIH-FPH-FSL

Table 13					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,31	8,68	0,37	14,70	0,38	14,87	175,70	0,37	8,91	0,54	14,82	0,39	15,52	175,70
				SL	0,77	7,73	0,76	13,72	0,59	14,12	175,70	0,70	10,42	0,84	15,99	0,64	15,63	175,70
			PL	ST	0,21	7,64	0,40	13,36	0,06	12,82	169,41	0,39	7,85	0,45	14,02	0,07	13,95	169,41
				SL	0,31	7,42	0,50	12,98	0,34	13,44	194,68	0,10	7,84	0,27	14,17	0,26	14,14	165,15
		IJL	PT	ST	0,44	7,33	0,59	13,92	0,50	13,55	168,98	0,32	7,81	0,41	14,55	0,24	14,09	186,60
				SL	0,50	7,57	0,51	13,84	0,73	14,57	156,19	0,34	7,40	0,41	13,59	0,38	13,11	153,96
			PL	ST	0,44	7,32	0,51	13,36	0,48	13,49	179,83	0,33	7,26	0,44	13,32	0,23	12,97	160,25
				SL	0,38	7,67	0,45	13,59	0,46	14,61	156,64	0,44	7,19	0,52	13,16	0,19	11,81	157,40
	JKL	IJT	PT	ST	0,45	7,36	0,57	13,28	0,42	12,80	157,60	0,40	7,40	0,48	13,52	0,16	12,49	151,70
				SL	0,18	7,11	0,35	12,62	0,29	12,94	150,18	0,44	7,48	0,53	13,81	0,58	13,94	151,28
			PL	ST	0,32	7,01	0,46	13,09	0,50	12,41	150,07	0,38	7,26	0,47	13,41	0,22	12,84	150,07
				SL	0,46	7,23	0,59	12,82	0,63	13,16	150,08	0,42	7,24	0,54	13,28	0,41	13,37	150,08
		IJL	PT	ST	0,43	6,70	0,57	12,54	0,45	12,62	150,08	0,25	6,74	0,36	12,38	0,32	10,40	150,06
				SL	0,49	7,05	0,66	12,84	0,51	13,56	150,07	0,37	6,94	0,53	12,28	0,21	11,79	150,05
			PL	ST	0,80	5,14	0,89	9,21	1,47	10,50	150,05	0,71	5,04	0,77	9,33	1,36	10,30	150,05
				SL	1,17	4,19	1,30	8,85	1,70	8,29	152,02	0,82	2,98	0,94	5,74	1,06	5,85	150,03
PH	JKT	IJT	PT	ST	0,76	8,48	0,99	15,48	0,81	14,98	166,46	0,69	8,40	0,83	14,96	0,64	17,58	166,46
				SL	0,16	7,56	0,31	13,61	0,20	13,10	166,46	0,81	9,14	0,94	15,24	0,79	17,05	166,46
			PL	ST	0,44	7,83	0,60	13,98	0,35	13,26	166,46	0,22	7,48	0,37	13,23	0,01	12,40	166,46
				SL	1,59	7,66	1,72	13,48	1,38	12,57	166,46	0,53	7,33	0,62	13,50	0,07	11,54	166,46
		IJL	PT	ST	0,17	7,85	0,23	14,53	0,23	14,52	173,55	1,04	7,55	1,08	13,77	1,41	14,77	188,34
				SL	0,36	7,43	0,54	13,85	0,51	13,10	151,32	0,45	7,49	0,55	13,71	0,46	14,44	153,94
			PL	ST	0,30	7,32	0,38	13,97	0,41	13,71	155,55	0,30	7,34	0,42	13,58	0,46	13,51	182,79
				SL	0,16	7,19	0,32	13,00	0,73	14,14	158,82	0,40	7,50	0,51	13,57	0,27	13,37	151,83
	JKL	IJT	PT	ST	0,41	7,30	0,53	13,38	0,59	13,55	163,19	0,43	7,35	0,53	13,75	0,55	13,14	151,41
				SL	0,27	7,30	0,35	13,35	0,39	13,90	150,16	0,41	7,36	0,46	13,38	0,34	13,63	151,33
			PL	ST	0,35	7,16	0,39	12,72	0,11	11,36	150,14	0,33	7,23	0,44	13,17	0,41	13,04	150,09
				SL	0,21	7,07	0,32	13,16	0,25	12,77	150,09	0,39	6,74	0,47	12,76	0,39	12,25	150,06
		IJL	PT	ST	0,26	6,96	0,28	12,22	0,54	12,78	150,18	0,24	6,65	0,32	12,08	0,36	12,26	150,19
				SL	0,27	6,86	0,40	12,21	0,61	12,57	150,19	0,27	6,63	0,45	12,44	0,25	12,02	150,19
			PL	ST	0,52	5,57	0,78	10,31	0,72	11,38	150,17	0,67	5,25	0,85	9,89	0,89	10,23	150,17
				SL	0,73	5,34	0,91	7,54	1,71	10,23	151,21	0,67	3,09	0,88	6,19	1,21	6,80	150,16

FKH-FIH-FPL-FSL

Table 14

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,87	10,22	0,96	14,94	0,63	13,73	155,97	0,41	9,96	0,56	14,58	0,55	14,26	155,97
				SL	0,11	7,91	0,18	15,08	0,26	16,62	155,97	0,55	9,60	0,69	14,50	0,16	13,46	155,97
			PL	ST	0,58	7,78	0,61	13,60	0,43	12,72	155,97	0,39	7,53	0,56	13,55	0,50	14,07	155,97
				SL	0,40	7,27	0,57	13,59	1,10	13,02	159,60	0,38	7,50	0,45	13,88	0,29	14,04	155,97
		IJL	PT	ST	0,30	7,52	0,48	13,95	0,32	13,09	164,83	0,26	7,21	0,33	13,06	0,55	13,02	151,17
				SL	0,63	7,17	0,77	12,80	0,69	13,25	164,13	0,06	7,18	0,20	13,27	0,32	13,28	161,79
			PL	ST	0,42	7,36	0,49	13,18	0,52	13,51	179,02	0,60	7,45	0,65	13,78	0,86	14,25	165,25
				SL	0,32	7,61	0,43	13,54	0,44	14,29	155,35	0,33	7,24	0,40	13,39	0,13	12,80	160,73
	JKL	IJT	PT	ST	0,28	7,18	0,41	12,81	0,76	14,52	170,84	0,49	7,33	0,67	13,52	0,55	13,22	151,65
				SL	0,39	7,05	0,47	12,42	0,26	12,94	150,16	0,23	7,31	0,45	12,74	0,29	13,54	153,80
			PL	ST	0,48	7,06	0,59	13,05	0,37	13,66	150,08	0,34	7,10	0,48	12,98	0,36	12,25	150,14
				SL	0,33	7,09	0,42	12,62	0,22	9,84	150,09	0,38	6,94	0,46	12,34	0,31	12,22	150,05
		IJL	PT	ST	0,49	7,01	0,59	12,33	0,23	11,42	150,07	0,58	7,44	0,67	13,32	0,48	12,76	150,10
				SL	0,46	7,02	0,60	12,77	0,55	13,85	150,06	0,34	6,77	0,48	12,34	0,20	12,13	150,06
			PL	ST	0,66	5,46	0,85	9,90	0,95	10,07	150,04	0,68	5,21	0,84	10,21	1,34	10,68	150,05
				SL	0,76	2,84	1,00	5,74	1,13	5,76	152,21	1,16	3,06	1,26	6,01	1,68	6,57	150,03
PH	JKT	IJT	PT	ST	0,54	9,05	0,63	16,49	0,83	16,00	183,97	0,33	8,90	0,41	15,70	0,40	15,18	183,97
				SL	0,30	7,59	0,41	14,86	0,42	15,15	183,97	0,33	9,46	0,54	15,92	0,23	14,89	183,97
			PL	ST	0,48	7,61	0,60	14,21	0,30	13,36	183,97	0,50	7,55	0,64	13,60	0,61	13,38	183,97
				SL	0,43	7,62	0,56	14,14	0,77	14,56	231,22	0,56	7,52	0,64	13,40	0,30	13,10	183,97
		IJL	PT	ST	0,24	7,74	0,31	13,97	0,69	13,63	151,78	0,39	7,56	0,52	13,63	0,63	14,56	159,38
				SL	0,36	7,51	0,51	13,96	0,62	14,37	153,73	0,17	7,52	0,33	13,77	-0,01	12,70	188,12
			PL	ST	0,45	7,43	0,54	13,58	0,01	12,07	157,10	0,25	7,26	0,42	12,93	0,36	12,99	155,77
				SL	0,47	7,76	0,56	13,82	0,40	12,96	155,68	0,40	7,30	0,61	13,59	0,56	14,12	160,48
	JKL	IJT	PT	ST	0,48	7,58	0,56	14,12	0,39	13,45	164,18	0,41	7,44	0,51	13,53	0,33	12,85	152,44
				SL	0,48	7,57	0,56	13,37	0,86	14,58	150,29	0,25	7,51	0,43	13,72	0,27	12,13	156,98
			PL	ST	0,33	6,82	0,49	12,53	0,54	13,39	150,11	0,39	7,10	0,56	12,81	0,44	12,76	150,11
				SL	0,28	7,29	0,48	13,14	0,38	13,06	150,09	0,44	7,24	0,61	13,01	0,65	12,95	150,06
		IJL	PT	ST	0,55	7,01	0,73	12,64	0,60	11,94	150,07	0,53	7,13	0,61	13,01	0,40	12,15	150,11
				SL	0,38	6,64	0,43	11,50	0,12	10,77	150,06	0,44	7,02	0,58	12,76	0,40	12,25	150,06
			PL	ST	0,62	5,18	0,78	9,84	1,21	10,36	150,04	0,71	5,43	0,91	10,14	1,31	10,73	150,05
				SL	0,87	2,84	0,92	5,52	1,41	6,00	151,76	0,83	2,96	0,90	5,66	1,23	5,77	150,03

FKH-FIH-FPH-FSL

Table 15

Capacity					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
					% E	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,29	8,63	0,40	14,38	0,23	13,22	190,13	0,64	9,00	0,70	15,43	0,32	14,35	190,13
				SL	0,66	7,77	0,84	14,99	0,41	14,43	190,13	0,55	8,58	0,67	15,45	1,15	16,15	190,13
			PL	ST	0,15	7,71	0,23	13,77	0,42	14,40	190,13	0,35	7,80	0,54	14,39	0,57	15,35	190,13
				SL	0,32	7,53	0,40	13,68	0,45	12,70	199,36	0,34	7,43	0,43	12,69	0,29	12,74	167,97
		IJL	PT	ST	0,33	7,69	0,40	14,08	0,06	13,24	157,31	0,32	7,62	0,34	13,03	0,06	11,38	171,83
				SL	0,45	7,53	0,59	13,53	0,42	12,83	196,48	0,37	7,50	0,52	13,88	0,25	12,97	151,82
			PL	ST	0,36	7,45	0,41	13,67	0,46	13,91	172,33	0,24	7,23	0,32	12,69	0,28	11,76	191,46
				SL	0,49	7,88	0,62	15,10	0,33	14,11	164,23	0,32	7,45	0,51	14,09	0,41	14,30	160,38
	JKL	IJT	PT	ST	0,36	7,24	0,46	12,82	0,71	13,60	171,56	0,39	7,53	0,52	13,85	0,96	14,30	152,76
				SL	0,54	7,37	0,61	13,64	0,31	12,83	150,13	0,46	7,38	0,70	13,73	0,24	12,82	150,73
			PL	ST	0,34	7,55	0,51	13,89	0,26	13,84	150,06	0,56	6,96	0,61	12,87	0,30	11,55	150,10
				SL	0,44	7,05	0,62	12,75	0,51	13,61	150,07	0,30	7,33	0,44	13,09	0,32	12,95	150,06
		IJL	PT	ST	0,66	7,12	0,74	13,15	0,58	12,75	150,06	0,36	7,18	0,58	13,23	0,44	13,38	150,09
				SL	0,41	6,63	0,58	11,74	0,22	10,84	150,06	0,83	7,00	0,93	12,55	0,78	12,28	150,06
			PL	ST	0,67	5,50	0,88	10,42	1,11	10,79	150,04	0,75	5,16	0,91	9,59	1,42	10,57	150,05
				SL	0,81	3,06	0,96	5,78	1,59	6,51	151,95	1,05	3,40	1,15	6,67	1,17	6,56	150,02
PH	JKT	IJT	PT	ST	0,44	9,07	0,56	15,76	0,05	15,32	176,81	0,46	8,87	0,56	15,59	0,75	17,02	176,81
				SL	0,22	7,43	0,27	15,56	0,23	17,69	153,89	0,33	8,96	0,35	15,88	0,39	17,18	176,81
			PL	ST	0,56	7,47	0,59	13,13	0,30	13,13	153,89	0,11	7,71	0,20	14,09	0,39	14,89	153,89
				SL	0,52	7,84	0,60	13,87	0,17	12,10	182,42	0,43	7,61	0,48	14,12	0,32	13,96	155,99
		IJL	PT	ST	0,36	7,45	0,47	13,93	0,03	12,72	152,31	0,76	7,39	0,86	13,90	0,85	14,69	176,93
				SL	0,24	7,38	0,40	13,19	0,70	14,35	165,30	0,43	7,39	0,51	13,58	0,06	12,79	153,05
			PL	ST	0,22	7,11	0,35	12,98	0,37	13,14	160,51	0,51	7,60	0,53	13,97	0,30	13,65	177,53
				SL	0,34	7,60	0,42	13,91	0,68	14,75	168,84	0,40	7,63	0,46	13,68	0,33	13,80	157,93
	JKL	IJT	PT	ST	0,31	7,26	0,46	13,70	0,53	14,20	173,29	0,32	7,44	0,41	13,65	0,41	13,86	159,76
				SL	0,30	7,29	0,43	12,98	0,51	13,46	150,19	0,34	7,17	0,41	13,04	0,28	12,58	150,95
			PL	ST	0,51	7,22	0,64	13,24	0,08	11,18	150,07	0,34	7,20	0,50	13,21	0,61	13,18	150,14
				SL	0,51	6,96	0,63	12,97	-3,93	12,23	150,08	0,36	7,29	0,48	13,59	0,14	12,94	150,05
		IJL	PT	ST	0,58	7,14	0,67	13,28	0,41	12,07	150,07	0,37	6,85	0,46	12,39	0,44	12,94	150,09
				SL	7,73	7,16	7,78	12,50	7,47	11,21	150,05	0,52	7,26	0,56	13,32	0,80	13,63	150,05
			PL	ST	0,82	5,53	1,00	10,21	1,35	11,00	150,04	0,85	5,65	0,99	11,09	1,41	11,76	150,06
				SL	0,75	2,94	0,99	5,88	1,59	6,87	151,78	1,18	3,40	1,11	6,48	1,48	7,12	150,03

FKH-FIH-FPH-FSH

Table 16					Low Transportation Cost							High Transportation Cost						
					LPH1		**LPH2**		**LPH3**		**CPLEX Solution Time**	**LPH1**		**LPH2**		**LPH3**		**CPLEX Solution Time**
Capacity					**% E**	**Time**	**% E**	**Time**	**% E**	**Time**		**% E**	**Time**	**% E**	**Time**	**% E**	**Time**	
PL	JKT	IJT	PT	ST	0,45	9,11	0,58	15,14	0,20	14,32	155,15	0,49	8,84	0,61	15,01	0,54	16,13	155,15
				SL	0,39	7,97	0,46	16,08	0,32	14,96	155,15	0,43	8,85	0,51	14,59	0,40	14,13	155,15
			PL	ST	0,18	7,91	0,33	14,62	0,17	13,94	155,15	0,45	8,03	0,57	14,68	0,60	15,91	155,15
				SL	0,40	7,67	0,58	13,96	0,54	13,93	155,15	0,45	7,77	0,55	13,42	0,30	12,84	155,15
		IJL	PT	ST	0,34	7,74	0,49	14,14	0,42	14,26	162,40	0,94	7,68	1,08	14,08	0,61	12,28	152,01
				SL	1,26	7,52	1,48	13,74	1,36	13,52	163,00	1,59	7,59	1,70	13,76	1,46	12,70	182,68
			PL	ST	0,43	7,68	0,58	13,63	0,48	13,19	175,33	0,28	7,23	0,38	13,16	0,25	13,19	174,70
				SL	0,27	7,71	0,41	14,36	0,40	15,05	161,03	0,32	7,27	0,49	13,38	0,56	13,02	160,69
	JKL	IJT	PT	ST	0,36	7,53	0,58	13,87	0,57	13,92	165,82	0,31	7,66	0,45	13,86	0,29	13,95	153,03
				SL	0,42	7,46	0,57	13,30	0,51	13,48	150,14	0,40	7,55	0,56	14,01	0,51	14,01	150,86
			PL	ST	0,39	7,00	0,57	12,86	0,32	12,25	150,08	0,41	7,46	0,55	13,51	0,61	13,26	150,09
				SL	0,43	7,19	0,53	12,71	0,40	12,27	150,07	0,29	7,49	0,43	12,88	0,19	11,78	150,07
		IJL	PT	ST	0,42	7,11	0,46	12,75	0,01	11,01	150,07	0,47	7,43	0,61	13,65	0,43	13,49	150,13
				SL	0,43	7,22	0,65	13,58	0,57	13,26	150,06	0,40	6,86	0,53	13,08	0,63	13,38	150,07
			PL	ST	0,88	5,44	1,01	10,27	1,57	11,17	150,04	0,69	5,42	0,84	9,79	1,12	9,94	150,04
				SL	0,90	3,01	1,11	5,83	1,09	5,78	151,62	1,03	3,08	1,17	5,96	1,47	6,43	150,03
PH	JKT	IJT	PT	ST	0,33	8,99	0,47	15,17	0,18	15,17	161,82	0,06	9,19	0,18	16,09	0,50	15,63	161,82
				SL	0,29	7,47	0,46	14,71	0,91	15,10	161,82	0,29	8,81	0,46	15,19	0,46	14,86	161,82
			PL	ST	0,56	7,78	0,64	13,60	0,31	13,77	161,82	0,38	8,03	0,46	14,62	0,14	14,84	161,82
				SL	0,33	7,23	0,49	13,59	0,39	13,82	161,82	0,77	7,81	0,83	13,59	1,15	13,15	161,82
		IJL	PT	ST	0,32	7,59	0,45	13,86	0,77	13,82	167,34	0,31	7,67	0,46	13,73	0,31	13,78	177,39
				SL	0,27	7,38	0,35	13,44	0,61	13,52	151,16	0,43	7,47	0,58	13,75	0,91	13,85	151,01
			PL	ST	0,38	7,60	0,49	13,96	0,17	13,71	163,51	0,53	7,57	0,61	13,92	0,94	13,47	173,33
				SL	0,38	7,66	0,48	13,73	0,80	13,79	154,70	0,48	7,31	0,59	13,59	1,23	13,35	168,40
	JKL	IJT	PT	ST	0,48	7,73	0,56	14,30	0,56	14,09	163,63	0,32	7,31	0,51	12,79	0,19	13,44	152,75
				SL	0,33	7,23	0,53	13,45	0,86	12,98	150,32	0,37	7,11	0,41	12,46	0,73	13,40	151,25
			PL	ST	0,50	7,56	0,66	13,55	0,15	13,22	150,08	0,44	7,54	0,59	13,77	0,91	13,98	150,15
				SL	0,44	7,11	0,54	13,29	0,87	13,28	150,09	0,34	7,45	0,50	13,84	0,82	13,61	150,05
		IJL	PT	ST	0,49	7,00	0,60	12,73	0,67	12,79	150,07	0,58	7,27	0,64	12,86	1,30	13,28	150,10
				SL	0,45	6,77	0,71	12,36	1,03	12,81	150,04	0,44	7,04	0,56	12,57	0,89	12,79	150,04
			PL	ST	0,86	5,71	1,17	9,77	1,17	9,98	150,04	0,94	5,33	0,85	9,73	0,92	9,70	150,03
				SL	0,72	3,03	0,83	5,90	0,96	5,83	151,86	1,05	3,17	1,21	7,25	1,21	6,64	150,03

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