PROPOSED OF DECISION POLICY MODEL DEVELOPMENT FOR CITY LOGISTICS STAKEHOLDERS

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ABSTRACT

City Logistics and urban freight transport has become an important issue in urban planning. Challenges City Logistics is a matter of planning, scheduling, integrated short-term operation and resoureces management, for the general case involving two level distribution structure. The complexity of the matter distribution arrangements and conflicts between key stakeholder groups (government, corporate transport or logistics service providers, customers, the environment, and business) requires the solution of various approaches (Thompson and Taniguchi, 2001). There are four key stakeholders City Logistics system which has a complexity of issues and conflicts distribution arrangements between key stakeholder groups (Thompson, 2001), are : (1) shippers, (2) freight carriers, (3) residents, (4) administrators / Governments. Each group has its own specific purpose and has different habits and behaviors and needs that must be considered. Consolidation and coordination is a fundamental concept of City Logistics (Taniguchi, 2000). Complexity in the logistical demands of integrated decision-making authority between actors are autonomous and decentralized without disturbing the overall total activity.

Key words: *City Logistics, Stakeholders, Policy Model, integrated decision making*

1. INTRODUCTION

Many research on City Logistics measures have been developed, such as the methodology to evaluate City Logistics traffic using dynamic simulation (Taniguchi, et al., 2000), and then approach the vehicle routes, scheduling (scheduling), and simulation as practiced by Barcelo et al., (2005), and Taniguchi et al., (2001a). Another approach taken is from a review of public policy planning for urban freight transport (Visser, et al., 1999). Other research that has been done is to combine the routes of vehicles with optimal logistics terminal location (Yamada et al., 2001). City Logistics Decision support system proposed by Walerjanczyk and Maciejewski (2003) using multi-objective optimization, and information technology such as Data Center, Geographic Information Systems (GIS) and Global Positioning Systems (GPS). Study of simulation models in City Logistics system to optimize the efficiency of the logistics of traffic congestion, by displaying a unique urban freight and consider the characteristics of the city conducted by Taylor (2006) with a case study of the City of Sydney, Australia.

The conflict between the objectives will result in failure to achieve optimal system-wide solution, which also resulted in the destination city logistics system, which achieved total system optimization. Stakeholders expressed as behavioral characteristics and criteria in achieving their stated objectives, which sometimes limits unclear/vague (fuzzy). Stakeholder behavior is what will affect the value chain along the chain of distribution system of city logistics. Optimization of the objective function of all stakeholders involved will answer the challenge of city logistics system problems (Taniguchi, 2001b).

The approach of the various studies that exist today do more optimization is local / partial and simultaneous, and do not involve all stakeholders in the system components of city logistics (Crainic, 2009), and cases of Transportation Planning Decision (Liang, 2006).

This study is a preliminary study conducted to evaluate the performance of city logistics by considering stakeholder key. The study is based on research conducted by Taniguchi and Tamagawa (2005), and Transportation Planning Decision Problem (Liang, 2006).

One approach that can be used in further optimization city logistics systems simultaneously is goal programming, a technique to analyze the problem and create a solution that involves a lot of goals.This method provides an opportunity for decision-makers in each stakeholder to involve multiple objectives that sometimes conflict with each other even in the process of formulation, the following priority objectives.

Fuzzy goal programming method reflects the philosophy of the effort to achieve an optimal compromise solution for a variety of purposes that sometimes conflict with each other and have a fuzzy nature (fuzziness) on each objective function. Characteristics of city logistics system with different conflicts among goals as the behavior of every stakeholder feels right to be approached with the concept of multi-objective programming, which will be developed in this research.

Policy behavior every stakeholder in city logistics will be modeled based on the characteristics of each in achieving the objectives and actions are coherent. Model each stakeholder behavior is described by the parameters to be found and be one of the contributions in this study.

2. RESEARCH FORMULATION

2.1 Problem Formulation, Scope And Limititation Issues

The problem in this study are how to build a model of stakeholders in policy-making system City Logistics.

Scope and Limitations issues :

- The research was conducted for city logistics distribution system with four key stakeholders, are : freight carriers, shippers, Residents, and administrators.
- The observed distribution system is composed of a hierarchy of levels, namely the distribution center / depot to the consumer / supermarket / retail located in residential areas.
- The study was conducted for the transport of goods using the road infrastructure.
- Commodities that were examined in the distribution system is a single-commodity categories of fast moving consumer goods (consumer goods of daily consumption of households).
- End consumers are modern retail in residential areas.

2.2 Assumption

Assumptions related to the research are:

a. City distribution center has been available for a meet and conditions consistent pattern observed characteristics of the city.
b. Stakeholder behavior can be observed with the use of indicators and parameters specified. Location depot and consumer / retail allocated randomly in the network. Each consumer/retail has a total demand for goods and time window for arrival different for each consumer/retail.
c. The volume of goods and a range of time window for each consumer / retail based on the survey results of the hypothetical movement of goods or the data otherwise available. The number of freight carriers, depot and consumer / retail for each freight carriers assumed using several different numbers allow.
d. Each carrier has a fleet of freight transport that consists of two types of vehicle type 2 ton and 4 ton.
e. Fines delays and early arrival is Rp/min for each subsequent shipment. The number of grievances against the emission goods vehicles if the amount of NOx emissions exceed 50g per 1 km
f. All functions are fuzzy objective is the level of aspiration that can not be ascertained. All objective and constraint functions/constraints are non-linear equations. The cost of transport and delivery times on a given route is directly proportional to the number of units shipped.
g. The value of all model parameters are known during the planning period non-linear membership functions assigned to represent fuzzy sets are involved, and the minimum operator is used to aggregate all fuzzy sets.

2.3 Research Contribution

In theoretical contribution of the study include:

a. Model optimization approach for stakeholders involved in the decision of City Logistics systems.
b. Modification and development of multi-objectives fuzzy models Programming with interactive consider each decision makers (stakeholders)
c. Models are built benefit every stakeholder, both shippers, Freighters, administrators, and consumers to establish the right decision every value chain through.

In practical terms, the contribution of this research for the consumer is to increase the level of service received. As for positive environmental impact by reducing pollution and exhaust emissions from freight vehicles in urban areas and provide savings on fuel. For businesses and the economy in urban areas, this study contributes to improve the city's economic competition that will ultimately provide significant benefits to urban planning in the future.

2.4 Research Positioning

There is an opportunity to study evaluating city logistics measures to develop an interactive model that is optimal for stakeholders involved in the decision of City Logistics systems. As a basic research to be done is the development of criteria and stakeholder (Taniguchi & Tamagawa, 2005) as well as the adjustment and development of an interactive model of multi-objective Fuzzy Linear Programming (Liang, 2006). Research positioning are shown in Table 1.

Table 1. Research Positioning in City Logistics System Evaluation Model

Research	City Logistics System Evaluation Model	Objective Function & Criteria	Stakeholders
-Barcelo et al (2005a) -Sheu (2006) -Thompson (2004) -Yamada et al (2001)	Assignment, Routing & Schedulling VRP, VRP-TW	Minimizing Transportation Cost, Optimization distribution center location	Partially Stakeholder (one or more stakeholder separately)
-Taniguchi et al (2001a) -Crainic et al (2009)	Network Modelling & Intelligent Transportation Systems	Minimizing Transportation Cost, Coordination Cost and Communication	Partially Stakeholder (one or more stakeholder separately)
-Barcello et al (2005b) -Walerjanczyk (2003) -Taniguchi et al (2000)	Simulation	Minimizing Transportation Cost, Cost Efficiency, traffic flow & congestion	Partially Stakeholder (one or more stakeholder separately)
-Duta & Murthy (2010)	Fuzzy Multi-Choice Linear Programming	Minimizing Transportation Cost	Partially Stakeholder (one or more stakeholder separately)
-Nunkaew & Phruksaphanrat	Multi-Objective-Programming	Minimizing Transportation Cost, Depot-Customer relationship	Partially Stakeholder (one or more stakeholder separately)
-Liang (2006)	Interactive-Fuzzy Multi-Objective Linear Programming	Minimizing Transportation Cost with fuzzy demand, and supply value	Partially Stakeholder
-Taniguchi & Tamagawa (2005)	Genetic Algorithm and VRP-TW	Minimizing Transportation Cost with stakeholders behaviour and freight transportation banned	5 stakeholders
This Study	Developing model for Fuzzy interactive decision multi-objective programming	Minimizing Total Cost with decision optimization of stakeholders	Simultaneously 4 stakeholders

3. THEORY REVIEW

3.1 City Logistics

a. Definition

The concept of "City Logistics" (e.g. Ruske, 1994; Kohler, 1997; Taniguchi and van der Heijden, 2000a) has the potential for solving many of these difficult and complicated problems.

Taniguchi *et al.* (1999a) defined City Logistics as "the process for totally optimising the logistics and transport

activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy." The aim of City Logistics is to globally optimise logistics systems within an urban area by considering the costs and benefits of schemes to the public as well as the private sector. Private shippers and freight carriers aim to reduce their freight costs while the public sector tries to alleviate traffic congestion and environmental problems.

b. Stakeholders

There are four key stakeholders involved in urban freight transport; (a) shippers, (b) freight carriers, (c) residents and (d) administrators. Each of the key stakeholders in urban freight transport has their own specific objectives and tends to behave in a different manner. City Logistics models need to recognise these factors.

Shippers are the customers of freight carriers who either send goods to other companies or persons or receive goods from them. Shippers generally tend to maximise their levels of service, which includes the cost, the time for picking up or delivering, and the reliability of transport as well as trailing information. Recently the requirement for carriers to arrive at customers within specified time windows for pickup/delivery has become popular. A recent survey in Osaka and Kobe in Japan, found that freight carriers were required operate with designated arrival times or time windows for 52% of goods delivered and for 45% of goods collected in terms of weight. Such strict time windows have led to smaller loads of goods being transported more frequently. The reliability of delivering goods has become more important for Just-In-Time transport systems. There are two types of reliability; (a) delivery without any damage to the goods, (b) delivery without any delay with respect to designated time at customers.

Freight carriers typically attempt to minimise the costs associated with collecting and delivering goods to customers to maximise their profits. There is much pressure to provide higher levels of service to customers at a lower total cost. This is especially important when carriers are requested to arrive at customers within a designated time period. However, freight carriers often face difficulty in operating their vehicles on urban roads due to traffic congestion.

This has led to the inefficient use of trucks, where smaller loads are being transported and trucks often have to wait near the location of customers when they arrive earlier than the designated time.

Residents are the people who live, work and shop in the city. They do not welcome large trucks coming into local streets, never the less these vehicles carry commodities that are necessary for them. They would like to minimise traffic congestion, noise, air pollution and traffic accidents near their residential and retail areas. Within the commercial zones of urban areas, retailers want to receive their commodities at a convenient time for them. However, this sometimes conflicts with residents who desire quiet and safe conditions on local roads.

City administrators attempt to enhance the economic development of the city and increase employment opportunities. They also aim to alleviate traffic congestion, improve the environment and increase road safety within the city. They should be neutral and should play a major role in resolving any conflicts among the other key stakeholders who are involved in urban freight transport. Therefore, it is the administrators who should co-ordinate and facilitate City Logistics initiatives. The key stakeholders in city logistics are shown in Figure 1.

3.2 Interactive Fuzzy Multi-Objective Linear Programming (*i*-FMOLP)

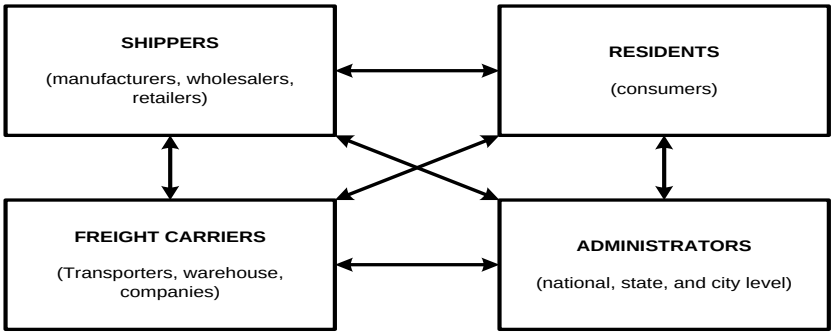
Liang (2006) proposed i-FMOLP model attempts to simultaneously minimize the total production and transportation costs and the total delivery time with reference to available capacities at each source and forecast demand at each destination.

The Transportation Planning Decision (TPD) problem examined herein can be described as follows. Assume that a distribution center seeks to determine the transportation plan of a homogeneous commodity from m sources

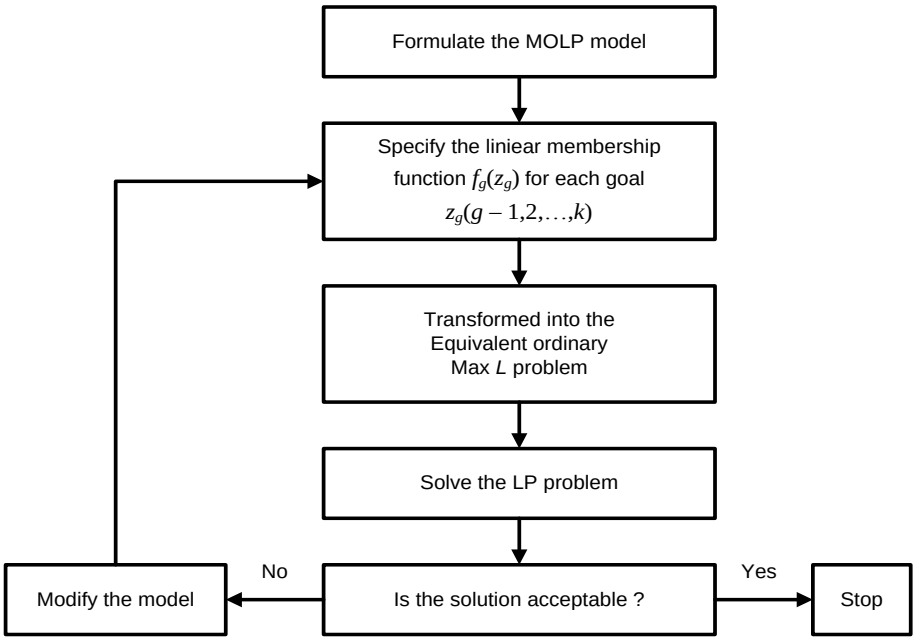
to n destinations. Each source has an available supply of the commodity to distribute to various destinations, and each destination has a forecast demand of the commodity to be received from the sources. The TPD proposed herein attempts to determine the optimal volumes to be transported from each source to each destination to simultaneously minimize the total production and transportation costs and the total delivery time. The TPD problem proposed in this work focuses on developing an interactive i-FMOLP model for optimizing the transportation plan in fuzzy environments.

The interactive solution procedure of the proposed i-FMOLP model for solving the multi-objective TPD problem is as follows.

Step 1. Formulate the original fuzzy MOLP model for the TPD problems.
Step 2. Specify the corresponding linear membership functions for all of the objective functions.
Step 3. Introduce the auxiliary variable L, and aggregate the original fuzzy MOLP problem into an equivalent ordinary single-objective LP (Max L) model using the minimum operator.
Step 4. Solve the LP problem and obtain the initial compromise solution.
Step 5. Execute and modify the interactive decision process. If the DM is not satisfied with the initial compromise solution, the model must be changed until a satisfactory solution is found.



Resource : Thompson, R.G. dan Taniguchi, E. (2001)
Figure 1. Key Stakeholders in City Logistics



Resource : Liang (2006) page 115
Figure 2. i-FMOLP model procedures

4. PROPOSED CONCEPTUAL MODEL

4.1. Preliminary Study

In this stage, performed formulation of the problem, limiting the scope of work, establishing a frame of mind as well as the intent and purpose of this study. The next stage is the collection of literature and a review of the studies that have been done before. This is very important as the basis of the research, as many studies and research that has been done related to the optimization of City Logistics system taking into account the characteristics and behavior of stakeholders. Thus, this process is very important to establish a baseline that will be used in this study at each process and later stages.

4.2. Stakeholder Identification and Determination

At this stage will be the identification and determination of the criteria of the stakeholders involved in city logistics schemes. Stakeholders will be identified include: freight carriers, shippers, Residents, administrators and urban expressway operator with respect to the criteria based on objective/purpose, condition to be achieved and the criteria of each individual stakeholder.

4.3. Build Objective Functions and Each Stakeholder Constraints

At this stage will be constructed objective functions and constraints of each stakeholder by taking into account the characteristics of each stakeholder. This stage will result in Model 1 (Based on model by Liang 2006).

a. The objective function for 1st stakeholder, Shippers :

$$Min\ Z_{shp} \cong \sum_{i=1}^{n} f(k_i) \qquad (1)$$

Shippers objective function for stakeholders consist of two objective, are :

1) The objective function Minimize Total Cost of Production and Transportation:

$$Min\ Z_1 \cong \sum_{i=1}^{m}\sum_{j=1}^{n}(P_{ij}C_{ij})Q_{ij} \qquad (2)$$

2) The objective function Minimize Total Delivery time:

$$Min\ Z_2 \cong \sum_{i=1}^{m}\sum_{j=1}^{n} t_{ij}Q_{ij} \qquad (3)$$

With constraints :

Total available supply for each source *i* :

$$\sum_{j=1}^{n} Q_{ij} = S_i, \qquad i = 1, 2, \dots m$$

Total demand for each destination *j* :

$$\sum_{j=1}^{n} Q_{ij} = D_i, \qquad i = 1, 2, \dots m$$

Non-Negativity constraints on Decision :

$Q_{ij} \geq 0, \qquad i = 1, 2, \dots m; \qquad j = 1, 2, \dots m$

where:

Z_1 = Total cost of production and transport
Z_2 = Total Delivery time (hours)
Q_{ij} = amount shipped from source i to destination j (units)
P_{ij} = Cost of production per unit from source *i* to destination *j* (Rp / unit)
C_{ij} = transportation cost per unit from source *i* to destination *j* (Rp / unit)
T_{ij} = transport per unit time from source *i* to destination *j* (*h*)
S_i = Total available supply from source *i* (units)
D_j = Total demand from destination *j* (units)
$Z_{shp, fc, rit, reg}$ =Total cost for each stakeholder shippers, freight carriers, retailers and regulators
$f(k_{1,2,3,4})$ = function of the characteristics of the *i* factor for each stakeholder

The symbol "≅" is a fuzzy version of the "=" and shows the fuzzification aspiration.

b. The objective function for 2nd stakeholder, Freight Carriers :

$$Min\ Z_{fc} \cong \sum_{i=1}^{n} f(k_i) \qquad (4)$$

Objective function for Freight Carriers stakeholders consist of two objectives, ie :

1) The objective function minimizing the total cost of transport
2) The objective function minimizing the total time delivery

c. The objective function for 3rd stakeholder, Modern Retailers :

$$Min\ Z_{rit} \cong \sum_{i=1}^{n} f(k_i) \qquad (5)$$

Objective function for modern retailers stakeholders consist of two objectives, ie:

1) The objective function minimizing transportation costs
2) The objective function minimizing shipping cost

d. The objective function for 4th stakeholder, Administrator/Regulators :

$$Min\ Z_{reg} \cong \sum_{i=1}^{n} f(k_i) \qquad (6)$$

Objective function for stakeholders Administrator/Regulator consists of two objectives, ie:

1) The objective function minimization of complaints
2) The objective function minimization emission levels

4.4. Building a Basic Model of Fuzzy Multi-Objectives Programming

This stage is the stage for building Model 2 is the basic model of Fuzzy Multi-Objectives of Non-Linear Programming (FMONLP) based on Model 1. FMONLP base model used is a modification and development of the model FMOLP used by Liang (2006) to make adjustments and city logistics system characteristics approach.

a) Determining Non-linear membership function

The relationship of non-linear membership functions for each fuzzy objective function can be defined as follows:

$$f_g(z_g) = \begin{cases} 1 & z_g \leq z_g^l \\ \frac{z_g^u - z_g}{z_g^u - z_g^l} & z_g < z_g^l < z_g^u, g = 1,2,\dots,k \\ 0 & z_g \geq z_g^u \end{cases} \qquad (7)$$

Where z_g^l and z_g^u are lower and upper bounds, respectively to the *g*-value of the z_g objective function.

b) Fuzzy decision Bellman and Zadeh

Build a model of the two that begins with initiating all possible solutions to the problem of decision every stakeholder to build Fuzzy membership function, and determine the maximum value corresponding membership functions.

4.5. Modifications interactive model-FMOLP (i-FMOLP)

Modification of the model is done at this stage is to build and modify interactive algorithm by Liang (2006) by adding regular iterative fuzzy control value generated in the previous iteration, in order to obtain optimum results that show the degree of whole each stakeholder satisfaction. This stage produces Model 3.

The Proposed Conceptual Model procedure shown in Figure 4.

5. CONCLUSION

Policy behavior every stakeholder in city logistics will be modeled based on the characteristics of each in achieving the objectives and actions are coherent. Model each stakeholder behavior is described by the parameters to be found and be one of the contributions in this study.

The final outcome of the study is to obtain an optimal interactive modeling approach to decision stakeholders involved in City Logistics system, so this model can be widely used for the study and analysis as well as contributing in the form of an alternative model that can be used for the measurement of city logistics system evaluation.

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SUPPLEMENT :

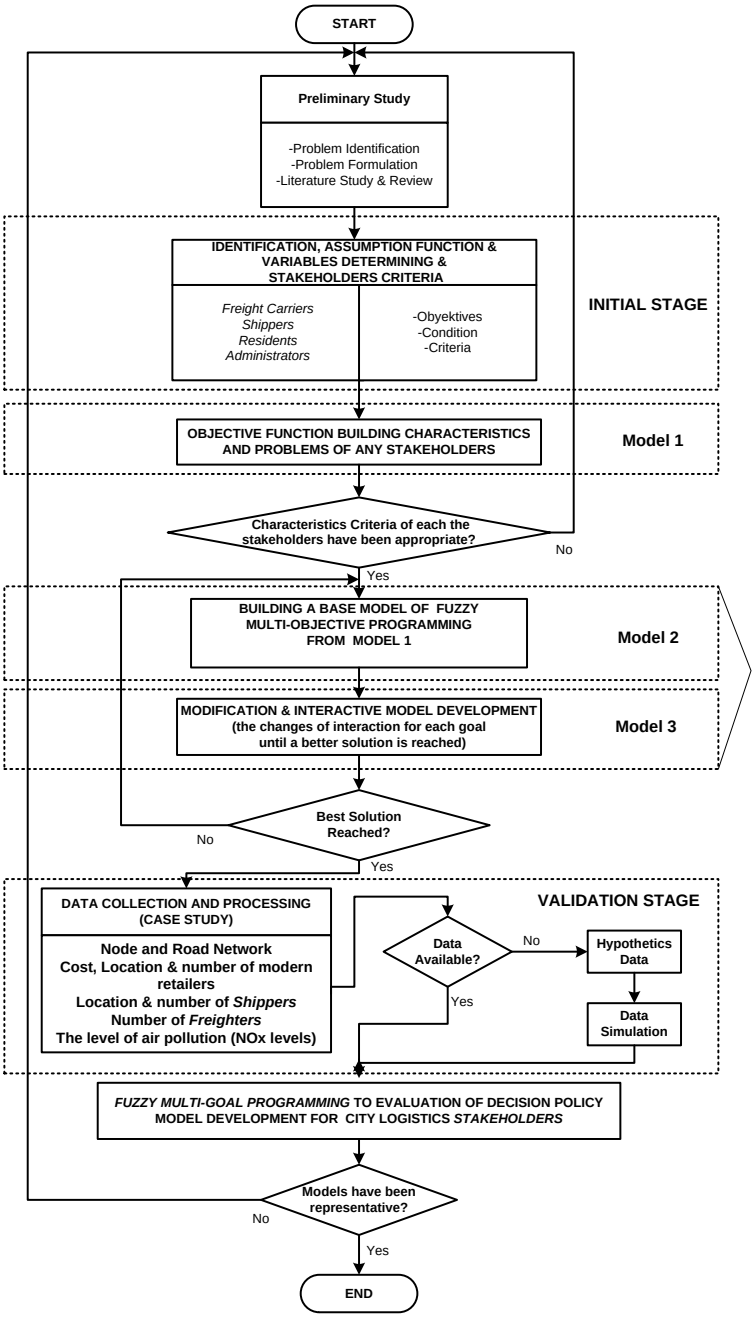

Figure 4. Proposed Conceptual Model Procedure