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The 9th International Conference on City Logistics, Tenerife, Canary Islands (Spain), 17-19 June 2015

Retail Precinct Management: A Case of Commercial Decentralization in Singapore

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Abstract

This paper reviews the logistics challenges of a decentralization strategy in Singapore. The main purpose of an urban decentralization, where the commercial hubs and retail clusters are distributed in several regional centers is to relieve congestion from the city center and to move business closer to home. However, this approach can also create congestion in regional centers due to the rapid flow of public, private and freight vehicles in and out of regional centers. This paper identifies three major challenges and proposes Retail Precinct Management (RPM) which consists of four inter-related components to overcome these challenges.

1. Introduction

Commercial decentralization is an urban concept that is often used as a land use policy to encourage a better balance between the number of residents and workers, to minimize work travel costs, and to allow companies to utilize labour

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resources in sub-urban locations (Malone-Lee et al. 2001). The decentralization development strategy in Singapore was introduced in the 1991 Concept Plan to guide future land use (Urban Redevelopment Authority 1991, Wong and Yap 2004). It diffuses commercial activities to a series of regional centers where each center covers up to 1.5 million m^2 of commercial space with approximately 50% of that taken up for commercial use. As illustrated in Fig. 1, there are four regional centers proposed: Tampines in the East, Seletar in the Northeast, Woodlands in the North and Jurong East in the west. In this paper, we focus on the largest regional center: Jurong East which is developed as a new growth area Jurong Lake District (JLD).

JLD covers 360 ha of land and is envisioned to provide at least 500,000 m^2 of office space, 250,000 m^2 of retail, F&B and entertainment space, 2,800 hotel rooms and a number of edutainment attractions (Urban Redevelopment Authority 2012). It comprises two district precincts: Jurong Gateway (JG) and Lakeside. JG focuses as a commercial hub whereas Lakeside focuses as leisure.

As a key commercial precinct and also a retail cluster in the west of Singapore, JG generates the bulk of transportation flows for many important activities: commuter traffic, retail distribution/logistics traffic, and visitor traffic for different amenities. JG currently has 5 shopping malls with more than 690 retail shops with an expected numbers of daily visitors of more than 150,000 and daily deliveries more than 550. JG also has a neighborhood center containing a number of markets, shops, eating houses and market stalls.

These conditions create high density of urban logistics activities which naturally prone and highly sensitive to traffic congestion, especially when both freight and people are channeled into the area, causing negative externalities to all stakeholders. One most obvious impact of negative externalities is the traffic congestion which result in the increased travel time. The average travelling time to go to work for working person in Singapore in 2005 and 2010 (Department of Statistics 2006, Department of Statistics 2011) is increased by more than 20% in each range of time. The highest increase is on private vehicles that travel more than 60 minutes (up by 75%).

In (de Souza et al. 2013), a collaborative urban logistics concept was proposed to improve last-mile delivery operations for reducing traffic congestion. This paper is an implementation of our concept in a retail cluster such as JG. More precisely, we introduce the concept of retail precinct management to improve the efficiency of JG logistics activities.

We conduct our study in two stages: (1) identify of urban logistics challenges in JG; and (2) propose a concept of retail precinct management to improve the efficiency of JG logistics activities. We conducted a group discussion with manufacturers, their suppliers and logistics service providers, agencies and academics to identify key challenges in JG (The Logistics Institute Asia Pacific 2014a). Following that discussion, we conduct a field study involving a non-participation observation, questionnaires and semi-structured interviews (The Logistics Institute Asia Pacific 2014b).

From our findings in this study, we propose the concept of Retail Precinct Management (RPM). RPM consists of four inter related components: (1) urban logistics activities visualization and analytics, (2) multi-party loading dock coordination, (3) real-time delivery with multi-objective optimization and environmental impact considerations and (4) in-mall delivery consolidation.
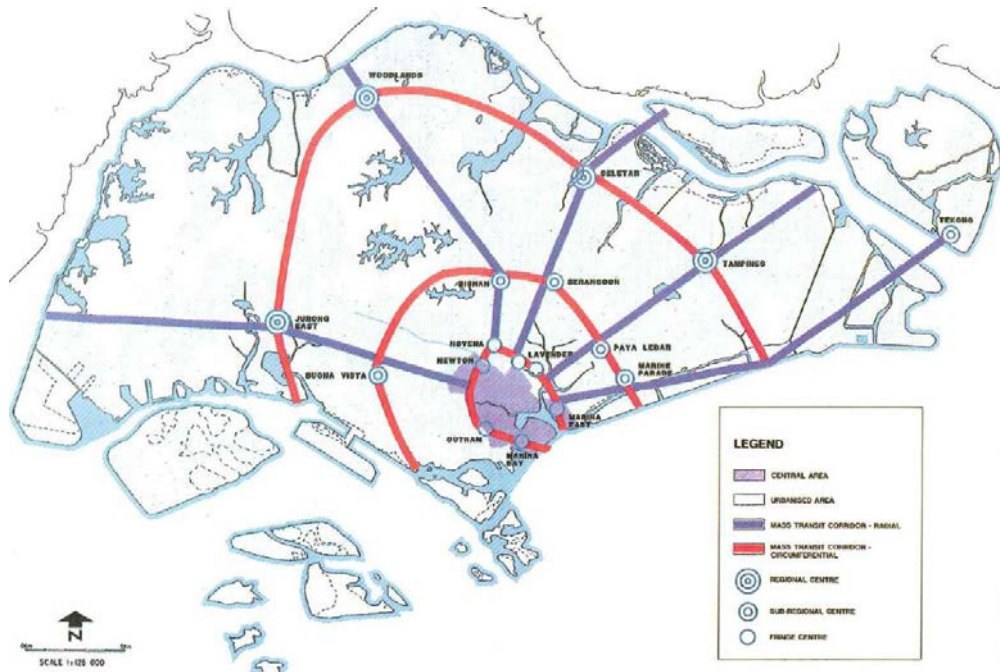
Fig. 1. Singapore Decentralization Strategy Based on 1991 Concept Plan (Urban Redevelopment Authority 1991)

2. Identifying Urban Logistics Challenges

To identify JG challenges, we followed the suggestions in the literature which recommended for a field study involving a group discussion, a non-participation observation, questionnaires and semi-structured interviews (McKinnon and Ge 2006, Puckett and Hensher 2008, Stathopoulos et al. 2012). The main purpose for the non-participation observation and the questionnaires is to map the real or structural situation in the region, whereas the group discussion and interviews are more focused on investigating possible problems in the region. The field study was conducted in February to June 2014. The detail description of the field study can be find in (The Logistics Institute Asia Pacific 2014b).

From our field study, we identify three major logistics challenges that cause JG to be prone and highly sensitive to traffic congestions, namely: (1) unconsolidated ordering from the retail shops, (2) unbalanced traffic density and (3) inefficient in-mall distribution.

2.1. Unconsolidated Orders from Shops

From logistics perspective, retailing, where people shop in an increasing number of places, is one of the major drivers of change (Dablanc 2007). In JG, the most representative form of this activity is in the case of shopping malls. JG currently has five large shopping malls with more than 690 retail shops in different categories. It requires frequent freight delivery trips to serve the demands of those retail shops. As a result, there are a large number of freight vehicles go to/from JG with the average of deliveries more than 550 daily.

From our interviews, it is revealed that one of the major reasons of high number of freight vehicles is unconsolidated orders from retail shops. Each retail shop places its own orders through online or offline system to one or multiple suppliers. The order time and frequency may be varied depending on the stock availability. The freight vehicles will deliver the items based on these orders. Mostly, one freight vehicle has at least one order in one or more shopping malls. If those vehicles have two or more deliveries to different shopping malls in the region, the freight vehicle needs

to go from one mall to another mall just to deliver the freight. The route is usually based on the driver own experience which may require them to go to the same road more than one time which will eventually contributes to the congestion in JG.

2.2. Unbalanced Traffic Density

Another major issue in JG is unevenly distributed traffic density with regards to the peak and non-peak hour. In this paper, we refer the traffic density as the number of vehicles per unit length of the roadway. Based on our traffic data collected in four points inside JG, during peak-hour, the number of vehicles, especially private vehicles, is quite high compare to non-peak hours. The average numbers of vehicles go through those 4 points of interest for every 15 minutes is illustrated in Fig. 2. Due to limited number of resources to conduct traffic counting, we are unable to capture the number of vehicles during the morning peak-hour, but the number of vehicle increment during lunch hours (11:15 am to 1:00 pm) and evening peak hours (5.30 pm onwards) is clearly shown. These high traffic densities result in traffic congestion or long queue length in the intersections.
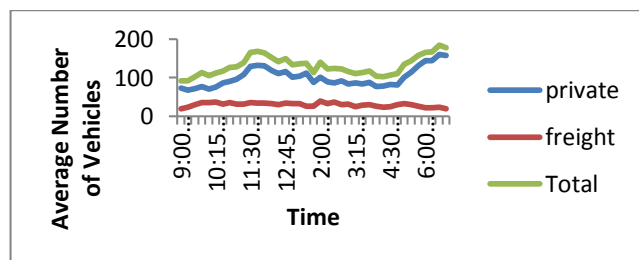

Fig. 2. Average Number of Vehicles inside JG.

Although the number of freight vehicles is smaller than the private vehicles, freight vehicles also contribute in JG congestion especially during those hours where the private and freight vehicles simultaneously move to the region and increase the traffic density. The peak hour for private vehicles are in the lunch time and evening, while for freight vehicles are almost equally distributed from 9 am to 5 pm. Currently, there is no time windows policy for freight delivery. The freight can be delivered though out the day depend on the operating hour of the destinations which usually from 7 am to 10 pm. The carriers will then choose to deliver their freight around 9 am to 5 pm where it is easier for them to find drivers and workers.

2.3. Inefficient In-Mall Distribution

The current practice for freight distribution in shopping mall is mostly inefficient because of low time utilization of critical logistics resources (drivers, helpers, elevators, and loading bays), retail delivery delays, and unintended queues of other vehicles waiting to enter the mall basement carpark. Current practice of loading/unloading starts with a freight vehicle, operated by a driver and a helper from a specific carrier, arrives at the loading bay. The helper unloads the freight and delivers them to one or more retail shops located in a specific floor using the mall shared facilities such as freight elevator. The helpers may need to wait for an available elevator which may impose additional waiting time and lead to late deliveries. Meanwhile, the freight vehicle needs to wait until the helper returns before it's departs from the mall. Other freight vehicles are then denied the space in the loading dock and need to wait until the loading bays are available again.

3. Retail Precinct Management

To tackle those challenges, we propose the concept of Retail Precinct Management (RPM) which aims to encourage different stakeholders to collaborate in addressing the issues of traffic congestion that challenges the development of JG. RPM consolidates deliveries, optimizes the delivery routes and utilizes the loading docks while provides a dynamic visualization and analytics to help tracking and monitoring the deliveries and traffic flow in the area.

Under the RMP concept, we pool together loading docks from different shopping malls within close proximity. JG offers a good case as it has 5 shopping malls within close proximity. Freight vehicles that have deliveries for retail shops in different shopping malls only need to go to any one of the shopping mall loading dock and unload all the deliveries in that loading dock. The last mile deliveries from the loading docks to the respective retail shops in different shopping malls are done on-foot or using an eco-friendly vehicle.

Stakeholder interactions in RPM are presented in Fig. 3. The system records the orders from the retail shops and order fulfilment and delivery requests from the suppliers. It consolidates these delivery requests and generates optimal routes for each freight vehicle based on the collection locations, collection schedule, delivery locations, delivery schedule (time windows), delivery volume and dimension, resource availability and traffic condition information using a real-time delivery with multi-objective route optimization. The traffic condition information is extracted from freight flow visualization and analytics system.
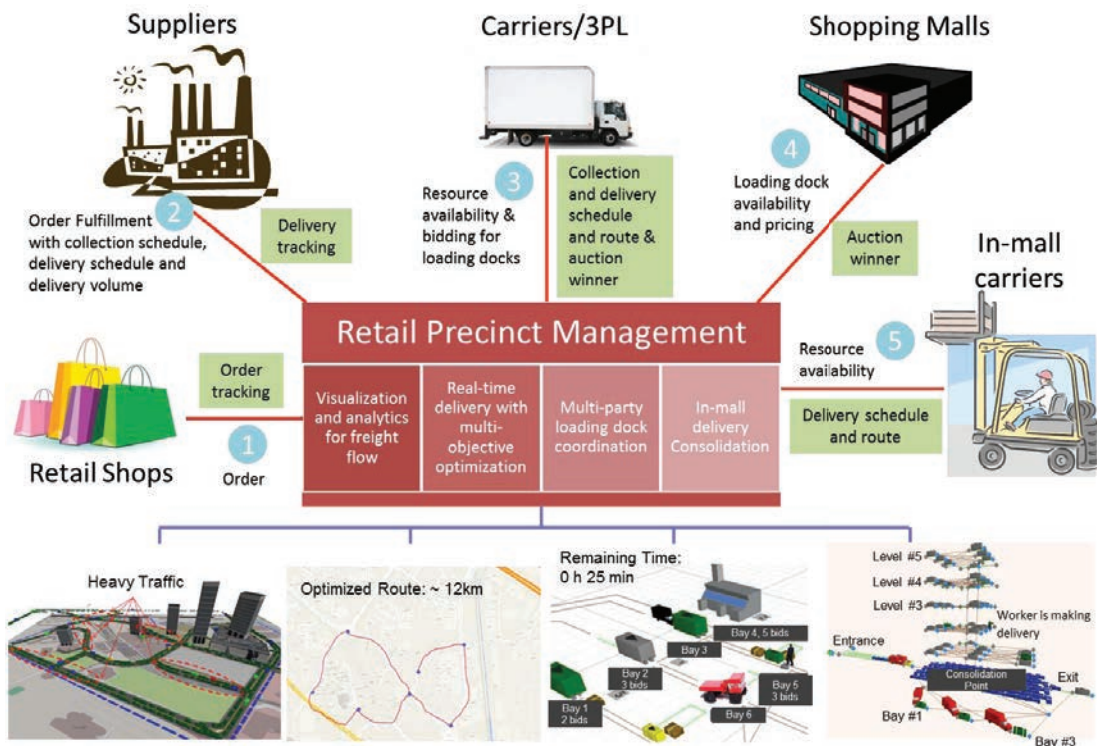

Fig. 3. Average Number of Vehicles inside JG.

After obtaining the delivery route, each freight vehicle needs to bid for a loading dock bay in a specific shopping mall and specific time windows before it delivers the freight. Based on the bids collected, RPM coordinates the allocated timings of loading docks for vehicles using an auction approach and broadcasts it to all the bidders. As a result, the delivery routes may need to be changed according to the loading dock allocation. RPM then generates in-mall distribution schedules and routes according to expected delivery arrival, retail shop locations, delivery volume

and dimension and in-mall resource availability using in-mall delivery consolidation. Each stakeholder is also able to track the delivery status and freight flow using visualization and analytics.

Based on the stakeholder interactions above, RPM is divided into four inter-related main components: (1) visualization and analytics for freight flow in the precinct, (2) real-time precinct delivery with multi-objective optimization and environmental impact considerations, (3) multi-party loading dock coordination and (4) in-mall delivery consolidation.

3.1. Visualization and Analytics for Freight Flows

With a high density of urban activities, JG experiences multiple urban logistics challenges in maintaining livability and self-sufficiency of the precinct and to satisfying the residents' need for a high-quality living environment. Planners and logistics players need to be informed about the JG's dynamics in both macroscopic and microscopic views, e.g., the movements of the dwellers, vehicles, freight, traffics and environmental. We focus on the freight flow to/from JG and inside JG. One of the most valuable means to understand the flow is through data visualization. We devise and employ Big Data Visualization, to help stakeholders understand the freight flow by placing it in a visual context. It is intended to analyze complex data and accelerates the identification of hidden patterns, trends and correlations that might go undetected in text-based data.

The core of the Big Data Visualization is based on an innovative platform called A*DAX (A*STAR Data Analytics Exchange Platform) as shown in Fig. 4. A*DAX is a scalable and open standards based platform designed to store, integrate and manage data for secure data exchange, analytics and visualisation. The platform incorporates data security and privacy features and handles both static and real-time data from the public and commercial sector. It allows translation and integration of data into actionable insights through machine learning and data analytics, so that citizens, businesses and public agencies can make informed decisions. The objectives of A*DAX are achieved through the following key features:

1. Secure Data Sharing. Data is securely managed and shared in a well-controlled way to the authorized parties. Secure data sharing gets automatically enforced, without getting comprised even the data is unified with other data in the system. This lays the foundation for the data owners to trustfully put their data in the platform for sharing, analytics and more.
2. Open Standards and Component-based Architecture. Under the design of standards-based architecture and flexible components substitution, A*DAX supports flexible data acquisition, management and processing. This is to accommodate the heterogeneities among the transport data, in terms of data size, type, arrival rate and usage pattern.
3. Data Unification and Integration. Underlying data fusion and unification, integrated data access, for better data accessibility and usage. This is to address the issue that data are obtained from various sources, with different schema, in different format. It is a critical feature that links related data set together to form a unified picture and derive useful insights.
4. Versatile Tools and APIs. Data APIs and management tools, data analytics tools, and visualization APIs are provided for convenience, accessibility, efficiency, and extensibility. This allows the developers to easily use our platform to share, analyze and visualize data.

In this study, we use A*DAX platform to analyse two external factors in JG: traffic condition in the immediate vicinity of the JG and car park occupancy patterns in shopping malls. We aim to derive an optimal time window for loading/unloading activities as an input for the real-time delivery with multi-objective optimization. Our visualization and analytics platform is illustrated in Fig. 5.
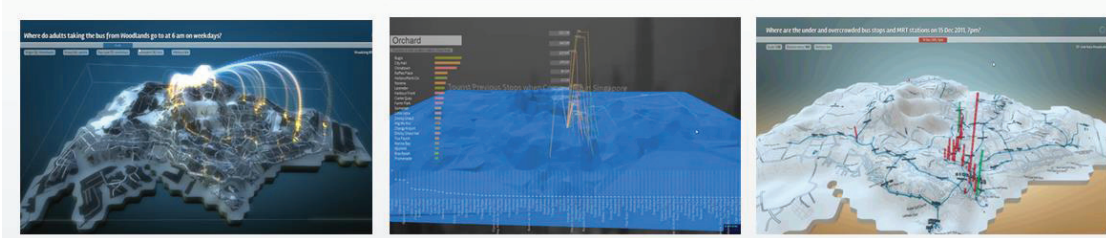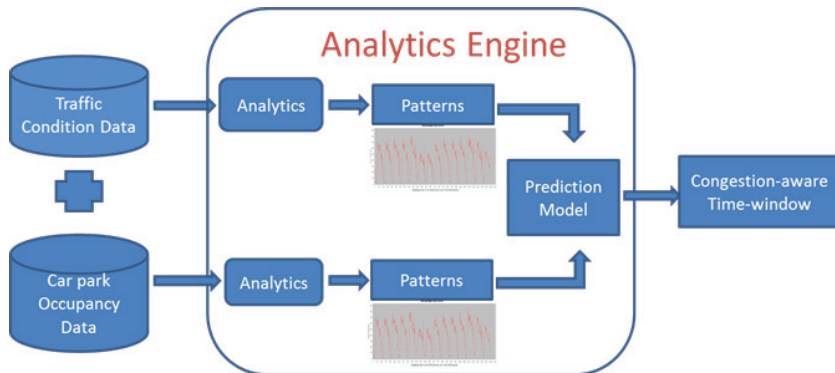
Fig. 4. Data Visualizations

Fig. 5. A*DAX platform for Visualization and Analytics of Freight Flow in JG

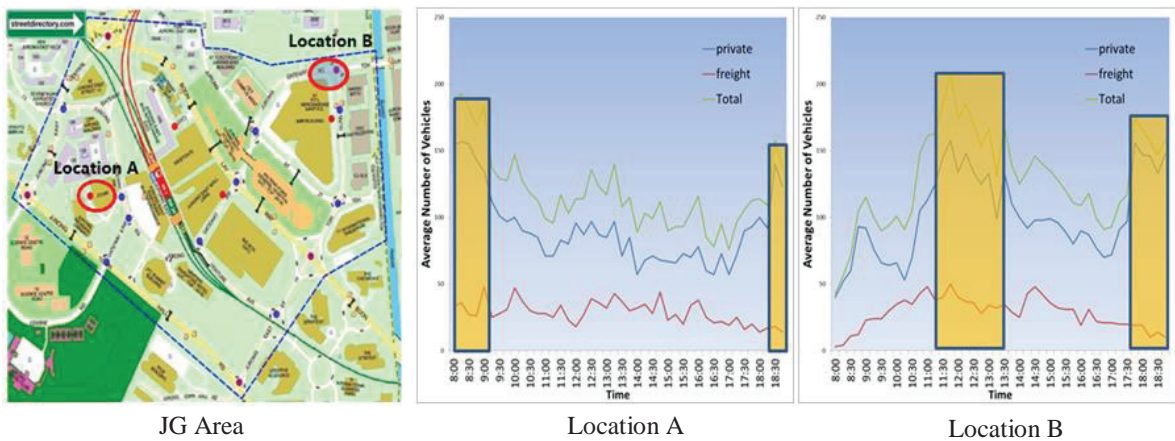| JG Area | Location A | Location B |

Fig. 6. Traffic Condition in JG

Based on our observation, traffic patterns can change depending on spatial, temporal and environmental conditions, such as time-of-the-day, day-of-the-week, weather, island-wide mega sale, festivals, holidays, exhibition etc. However, in recent years, advances in satellite tracking technologies have enabled the massive use of positioning systems in the transportation sector. This has provided an unprecedented opportunity for the emergence of intelligent, predictive location-based services. Figure 6 shows the traffic conditions in the vicinity of the JG. It is observed that the traffic flow behaviour in the vicinity of the JG is different for the two locations, as such it provides an opportunity to segregate the delivery time windows more efficiently.

We also perform a time series analysis of car park occupancy for several shopping malls. Based on the analysis, we find that the pattern of car park usage is predictable. There are regular numbers of visits on weekdays. More car park visitors on certain days indicate a trend of higher business activities on these days. Preliminary investigations of the traffic conditions and car park occupancy have suggested the data exhibits patterns on weekday/weekend and the patterns at various main roads and shopping malls differ. This suggested that we can fuse traffic and car park data to provide better information for the real-time delivery optimization to avoid traffic peak hours on the main road in the entrance vicinity as well as to avoid excessive competition for car parks/lanes with shop visitors.

3.2. Real-time delivery with multi-objective optimization and environmental impact considerations

To achieve higher efficiency and better service levels performance for delivery from supplier' locations to retail malls in JG, we propose a multi-objective vehicle route planning (MoVRP) using a novel multi-objective co-adaptive memetic algorithm (MO-CAMA) to search optimal delivery routes for freight vehicles by considering several objectives such as travel distance, waiting time, delay time and eco-friendly indicator. Appropriate constraints such as soft time-windows of deliveries are also built-into the developed models. By using the proposed MO-CAMA approach, freight can be effectively collected from suppliers and delivered to shopping malls. Furthermore, the developed MO-CAMA algorithms are also designed for fast response to real traffic information (e.g., traffic jam and vehicle breakdown) from the *visualization and analytics* component, orders changes from customers (e.g. changing delivery addresses or time windows) and loading dock timing allocation from the *multi-party loading dock coordination* component.

In this study, we formulate the problem as follows. The transportation network is an undirected, complete graph $G = \{I, J, A\}$ with $I = \{i_1, \ldots, i_n\}$ as the set of supplier nodes (supplier locations), $J = \{j_1, \ldots, j_h\}$ as the shopping malls, $A = \{(i, j) | i, j \in (I \cup P)\}$ as the set of arcs defined between each pair of nodes. There exists a set of homogenous vehicles $V = \{v_1, \ldots, v_m\}$ and a vehicle v has a capacity Q_v. A node $i \in (I \cup J)$ has a collection demand p_i, a delivery demand d_i, a service time s_i and a time window $[b_i, e_i]$. The service time s_i is termed as the actual time that the collection and/or delivery takes once a vehicle arrive at a node $i \in (I \cup J)$. The time window constrain $[b_i, e_i]$ means that a vehicle should be arrived at the location of node $i \in (I \cup J)$ not later than the latest time e_i. A vehicle is allowed to arrive before the earliest time b_i, in which case it must wati untile b_i and then begins to serve the node. The terms g_{ij} and u_v are defined to measure the load factor between two nodes and speed of vehicle $v \in V$, respectively.
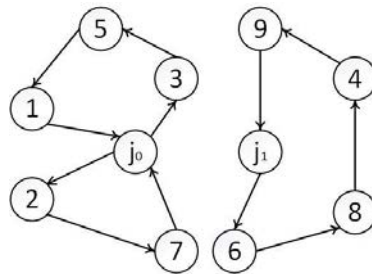

Fig. 7: Three routes $R = \{r_1, \ldots, r_3\}$ associated with two shopping malls $J = \{j_0, j_1\}$

Fig. 7 gives an illustrative example to show the solution including three routes to serve 9 suppliers and 2 shopping malls using three vehicles. The goal of the problem is to search a set of routs $R = \{r_1, \ldots, r_M\}$ for optimizing the objective functions such that each vehicle departs and return to the same shopping mall and each supplier is served once by a vehicle. Suppose $r_j = \{c(1, j), \ldots, c(N_j, j)\}$ is the sequence of N_j suppliers in a route r_j, where $c(i, j)$ denotes the ith supplier in route r_j. In addition, let $c(0, j) = c(N_{j+1}, j)$ represents the shopping malls associated with route r_j. In Figure 7, there are $M = 3$ routes $R = \{r_1, \ldots, r_3\}$ connected with two shopping malls $J = \{j_0, j_1\}$. For instance, $r_3 = \{c(6, 3), c(8, 3), c(4, 3), c(9, 3)\}$ is served with the sequence of four suppliers (i.e., suppliers 6, 8, 4 and 9) and the shopping mall is $j_1 = c(0, 3) = c(5, 3)$.

The procedure of the proposed MO-CAMA is as follows. At first, the population of solution is initialized, which includes different number of routes. At the same time, a population of memeplexes is randomly initialized. Each

memeplex consists of a number of memes (i.e., local search operators). The typical local search operators include intra-route merge, inter-route edge exchange, inter-route customer swapping, 2-opt edges swapping, etc. Secondly, our algorithm performs crossover and mutation to generate offspring solutions. Then, each offspring will select a memeplex to improve its quality (e.g., reduce the travel distance). After that, the mechanism of credit assignment will reward memeplexes with positive or negative values based on whether the fitness of an offspring is better or worse than its parent solution. The idea behind meme selection is that the meme with a larger accumulated reward value will have more chance to be chosen by offspring solutions. Thirdly, the offspring solution will compete with parent solutions to enter the archive. The proposed MO-CAMA will adopt a fast selection method, which is able to fast the process of the offspring selection.

   Due to our data limitation in JG, we cannot get the real delivery route from suppliers to the shopping malls. Hence, we use real delivery route from one carrier who serve customers in different region in Singapore to collect and deliver items and use it in JG scenario. We then compare the real delivery route with our MO-CAMA route. Using 5 objectives for the MO-CAMA, we summarize the improvement between the real routes and the first optimal routes found by MO-CAMA in Table 1. In particular, the solution found by MO-CAMA needs less number of vehicles to serve all the customers (i.e., 40% of number of vehicles in rea delivery route). On the other hand, the total travel distance is decreased (i.e., 59% of travel distance in real delivery route). In addition, the waiting time and CO emission are significantly decreased by MO-CAMA.

Table 1. The improvement between real delivery route and MO-CAMA route

f_1 No. of vehicles	f_2 Distance (km)	f_3 Waiting time (hr)	f_4 Delay time (hr)	f_5 CO Emission (kg)
40%	59%	0%	100%	59%

3.3. Multi-party loading dock coordination via auctions

   It is interesting to note that in global logistics, electronic marketplaces have been implemented that allow multiple stakeholders to coordinate their freight deliveries. In the context of retail precinct management, our concept is in establishing an e-marketplace that enables the coordination of arrivals of delivery trucks into the precinct so as to minimize congestion. We envision the establishment of an Urban Consolidation Center (UCC) within the precinct where shipments will arrive at the loading docks centrally, and the actual deliveries to the retailers within a mall and across malls are performed via a neutral provider, who may operate by either its own fleet or make use of the carriers' fleets making deliveries into the precinct.

   While the idea of a UCC and cross-docking is not new, and has been practiced in various settings in different parts of the world, what is lacking generally is the technology and business model that enable different stakeholders (namely, shippers, providers and retailers) to benefit from the result of consolidation. This involves not simply optimizing the arrival and departure timings of each truck and how loads are consolidated, but also how the cost savings should be shared among the different stakeholders. At the same time, the UCCs' sustainability also needs to be ensured through profitable consolidations. For this purpose, we propose appropriate mechanisms to ensure every stakeholder stands a fair chance to benefit from the consolidation and to obtain a fair allocation of cost savings. In the case where a UCC owns a fleet of vehicles to perform in-mall or cross-mall deliveries for example, auctions may be employed that allow carriers and/or retailers to bid on arrival timings of trucks, and specify side constraints and preferences of consolidation. Unlike a first-come-first-served, fixed-rate mechanism, an auction requires carriers and retailers to participate by submitting competitive bids. The UCC then selects the bids that yield the highest profit, which consequently makes it more sustainable financially.

   For the purpose of the RPM concept proposed in this paper, the UCC can be located near the boundary of the Jurong Gateway precinct, where the traffic is not dominated by private cars, so as to minimize the interference of cargo trucks to the traffic flow of private cars going into the malls. The cargo trucks drop their deliveries off at the UCC. The UCC then performs zone-based consolidation in which each mall constitutes one zone. Using its own fleet of eco-friendly delivery vehicles, the UCC delivers the consolidated loads to the respective malls. These loads will

then be subjected to the in-mall delivery consolidation discussed in the next section. Similar to the zone-based consolidation proposed by Handoko et al. (2014), an auction mechanism is used to maximize the profit of the UCC. However, rather than specifying the arrival at the UCC and the delivery deadline in the bid, a participating carrier must specify the time window it is expected to arrive at the UCC. At the end of the auction, the UCC determines the winning bids and then decides on the actual arrival of the winning carriers at the UCC via loading dock scheduling. Based on the assigned schedules, delivery routes may need to be changed by re-running the multi-objective route optimization discussed in the preceding section.

Due to the unavailability of detailed delivery data at JG, we present below the results of zone-based consolidation for deliveries to a central business district using the auction mechanism proposed in (Handoko et al., 2014). In our experiment, a total of 76 deliveries to 4 zones are simulated for a period of one week. 28 deliveries result from re-stocking after the weekend and can be carried out on either Monday or Tuesday, while the remaining 48 deliveries arise from re-stocking for the weekend and can be carried out on Wednesday, Thursday, or Friday. Assuming that all cargo trucks and delivery vehicles are of the same capacity, Table 2 summarizes the efficacy of zone-based consolidation in reducing the delivery cost as well as the traffic within the delivery area. Furthermore in Fig. 8, we present a pictorial view of the detailed consolidation of the deliveries that is output by the prototype system developed for this purpose.

Table 2. Efficacy of the UCC

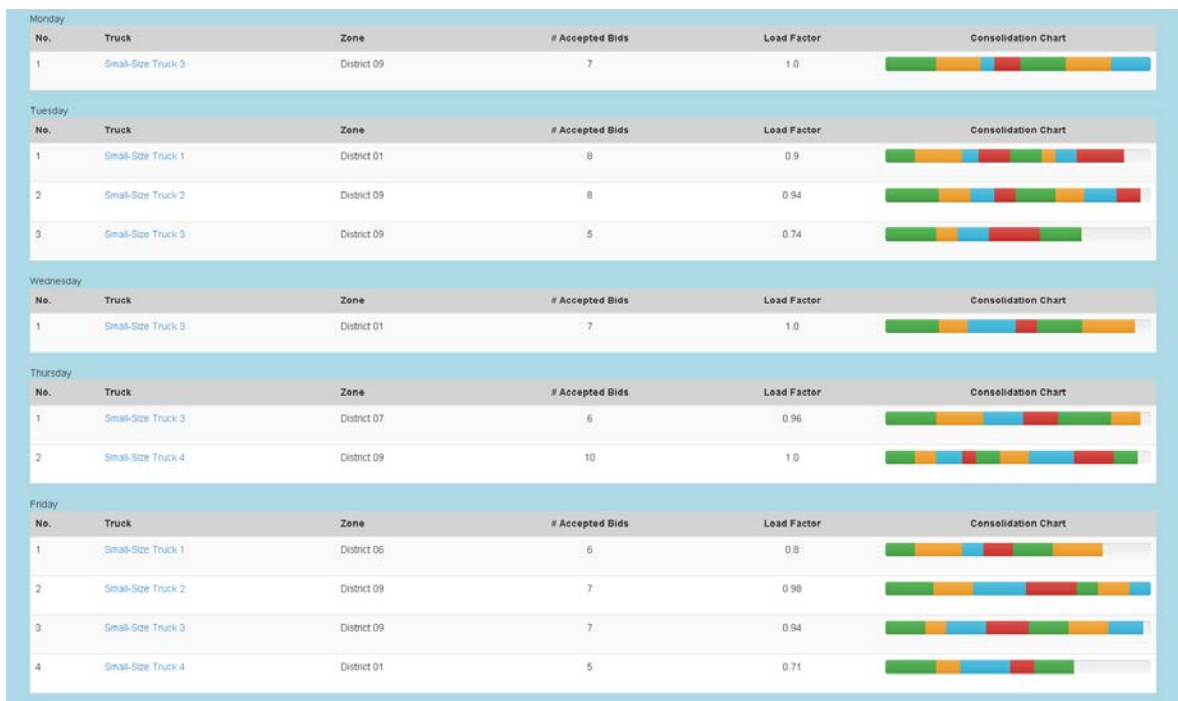|	Without UCC	With UCC
Number of Trucks	20	11
Average Truck Utilization	49.85%	90.64%

Fig. 8: Consolidation Results at the UCC

3.4. In-mall delivery Consolidation

To improve the efficiency of in-mall distribution, we propose the concept of in-mall delivery consolidation. Using expected arrival time from multi-party loading dock coordination component and real-time delivery with multi-objective optimization component, we generate in-mall distribution schedule and route. After different orders of different retail shops are unloaded at the loading docks, these orders are collected, sorted, and consolidated at the loading docks area based on the generated schedules and routes. All orders that have the same destinations (i.e. floors or shop clusters) are sent out together while considering capacity (elevator or worker) and time window (preferred delivery time) constraints. This in-mall delivery consolidation can be operated by the shopping mall operators itself or by independent logistics service provider.

We propose a capacitated traveling salesman problem with time windows (CTSPTW) to generate the schedule and route for in-mall distribution, which could overcome the typical setting of in-mall deliveries to optimize the in-mall delivery route (The Logistics Institute Asia Pacific 2014b). This approach attempts to deliver as much as possible freight that have already been consolidated in the loading dock to be delivered to different retail shops in the same or different shopping malls by the same in-mall trips as long as operational constraints or the delivery time windows are not violated. The time window is the time interval in which each retail shop requests to be serviced at its location.

To investigate the impact of routing optimization for in-mall distribution, we run our algorithm to generate route for in-mall delivery in the first floor of one shopping mall. We generate one week demand for nine retail shops in the same floor. We assume that all in-mall deliveries are made internally by shopping mall operator staffs or in-mall logistics service provider staffs instead of the carrier helpers.

Fig. 9 shows the comparisons between the typical delivery operation where a driver and a helper deliver the freight to the retail shops individually and the optimal in-mall delivery operation using CTSPTW algorithm. As much as 61% reduction in total travel time is found for the entire week. This reduction in overall travel time may also reduce the congestion at peak-hour delivery inside the mall, which might indirectly impact on shoppers' satisfaction. Further, our result also shows reduction in the number of trips that will reduce logistics resources use, especially elevators, causing less operating costs, less often maintenance required, and longer life span of resources. The detail results of our algorithm are available in (The Logistics Institute Asia Pacific 2014b).
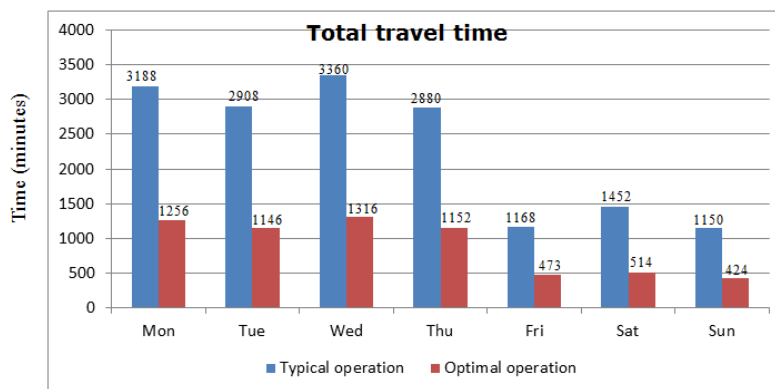

Fig. 9. Comparisons of total travel time (routing time) that delivery guys spend to serve all retail shops

4. Conclusions

In conclusion, this paper has outlined the logistics challenges and urban logistics concept to improve the urban logistics activities for one example of retail cluster in Singapore, JG, which is experiencing the negative effects of uncoordinated and inefficient logistics operations and will be accentuated with the upcoming expansion of urban functions. Using the four inter-related components in our proposed Retail Precinct Management (RPM) concept, we

show significant improvement in reducing number of logistics resources used, increasing resource utilization, reducing traffic congestion and reducing CO2 emission.

We see three limitations in our study. First, in term of data, we do not have real delivery data in JG which force us to use synthetic data based on our field study findings. In the future, we would like to collaborate with different stakeholders to get more delivery data. Second, in term of evaluation and integration, we evaluate and report the finding of the four components individually. In the future, we would like to integrate all the components and conduct an experiment to investigate the overall impact of RPM concept. Third, in term of scope, we only study one precinct in Singapore: JG. In the future, we would expand our study to other retail clusters in Singapore or other country.

Acknowledgements

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