Building Last Mile Delivery Scenarios: A Case Study of Melbourne

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Abstract - **This paper aims to build plausible scenarios to formulate the future of last mile delivery using planning and transport infrastructure attributes as key drivers of last mile bottlenecks. The scenario thinking method is applied to understand and analyse apparent perverse last mile challenges with 'critical uncertainties' associated with projection of future patterns. Key stakeholders associated with last mile delivery in an urban setting were identified and their positioning assessed on *power* and *interest*. The state and local government with HighPower:LowInterest (HP:LI), and truck associations/drivers LowPower:HighInterest (LP:HI) were identified as key stakeholders with different levels of power and interest. Players such as VicRoads and Traders Associations represent the quadrant of HP:HI who could play a vital role to gain support for more infrastructure investment and technological innovation to help improve the efficiency of city logistics operations. Four plausible urban scenarios were identified using two extracted dimensions: *Infrastructure Supply* and *Intensive Land use*. The worst/worst scenario highlighted the area of need for strategic planning to mitigate risk associated with damaged products, congestion, last mile delivery stagnation and ageing infrastructure.**

Keywords - **Last Mile, scenario thinking, city logistics and supply chain.**

I. INTRODUCTION

Melbourne is experiencing accelerated growth and social change with increased population, changing outer boundary, creation of new activity centres, new suburbs coupled with changing planning and transportation regulations. All these changes create challenges to last mile delivery. Last mile deliveries are expected to escalate as a result of increased population, online retail transactions, changes in demand for global products, and the increased complexity of logistics and supply chain networks. It has therefore continued to increase in terms of volume, distances and fuel consumptions. While last mile delivery can be blamed for its contribution to CO2 emission, planning and transportation network systems however, creates different level of impedance to last mile delivery resulting in high level of inefficiency, delays and high cost of last mile delivery. For instance lack of loading and unloading area can make last mile delivery vehicles to circle for longer until there is an available space for pick-up or delivery. One of the ways to gain a better understanding of the future possible and plausible of last mile delivery is creating situations through scenario thinking.

Last mile (LM) is a term used in the description of goods within the city to the final destination. This could be in terms of delivery to warehouses within the city or to the final consumer. The delivery is often complex, slow, expensive and inefficient. To add to last mile delivery complexity is the fact that government are seeking towns based on compact city model with the aim to contain and manage urban growth and to increase population within the inner city and Activity Centres. Last mile city logistics to account for 20 to 30 per cent of all vehicles kilometres. In Melbourne for example, it accounted for 32 and 34 per cent of light delivery/service vehicles and heavy commercial vehicles respectively entering the Melbourne.

This paper therefore aims to present scenario thinking methodology in the discussion of last mile delivery impedance using planning and transport systems attributes. The paper proposed to examine the different built environment dimensions that will impact future last mile delivery including possible and plausible future of last mile delivery in a dynamic compact city, and examine the stakeholders with powers and interests in business to business last mile delivery.

II. RESEARCH METHODOLOGY

Scenario thinking approach has emerged in an attempt to bridge the void and the uncertainty that cloud the understanding of the future in the present time. Its emergence therefore can be traced to the application of ideas of foresight studies [1] in the field of management and future studies [2]. It offers a range of future possibilities against which to test current plans, develop and appraise new options and, hopefully, make better informed and considers the degree of possibility and plausibility.

Scenario thinking workshop with 14 participants was conducted. Three major stakeholders identified in the last mile delivery [3], [4], [5] [6] participated in the scenario thinking. These stakeholders include administrators, operators and end-users. Officials from state government agency (VicRoads), and local government council officers represents the ***administrators***. Drivers and Logistics Managers represents the ***operators***, while retailers represents the ***endusers***. Purposeful sampling [7], with small number of participants [8] was utilised in selecting the participants. Participant for scenario thinking were selected based on their understanding of the issue of last mile delivery. Participants at the scenario thinking have initial understanding of the issue relating to last mile delivery and have been involved in last mile delivery for the past 5 years either as a Transport Planner, Driver, Logistic Manager or Retailer.

Five steps procedure are followed in the scenario thinking workshop. The five steps balanced the three steps and eight steps approach used in scenario thinking workshops [9], [10] and [11]. The three steps limit opportunity for important discussion for example stakeholders' analysis, while the eight steps duplicates some steps that can be discussed in one step.

Participants identified various last mile environmental planning and transport attributes and clustered the attributes through rational reasoning. An impact and certainty analysis was carried out to determine various scenarios.

III. RESULTS

The findings of the scenario thinking workshop is presented in this section.

Step 1: Identification of last mile delivery impedance attributes.

Participants are probed to list what they perceived as built environment, planning and transportation network attributes that impedes last mile delivery within Metropolitan Melbourne. The process of impedance listing/identification was conducted first on an individual basis, so that each participant raised as many issues as they can think of in the time allocated. At this stage, last mile delivery impedance issues relating to built environment, planning and transport systems are recorded individually, each on separate Post-it note without any discussion. A total of 34 different attributes and issues are identified by the participants.

The identified issues and attributes revealed what are important to each category of participants. Importantly, four attributes identified by the drivers are not considered significant by the other participants. These includes: Intersection constraints, roadwork restrictions when road works has been completed, lack of drivers' knowledge on how to merge and toll. Specifically, drivers are frustrated when traffic work restrictions are still on the road after completion of construction works. Generally, the scenario thinking identified toll as a major impedance. While toll is not applicable to large operators, small scale operators identified it as major impedance and small scale drivers tends to avoid toll as much a possible given the high cost of toll.

On the other hand, the sections representing the administrators identified surrounding area and vehicle ownership rate; dwelling density; the year of land subdivision; change in road hierarchy and change in number of lanes; proximity to freeway interchange; and distance from freight network as the attributes of impedance to last mile delivery apart from the ones identified by the drivers.

Step 2: Clustering of attributes and defining of cluster.

The identified attributes are clustered through a group process of action discussion and consensus building. The stage starts with putting all the Post-it® on a wall and discussing the attributes by participants. Each attributes are clustered together by ensuring coherence of attributes within each clusters. This was followed by discussion of best and worst level of impedance of each attributes, positive or negative. The attributes were then clustered into six dimensions which fully captures every attributes within it. The six dimensions are Freight Infrastructure (1), Land Use Intensity (2), Infrastructure Supply (3), and Infrastructure Sharing (4), Intersection Control (5), and Behaviour (6).

The attributes clustered into the *Freight Infrastructure* dimension includes loading and unloading area, number of available loading and unloading area and parking restrictions. These attributes relates to the basic physical structures and facilities required for last mile delivery. Attributes within the *Intensive Landuse* dimension includes surrounding area and vehicle ownership, parking restrictions, traffic count, density dwelling density, size of shopping centres, traffic generation and activity centres. The dimension for *Infrastructure Supply* relates to quantity. Attributes in this dimension to is made up of intersection constraint, speed limit and change in speed limit, road network capacity, change in road hierarchy and change in number of lanes, road closure, road width, number of lanes, distance from freight network, road network design & alignment (road geometry), road hierarchy and toll.

The fourth identified dimension is "*Intersection Control"* that includes railway boom gate, traffic lights and road design after thought. *Infrastructure Sharing* includes bicycle lanes, trams and proximity to other transport modes (Railway/Tram). The last dimension is *Behaviour* with attributes that includes lack of drivers understating of road merge and road wok restrictions when there is no road works.

Step 3: Impact and Uncertainty Analysis.

The six cluster dimensions on a Post-it® are arranged along the full length of the Impact axis, positioning them relative to each other through a process of discussion of the perceived degree of impact/ impedance of each attributes on last mile delivery. After the impact and level of impedance has been considered, the group proceeded to move the Post-its® relative to the High/Low Certainty (of the impact/impedance of the outcomes) axis. This is done using the full extent of the axis and without disturbing the relationship on the Impact axis. Impact refers to the effect on last-mile delivery performance, while certainty is the levels of confidence about the likely impact.

Two-dimensions framework driven by *Infrastructure Supply* and *Intensive Landuse* based on high impedance/impact and high uncertainty were developed. Figure 1 reveals the level of certainty and impact of the clusters. Freight Infrastructure is identified to be of low impact and medium impedance. Behaviour is considered to be of low impedance and low certainty. Infrastructure

Sharing is of medium impact and medium certainty. Infrastructure Supply (A) and intensive land use (B) are identified to be of high impact/impedance and of high uncertainty. These attributes are considered by participants as independent of each other and are used to form the last mile delivery impedance Scenario Dimensions.

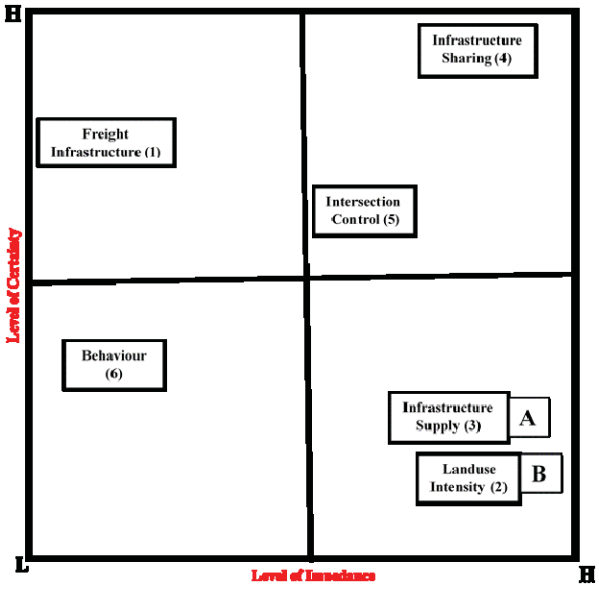

Figure 1. Cluster movements on the axis.

Step 4: Scoping the Scenarios and Developing the Scenarios

The two dimensions highlighted during impact and certainty matrix are combined for scenario thinking. This is in terms of best/worst, best/best, worst/best and worst/worst (see Figure 2) combination of the selected dimensions. The best/best outcomes described an 'ideal world' which the dimensions favours last mile delivery.

However, last mile impedance issues arise by consideration of the best/worst of the dimensions, a scenario in which one set of positive descriptors was moderated by a set of largely negative descriptors. Combining the two selected dimensions, participant considered the level of impedance to last mile delivery over the next 10 – 15 years within the Metropolitan Melbourne. The dimension with the highest likely impact is combined with the one with highest level of uncertainty to formulate the scenario over the next 10 – 15 years. The broad possible scenario outcomes are discussed at their best and worst situations over the next ten years. This is given the level of future impact/impedance and level of certainty perceived.

In quadrants 1, infrastructure supply will be at its best, while intensive landuse will be at its worst. An indication of improvement in the identified associated individual attributes for infrastructure supply and a worst case for landuse intensity - decayed landuse. Participants agreed that at this instance, there is possibility of efficient fast and cost effective delivery as a result of the best outcome of the infrastructure supply.

Quadrant 2 represents the best of infrastructure supply and best of landuse intensity. The best of infrastructure supply includes less constraint on last mile delivery vehicles in terms of reduced road closure and height restriction improved road alignment, increased number of lanes and reduced toll for last mile delivery vehicles. Best of landuse intensity, will include reduction in the number of traffic competing with last mile delivery vehicles, especially within activity centre zones and shopping precinct. On the contrary, the worst of infrastructure supply and landuse intensity will include continued closure and restriction to last mile delivery vehicles, increased toll, reduced number of lanes and more intensity landuse with increased in number of vehicles competing with last mile delivery vehicles within activity centres and shopping stripes. Within this quadrant the attributes clustered into Factors A and B will be at their best. This will result into an increase in usage of the available infrastructure, decrease congestion as a result of better infrastructure, low cost delivery resulting from low level impedance and increased productivity.

Quadrant 3 represents a worst/worst situation of the two factors. This will result into a likely total collapse of last mile delivery resulting from gridlock and decrease in usage, delay increase, increased and high cost, productivity loss, less delivery per day and negative environmental impact on air quality, increased Greenhouse gas emissions, increase noise from last mile delivery vehicles, safety with accompanied unsustainable delivery system.

Quadrant 4 represents the best of Factor B and the worst of Factor A. Participants agreed to the following possibility and plausibility of ageing and damaged infrastructure resulting into higher environmental impact, damaged product, congestion, gridlock, and business stagnation.

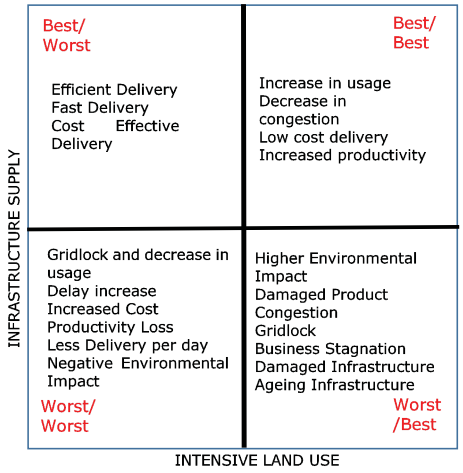

Figure 2: Future Possible Scenarios.

Step 5: Stakeholders Analysis.

The matrix on power and interest is to identify different stakeholders in last mile delivery. The matrix is categorised into *Context Setters, Players, Crowds and Subject*. The context setters represents the unaffected; the players are the involved actors; the crowd unaffected bystanders; and the subject as the involved bystanders.

Participants recognised the following as stakeholders in the future of last mile delivery impedance. The participants agreed that the power over and interest in can change over time. For instance the interest of a particular person in the local community i.e. customer expecting a delivery can change from crowd to players. Also depending on situation, a context setter can become a crowd or player.

From the matrix, Administrators (Federal, State and Local Governments) are Context setters of high power, but of low interest. Trans Urban, the agency in charge of tolls and Trucks Association are also identified to have also of high power with low interest in last mile delivery. These groups are [identified players in last mile delivery. On the extreme are Road users and NGO's identified as with low interest and low power. VicRoads, Traders Association and Lobbyist (Players) are identified to have high interest, but low power. The Drivers, Local community and Business owners are the Subjects. These groups have low power but high interest.

From the discussion, the stakeholders with high power can improve last mile delivery and reduce the level of impedance. Public Transport Victoria and VicRoads for example can influence speed limit and traffic lights management. Also, the removal of railway boom gates and removal of other last mile delivery constrains are in their powers. Also reduction in toll paid by last mile delivery vehicles is in the power of Trans Urban. However, these agencies have low interest in mitigating last mile delivery.

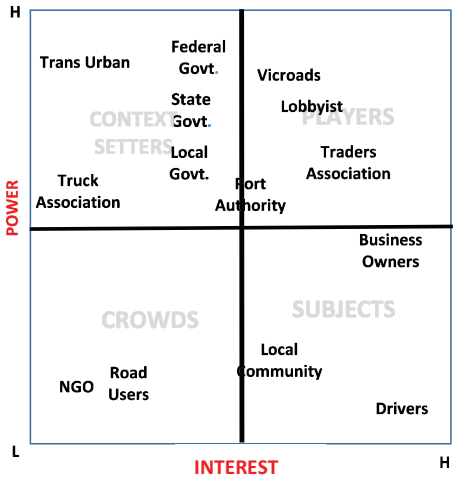

Figure 3: Stakeholders in last mile delivery.

IV. CONCLUSION

This paper identified the potential planning and transport systems attributes of the last mile delivery impedance using a scenario thinking approach. A total of thirty four different attributes with different levels of impedance to last mile delivery were identified. These are then iteratively aggregated into six clusters, which represent various dimensions of last mile hurdles through discussion and consensus building. The dimensions of 'high impact' and 'high uncertainty' were used to ascertain the positioning of attributes representing the last mile impedance levels. Key stakeholders that affect and or affected last mile delivery were identified and their alignment evaluated on power and interest. State and Local Government (HP:LI), Truck Association/drivers (LP:HI) were identified as key stakeholders with different levels of power and interest.

Players such as VicRoads and Traders Association represent the high power and high interest to help lobby and campaign for more infrastructure investment and technological innovation. Four plausible urban scenarios were identified using two dimensions (i.e. Infrastructure Supply and Intensive Landuse). Worst/Worst scenario highlighted the need for strategic planning to ensure low level last mile delivery impedance and guide against damaged products, congestion, last mile delivery stagnation and ageing infrastructure.

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