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Towards sustainable urban freight distribution – a proposed evaluation framework

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Abstract

Cities around the world are confronted with a great challenge from the rapid growth of urban freight distribution that has resulted in numerous adverse impacts. Goods movement plays a fundamental role in urban economic and social development. Therefore, the urban area as a centre of commercial and social activities, a place to work and live requires reliable and efficient freight transport systems to sustain it.

Transport policy making is becoming more complicated as there are multiple factors and stakeholders with different and sometimes conflicting objectives to consider. This is not an easy task to implement transport policy as well as equally satisfy all stakeholders. A more inclusive evaluation tool that enables dealing with such a complex urban environment is necessary to assist decision makers in making such decisions.

The aim of this paper is to discuss an ongoing research on the development of an evaluation model for prioritising and selection of last kilometre urban freight distribution initiatives. This paper presents part of the research on the findings from investigation of the study area, retailer survey and the proposed conceptual framework. An overview of urban freight distribution will be briefly introduced. The case study of the Rundle Mall Precinct in Adelaide and preliminary findings from retailer survey will be discussed. Next, the policy evaluation of sustainable urban freight distribution and different methods will be elaborated and the proposed sustainable urban freight distribution evaluation framework will be presented.

Keywords: urban freight distribution, transport policy evaluation, sustainability

1. Introduction

Goods delivery within the city centre is a fundamental activity that maintains the liveability of the urban community and strengthens economic development. However, urban freight transport significantly contributes to various negative effects on the urban environment such as air pollution emission, noise, vibration and accidents. At the same time, the recognition of environmental and social consequences on policy implementation is raising concerns with regard to sustainable transport. This awareness puts pressure on both public and private sectors and also influences transport planning and decision making.

In the past decade, several studies have been carried out on urban freight transport planning and evaluation. Various measures have been implemented and their outcomes have been reviewed (COST 321 1998; Organisation for Economic Co-operation and Development 2003; Munuzuri et al. 2005; BESTUFS 2007). However, not all of the measures were implemented successfully.

In determining the appropriate measures to minimise the impacts of urban freight transport it is necessary to understand not only the specific issues that the measures need to improve in the particular urban area, but several stakeholders involved with different objectives. This is a complicated task. In addition, the last kilometre freight distribution is carried out in urban areas where several constraints exist such as limited infrastructure that has to be shared with passenger and public transport, regulations and restrictions such as vehicle access restriction and time windows.

This paper presents part of an ongoing research which aims to develop an evaluation model for last kilometre urban freight distribution initiatives. The emphasis in this paper is on the investigation of the case study area which allows identifying the issues for research as well as the preliminary findings of retailer survey and the formulation of an evaluation model for last kilometre freight distribution initiatives. The following section provides an overview of urban freight transport and last kilometre freight distribution, stakeholders, urban freight initiatives and success factors. The case study of the Rundle Mall Precinct and associated plans and policy that set out the issues to examine, will be brought into consideration. Next, findings from a retailer survey will be presented. The review of different methods used for policy evaluation of urban freight distribution will be elaborated. Then the proposed sustainable urban freight distribution evaluation framework will be presented.

2. Urban freight transport and last kilometre freight distribution

Different types of freight flow in, out and through the urban areas including consumer goods, waste products, construction materials, mail, etc. (Dablanc 2007). Changes in modern society influence the continuing growth of urban freight transport such as movement towards a post-industrial society, urbanisation, aging, individualisation and also the increasing awareness of sustainable development (Organisation for Economic Co-operation and Development 2003). At the same time, businesses are also moving towards just-in-time (JIT) operation which requires timely delivery with small shipments and less storage space. Furthermore, the rapid growth of online shopping has also generated significant increase in the volumes of home deliveries as well as the level of freight traffic.

Last kilometre freight distribution emphasises the last link of the supply chain that delivers goods to retailers in urban areas. Traditionally, the retailer as the last party in the supply chain is the one who finally sells the product to the consumer. The key characteristics of last kilometre freight distribution are: a wide variety of goods, taking place over relatively short distances in a congested urban setting and small shipment size with high frequency of delivery. Freight carriers will serve a number of locations in one delivery round with less capacity utilisation in comparison with long-distance freight transport. The study by Allen et al. (2000) also stated that the degree of centralisation in the supply of goods to retail outlets also influences the level of freight transport.

In the past, the area of urban freight transport has not been extensively researched. Most of the attention has been paid to passenger transport and long-distance freight transport. Prior to the mid-1990s, urban freight transport has received less attention from researchers and policy makers (BESTUFS 2007). Over the following decades, there has been growing interest in urban freight transport, for example, the comprehensive book by Ogden (1992) “Urban Goods Movement: a guide to policy and planning” which is a compilation of previous studies, the OECD report “Delivering the Goods: 21st century challenges to urban goods

transport" (Organisation for Economic Co-operation and Development 2003), the founding of the Institute of City Logistics in 1999 and several projects in Europe such as the "BEST Urban Freight Solutions" (BESTUFS 2007) and Electric Vehicle City Distribution (ELCIDIS) (Vermie 2002). The overall objective of these studies and projects is to search for a more sustainable urban freight distribution solution and to circulate best practices.

2.1 Stakeholders in urban freight distribution

Various groups of stakeholders are involved in urban freight transport with different and sometimes conflicting interests (Taniguchi et al. 2001). The key stakeholders which are residents, retailer, transport operators and government authorities and their interests are summarised as shown in Table 1.

Table1: Major stakeholders and their interests

Stakeholders	**Objectives/Interests**
Residents (consumers/workers/visitors)	- Good living environment, minimum hindrance caused by freight vehicles and negative environmental impacts - Timely availability of goods - Attractiveness, good shopping atmosphere - Accessibility and parking spaces
Retailers/receivers	- Good shopping ambience - Competitiveness and profitability
Transport operators	- Attractive working environment - Adequate freight transport infrastructure - Cost efficiency and profitability - Accessibility
Government authorities (local, state and national)	- To manage quality of the city centre to attract shoppers, tourists, workers and residents - Effective and efficient transport operation - To resolve the conflict between stakeholders - Economic growth

Recently, a number of pieces of research work on policy evaluations of freight transport have attempted to incorporate relevant stakeholders and their interests into the planning and decision-making process. Policy recommendations by the OECD (2003) also suggested that agreement among all stakeholders was crucial in developing a feasible and practical policy vision.

2.2 Classification of urban freight distribution initiatives

A more innovative measure is emerging across cities with the objective being to minimise the negative effects of freight transport, increase efficiency and ultimately enhance sustainability in urban areas. Different classifications of city logistics' measures have been proposed (Munuzuri et al. 2005; BESTUFS 2007; Quak 2008; Patier & Browne 2010; Russo & Comi 2010). The summary of initiatives, objectives and examples is presented in Table 2.

Table 2: Categorisation of major urban freight initiatives

Category of initiatives and objectives	Example
Operations - To improve operational efficiency including speed and reliability of deliveries, reduction of costs, convenience and customer service, and operational safety	- Off-peak/night deliveries - Information and technology tool (real-time traffic information, routing and scheduling, vehicle tracking systems) - Consolidation of deliveries
Land use and infrastructure - To reduce demand for freight transport by reorganising land use patterns in urban area	- Relocating logistics and industrial activities - Off-street unloading facilities - Underground logistics system
Environment - To reduce or minimise the environmental impacts of urban freight transport	- Urban consolidation centre - Use of environmentally-friendly/clean vehicles (electric vehicles, freight trams, cargo bikes) - Low emission zones
Regulations - To influence urban transport behaviour and patterns through the implementation of traffic and transport policies	- Access restriction (vehicle weight/size/ dimension/time/load factors) - Dedicated facilities for freight traffic - Road pricing - Incentives
Technology - To improve operational performance and/or equipment and facilities - To reduce environmental impact through the application of technological initiatives	- Access control systems - Information technology - Technology for reduced noise in operations - Vehicle design and technology to reduce pollution emission - Reservation of parking lots

It is arguable that most urban freight distribution initiatives could be categorised in more than one category. However, the initiatives presented in Table 2 offer a good foundation for further investigation into proposing appropriate urban freight distribution initiatives.

2.3 Key success factors

From the literature reviewed, not all the initiatives could be successfully implemented. The lesson learned from previous experiments or implementations addressed several factors that need to take into account for successful implementation:

- The involvement of relevant stakeholders from the beginning of the project
- Identification of the target group as the measures might benefit one particular group of stakeholders more than the others
- Cooperation and communication among stakeholders (Lindholm 2010)
- Enhancement of knowledge, understanding and awareness of sustainable urban freight distribution (Lindholm 2010)
- The importance of evaluation for assessing the possibilities and negative effects of the implementable measures
- The analysis and selection of implementable measures has to consider stakeholders and find the best possible compromise between all the interests of the stakeholders involved (Russo & Comi 2011).

The abovementioned factors are some of the key issues that need to be taken into account in order to enhance the urban freight transport policy planning and implementation. These factors are acknowledged in the research as a crucial point in the evaluation model development especially the involvement of stakeholders in the planning process. Even though the issues of urban freight transport in many cities are relatively similar, the characteristics of the urban areas are case specific and some initiatives cannot be easily transferred.

3. Case study: Rundle Mall Precinct, Adelaide

The Rundle Mall Precinct is Adelaide's major retail destination, established in 1976. The precinct is located in a strategic location and bounded by King William Street, Grenfell Street and Pulteney Street as shown in Figure 1. The Rundle Mall Precinct is connected to other key city precincts (North Terrace and Hindley Street) within walking distance and is well served by public transport and several undercover car parks. The precinct is managed by the Rundle Mall Management Authority (RMMA).

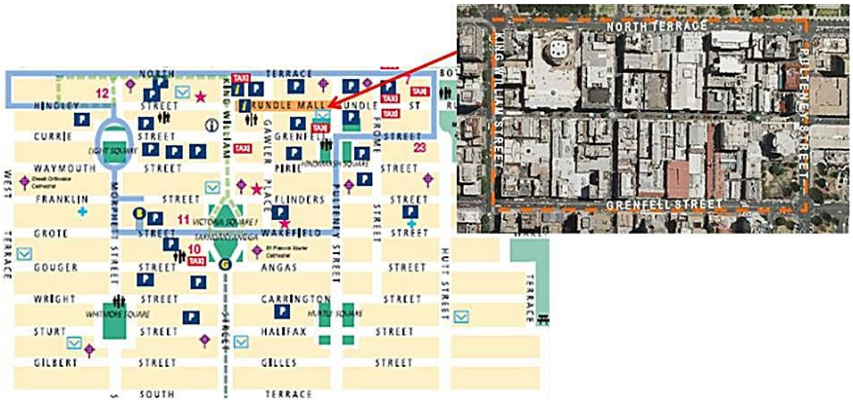

Figure 1: Location of Rundle Mall Precinct (Adelaide City Council 2010a)

3.1 Current freight operation restrictions

At present, all vehicle activities are banned in the Rundle Mall Precinct and the northern half of James Place at all times unless a permit has been obtained from the Adelaide City Council (ACC). Vehicles are not allowed to have access to, from or within the precinct between 10 a.m. and 5 p.m. Monday to Saturday and 11 a.m. to 5 p.m. on Sunday. Outside of these hours, vehicle access is allowed under permit only (Adelaide City Council 2010b).

3.2 Plans and policy strategy

There are several plans and policy strategies that involve economic and social development in the city of Adelaide and South Australia which might have some implications for freight transport within urban areas.

3.2.1 The Rundle Mall Master Plan

The Rundle Mall Master Plan is a framework that guides the future direction and implementation of projects towards repositioning the Rundle Mall Precinct and transforming it into the primary retail precinct in South Australia. The Master Plan has suggested numerous physical improvements, an increased variety of retail mix, cafes and restaurants,

and the encouragement of more activities both during the day and at night. However, the Master Plan does not address management of the expected increase in freight traffic as a consequence of the precinct's revitalisation.

3.2.2 Strategic plans

The report by Blandy (2008), "The size, structure and growth of the City of Adelaide's economy together with prospects and strategic options for the future", projected a twofold increase in population and economic growth over the next 30 years. The critical component is to revitalise the city itself. The vision for the Rundle Mall Precinct is its redevelopment into a community garden with trees and flower boxes, attractive laneways, cafes and restaurants. Blandy also agreed on extended trading hours.

The 30-Year Plan of Greater Adelaide expects significant growth of 27,300 residents and 50,000 jobs for the City of Adelaide (Department of Planning and Local Government 2010).

Adelaide City Council is currently drafting a new integrated movement strategy that will become a framework for movement and transport issues in the city. Several public consultations have been held since April 2011 and will be finished in 2012. Discussion Paper 7 outlines a number of strategy options such as a public logistics terminal (freight distribution centre); community collection and delivery points; establishing coordination among stakeholders; and cargo bike hire (Adelaide City Council 2012).

3.3 Implications from strategic plans

The strategic plans mentioned are projecting towards the same direction of economic and population growth. The expected changes and planning within the Adelaide city centre present new freight challenges and implications for urban freight distribution in the near future. Several scenarios can occur. First of all, with the issue of extended retail trading hours in the Adelaide CBD and revitalisation of the Rundle Mall Precinct with more cafés, restaurants and retailers will certainly lead to more deliveries to supply these businesses resulting in potentially more freight traffic. Increases in urban residents as well as in visitors will also initiate more demand for goods and services. However, the suggestion of transforming laneways, which are traditionally used for delivery, into café and alfresco dining will definitely reduce the number of loading zones. On the other hand, urban residents might be concerned about sustainable development of the city and could perceive truck deliveries in urban areas as a nuisance. This might lead to tighter time windows for deliveries or stricter access regulations for particular types of freight vehicles entering the city centre. Other new developments might not have a direct impact on urban freight traffic but could generate sufficient freight volume to utilise the proposed public logistics terminal and lead to more cooperation in freight delivery. These possible scenarios will certainly put pressure on the freight carriers, transport planners and other stakeholders in urban freight distribution as a whole.

4. Investigation of the study area

The study focus was on the last kilometre freight distribution to retail shops in the Rundle Mall Precinct. The examination of study area was undertaken to set out the existing freight distribution operation and identify any related issues. A combination of qualitative and

quantitative methodology was employed. The methods of data collection used were as follows:

4.1 Observation

Due to data being unavailable on existing freight distribution in the study area, the field observation was carried out to observe the deliveries to and collection from the Rundle Mall Precinct during a weekday.

4.2 Survey and interviews

A number of survey and interviews are planned to conduct including retailer survey, interview with fleet managers and transport planner. First, a retailer survey was carried out to explore the current urban freight distribution, related issues and opinions in relation to alternative urban freight distribution. The questionnaire comprised three sections, including business ownership and size, current deliveries and collection operation and perception towards alternative delivery measures or initiatives. The questionnaire was handed out in personal visits made in the mornings on weekdays in November 2011 to 120 retailers. The response rate was 49%.

Then, the name of freight carriers who performed deliveries and collections in the precinct were obtained from the retailer survey with these to be contacted for the interviews. Next, the fleet manager interviews which aim to gain information about their distribution operation with an emphasis on the Rundle Mall Precinct, the problems experienced, suggestions, opinions and attitudes towards sustainable issues and potential urban freight measures. Lastly, the interviews with transport planners are intended to gain insight from the authority perspective, and the vision and plan towards sustainable urban freight distribution.

5. Findings from retailer survey

5.1 Field observation

The majority of freight carriers carried out goods delivery to retail shops in the early morning up to 10 a.m. using light commercial vehicles (LCVs) and mid-sized trucks. Most of the goods delivered were clothes and fashion accessories. Freight vehicles were not fully loaded, as goods did not occupy the floor space of vehicles. The driver was mainly responsible for unloading the product and delivering it to individual shops to complete the delivery. During the day, the driver might have to drive around to find a parking space which was a distance away from the premises, thus taking more time to complete deliveries and it was also difficult to push the hand truck along the precinct when it was crowded.

5.2 Retailer survey

Relative to current freight distribution in the Rundle Mall Precinct, the majority (57.6%) of retail shops were part of retail chains and had various floor spaces (20-300 m^2). Only 17% of premises had their own vehicle for delivery or collection. Forty percent of retail shops received deliveries 1-6 times a week while 30% received daily deliveries. Most of the shops (71.2%) did not have fixed times for delivery. The shipment sizes also varied significantly in dimension and weight. Goods were packed in boxes, on hanging rails, parcel bags and pallets respectively. Once goods were unloaded, they were transferred to shops by hand,

hand trucks and platform trolley in the same proportions. The majority of businesses (70%) had a storage area on-site (5-30 m^2). With regard to collection, 56% of retailers had a collection of goods for the return trip including old stock, returns, faulty goods, transfer deliveries and boxes. However, this occurred infrequently. Trucks and LCVs were the main types of vehicles used, whereas only 2% used an environmentally-friendly mode such as bike or walking. Currently, 50% of delivery vehicles park on the street.

Retailers raised several issues related to current goods distribution such as irregularity of delivery, lack of parking space, illegal parking and incorrect amount of goods delivered. Moreover, other factors pointed out included lack of on-site storage, strong peaks of customer demand, suppliers not delivering earlier or later than at a certain time of the day and minimum order quantities which meant that deliveries could not be as frequent as they wished.
The retailers ranked alternative delivery measures as follows:
1) To implement time windows (off-peak/secure night-time delivery services)
2) To use clean/environmentally-friendly vehicles (cargo bikes, electric vehicles)
3) To set up a common and centralised delivery centre to consolidate the goods destined for the city centre and for customer pick-up points
4) To set up a central collection area for waste
5) To implement access restrictions (vehicle weight, size restriction).
Further measures suggested by the retailers were the removal of recyclable waste, loading zones for freight vehicles and more parking spaces.

The findings from the observation and retailer survey provided essential information on current goods distribution and revealed an opportunity to enhance the last kilometre freight distribution. A number of urban freight distribution alternatives could potentially improve efficiency, accessibility and reliability of goods movement. However, further investigation and information from interview with fleet managers and transport planners is necessary to incorporate in the planning for appropriate solutions.

6. Approaches used for the evaluation of urban freight transport

The importance of incorporating stakeholders with different objectives into account in the decision-making process has been recognised (Macharis 2005). Policy makers are also confronted with numerous and diverse policy alternatives that generate several consequences that are difficult to predict (Walker 2000). Therefore, a comprehensive approach that allows to incorporate stakeholder points of view and different criteria in the evaluation process will enhance the likelihood of acceptance of the proposed solution.

Evaluation of freight transport policy has been achieved using various methods. The existing evaluation methodologies that have been applied in the assessment of transport projects or policies are: cost-benefit analysis (CBA), multi-criteria analysis (MCA) and simulation and mathematical modelling.

Traditionally, CBA has been used for assessing transport infrastructure and projects from an economic perspective. CBA is used to determine whether the benefits involved in undertaking a particular project offset the costs and achieve efficient use of resources. However, non-quantifiable effects are usually treated by description only and various

assumptions are established. CBA also lacks flexibility in terms of integrating different stakeholder opinions. However, policies represent a much wider context where infrastructure is only one of the possible alternatives, besides technological investments, education, pricing, etc. to achieve the ultimate objective (Beria, Maltese & Mariotti 2012).

Multi-criteria analysis (MCA) is an evaluation tool that addresses multi-objective problems as well as multidimensional issues, assisting decision making in a complex policy-making context. MCA allows the decision makers to definitely consider stakeholders' opinions in certain aspects (Tudela, Akiki & Cisternas 2006). There has been a growing awareness internationally over recent years that besides the social costs and benefits associated with transport, other impacts that are more difficult to quantify should also have influence on the decision-making process (Barfod, Salling & Leleur 2011).

MCA is seen by researchers as an alternative and appropriate tool to adopt (Walker 2000; Macharis 2005; Tudela, Akiki & Cisternas 2006). Tsamboulas and Kopsacheili (2003) supported the view that in MCA, weight applied to different impacts can be established with reference to decision makers' opinions. Such a method can be used in transport projects and policies in many different ways. A methodological framework that incorporates MCA has been formulated for strategic evaluation of transport policies and applied to the actual case study of the Athens 2004 Olympic Games (Tsamboulas, D. & Kopsacheili 2003). Awasthi and Chauhan (2012) proposed a hybrid approach based on Affinity Diagram, Analytical Hierarchy Process (AHP) and fuzzy TOPSIS for evaluating city logistics initiatives. Macharis (2005) developed the multi-actor, multi-criteria analysis method (MAMCA) for the evaluation of transport projects by stakeholders who are explicitly taken into account. Kapros, Panou and Tsamboulas (2005) utilised an integrated methodological process based on MCA to evaluate the anticipated effects of intermodal freight villages.

Other evaluation approaches have also been applied to urban freight transport. Patier and Browne (2010) proposed a methodology to enhance the consistency of the evaluation of urban goods' innovations and projects by developing a matrix that took into account both quantitative and qualitative aspects. The study by Hosoya et al. (2003) developed a micro-simulation model to evaluate a number of logistics' policies in Tokyo's metropolitan areas considering individual company's behaviour and interaction. Taniguchi, Tamada and Okamoto (2007) utilised multi-agent models for the evaluation of the behaviour and interaction among stakeholders who were associated with urban freight transport and the consequences of city logistics' measures.

From the reviewed literature, it is apparent that the traditional evaluation methods have limitations in incorporating multiple stakeholders and objectives in the decision-making processes. The assessment technique such as CBA has difficulties in measuring relevant impacts of an initiative that cannot be quantified. Stakeholders' priorities cannot be taken into consideration in such a quantitative evaluation. In addition to this, the majority of studies on freight transport evaluation concentrate on the impacts of specific measures while few studies focused on prioritising and choosing the urban freight distribution measures.

The MCA methods seem to be a promising approach to apply in this research that aims to develop an evaluation model that can assist decision makers in the evaluation and ranking of alternative last kilometre freight distribution initiatives. MCA has provided several characteristics that has enabled one to deal with the limitation of the existing evaluation

approach. MCA offers the possibility of working with complex issues such as urban freight transport and in particular the inclusion of stakeholders and their different objectives into the decision making process. Furthermore, the criteria that are difficult to quantify can also be taken into consideration.

7. The proposed methodological framework

The proposed methodological framework for the evaluation of alternative urban freight transport measures based on multi-criteria decision analysis is presented in Figure 2. Basically, there are 3 main parts in the proposed framework. The first part involves setting out the objectives, data collection and identification of alternative solutions. Next, the analysis of the data using Analytic Hierarchy Process (AHP) method in the estimation of criteria weights and scores, based on pairwise comparisons between criteria and between initiatives. Finally, the alternative initiatives will be prioritised. The framework comprises of seven steps which are described below.

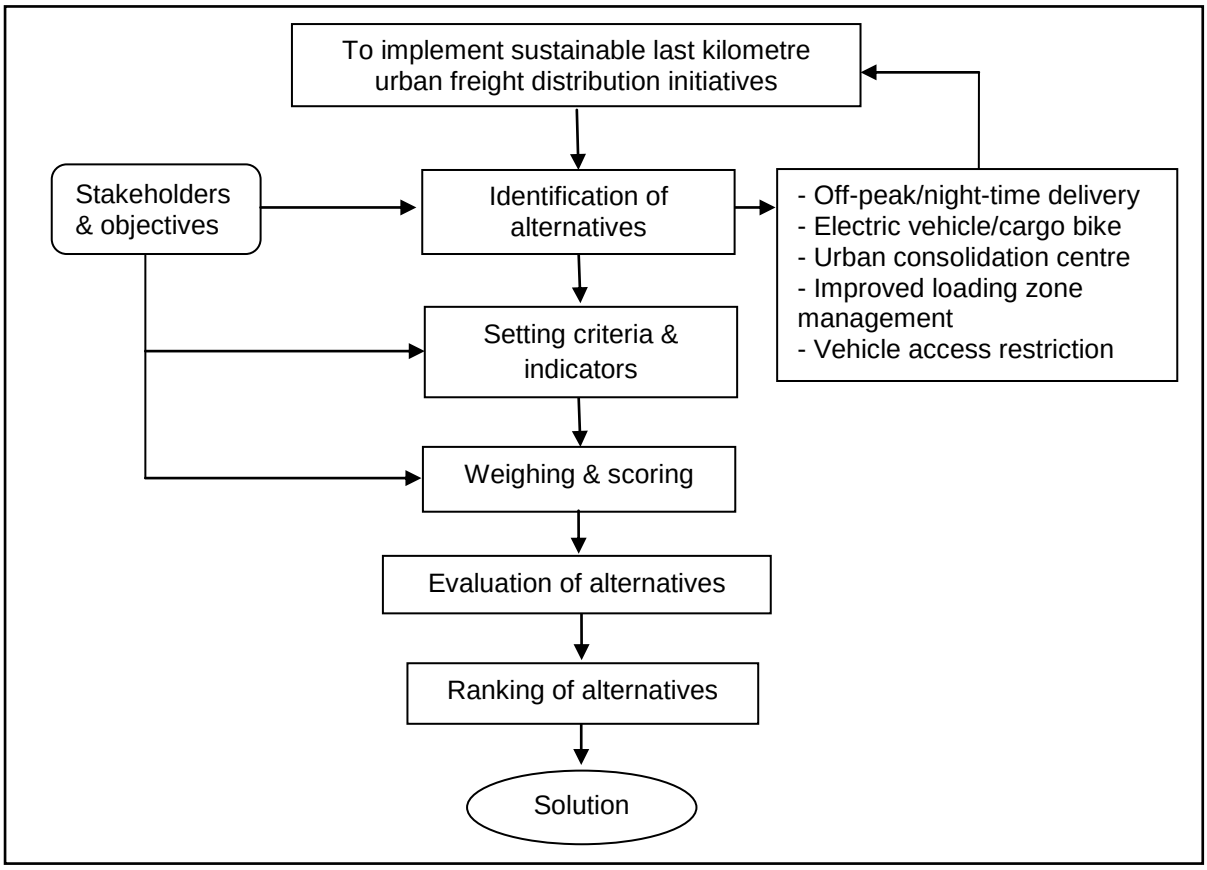

Figure 2: Proposed sustainable urban freight distribution evaluation framework

The first step is the definition of the problem namely, the implementation of sustainable last kilometre urban freight distribution initiatives. Secondly, the relevant stakeholders involved in the last kilometre urban freight distribution will be identified along with their objectives. Stakeholders in the transport policy context are those individuals and groups who have a particular concern, or an interest in a problem or in the consequences of any decisions taken. The analysis of each stakeholder group's objectives is critical in order to appropriately assess the different alternatives. Stakeholders' views will need to be taken into account in

the evaluation process. The key stakeholders, in the study context, are retailers within the Rundle Mall Precinct, freight carriers, local government or transport planners and the urban community. The third step is the setting of alternatives. The alternatives for evaluation will be formulated from the retailer survey, interviews with fleet managers and transport planners, and the potential strategies as proposed in the discussion paper "Integrated Movement Strategy" by Adelaide City Council (2012) and also from the literature reviewed. Fourthly, the criteria that are of concerns to all stakeholders will be set (e.g. economic, environment, social and operation) and the indicators will be established for each individual criterion. In the fifth step, all the criteria will be weighed according to their significance (relative importance) to the decision. The proposed methodology will employ the AHP method based on pairwise comparisons for establishing weight for criteria and performance scores for initiatives on the different criteria. The criterion scores can be expressed in quantitative such as: investment cost, or scores on an ordinal indicator such as high/medium/low for criteria with values that are difficult to quantify. The sixth step is the overall analysis, summation of weighed criteria and calculation of final scores for each of the alternative measures. The performance of the alternatives will be assessed against the criteria. Finally, the final ranking and selection of the appropriate alternative sustainable last kilometre urban freight distribution will be obtained. The appropriate measures will be the one with the maximum total scores.

7.1 Illustration of a simplified version of the proposed framework

Assume that all the objectives, criteria and alternative freight distribution initiatives are determined. Figure 3 presents the provisional hierarchy of criteria and initiatives for the sustainable last kilometre freight distribution.

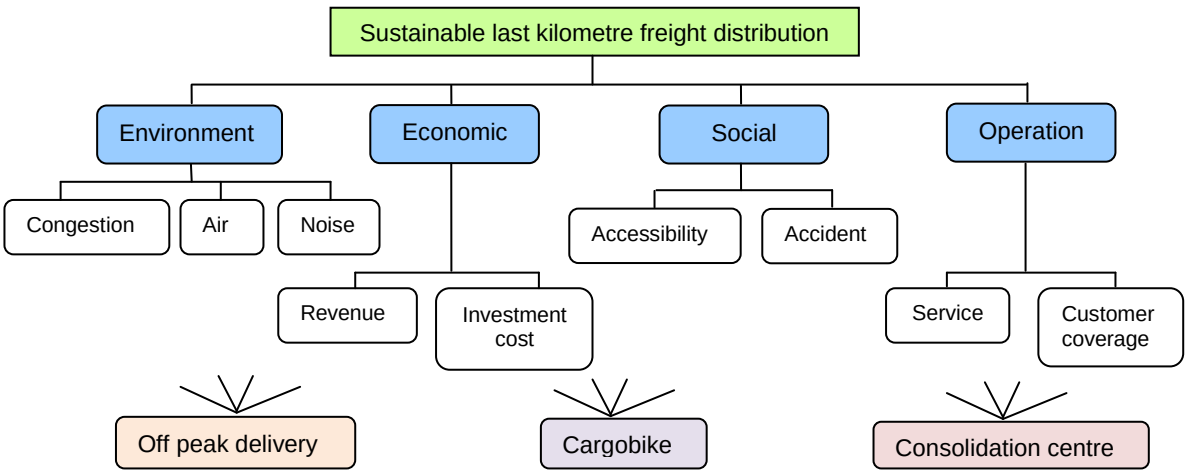

Figure 3: The sustainable last kilometre freight distribution hierarchy

The measurement of preference is done according to Saaty's nine-point scale (Saaty 2008). A criterion compared with itself is assigned the value of 1. The number 3,5,7 and 9 correspond to the verbal judgements given in Table 3. The pairwise comparison matrix of criteria according to priorities set out from the survey and interview with stakeholders will be presented in Table 4. The criteria on the left are always compared with the criteria at the top. After an importance matrix is developed as shown in Table 4, it is normalised by totalling each column and by dividing each entry by the sum. Entries of this new, normalised matrix

are in comparable scales and the average values of each row which give an approximation of the priority ranking of each criterion.

Table 3: Nine point scale for pairwise comparison

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favour one activity over another
5	Strong importance	Experience and judgement strongly favour one activity over another
7	Very strong importance	An activity is favoured very strongly over another
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation

Table 4: An example of pairwise comparison matrix of criteria with respect to the selection of sustainable last kilometre freight distribution initiatives

	Environment	Economic	Social	Operation	Priorities
Environment	1	3	2	3	0.449
Economic	1/3	1	1/2	2	0.170
Social	1/2	2	1	2	0.259
Operation	1/3	1/2	1/2	1	0.120

The comparison of last kilometre freight distribution initiatives will be carried out with respect to each criterion using the same nine-point scale. Then the preference rating of each alternative will be multiplied by the importance of the criteria and summed to obtain the final ranking as in Table 5. The initiative that has the highest final score is the best solution to implement.

Table 5: Synthesis of the priorities

Criteria	Environment (0.449)			Economic (0.170)		Social (0.259)		Operation (0.120)		Overall priorities
Initiatives	Congestion (s_1)	Air (s_2)	Noise (s_3)	Revenue (s_4)	Investment cost (s_5)	Accessibility (s_6)	Accident (s_7)	Service (s_8)	Customer coverage (s_9)	
Off peak delivery	p_{11}	p_{12}	p_{13}	p_{14}	p_{15}	p_{16}	p_{17}	p_{18}	p_{19}	P_1
Cargobike	p_{21}	p_{22}	p_{23}	p_{24}	p_{25}	p_{26}	p_{27}	p_{28}	p_{29}	P_2
Consolidation center	p_{31}	p_{32}	p_{33}	p_{34}	p_{35}	p_{36}	p_{37}	p_{38}	p_{39}	P_3

where s_j is score of indicator (sub-criteria) j , p_{ij} is the performance of initiative i with respect to indicator (sub-criteria) j and P_i is the total score for initiatives i

8. Conclusion

The last kilometre urban freight distribution is an essential activity for maintaining the liveability and economic function of the city. Making a decision in evaluating and prioritising appropriate urban freight transport policy to implement with multiple objectives and various stakeholders is a challenging task. This paper presents part of an ongoing research, with emphasis on the retailer survey findings and the proposed conceptual framework. The evaluation framework proposed in this paper is an initial step towards a model development that aims to assist decision makers in prioritising and selecting the appropriate last kilometre urban freight initiatives.

The next stages of research will be the interviews with fleet managers and transport planners. Then, the obtained data will be incorporated into the evaluation model development. It is expected that the proposed evaluation framework will assist decision makers for strategic evaluation of urban freight distribution so that they can derive the best solution leading to successful implementation and sustainable urban freight distribution.

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