Change trends in urban freight delivery: a qualitative inquiry

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ABSTRACT

In this paper we present the findings of a qualitative investigation of change trends in urban freight deliveries. The empirical material was gathered with urban freight (courier) company managers and drivers in Aotearoa New Zealand. It presents personal accounts of the everyday lived experiences of those intimately involved in the delivery of goods within the urban environment. Twenty five interviews were conducted across four urban centres between June and September 2015. We use the four elements of the Energy Cultures Framework to explore what urban freight managers and drivers 'have', 'do' and 'think', and the pressures of an external context. Four interrelated themes are presented, 1. Online shopping and home deliveries, 2. Tracking and transparency, 3. New technologies, and 4. Meeting (changing) expectations, with evidence provided by way of verbatim quotations. The 'mobility cultures' concept is used to explore the relationships between the four themes, and to identify the key change trends that may affect the ability of the freight industry to contribute to a low-carbon transport transition. We conclude by signalling some policy implications and future research directions.

KEYWORDS

Freight, Urban delivery, Carbon reductions, Change trends, Energy Cultures Framework, qualitative

1. INTRODUCTION

Increasing demand for both passenger and freight transport is contributing to rising greenhouse gas (GHG) emissions, and 'aggressive and sustained' mitigation policy is required in order to curb growth (Sims et al., 2014). Yet while passenger transport has received significant attention from researchers across the physical and social sciences (see, for instance: Johansson and Ahman, 2002, Bristow et al., 2004, Hensher, 2008, Marcucci & Gatta, 2011, 2012, Brand et al., 2013, Stathopoulos & Marcucci, 2014), research into freight transport has, with exceptions (e.g. Stathopoilos et al. 2011, Marcucci et al., 2012) been relatively modest (Schwanen, 2015, Wygonik et al., 2015). The energy-intensity of freight transport is significant; in 2009, it accounted for almost 45% of total transport energy (Sims et al., 2014). Travel avoidance, modal shift, lowering energy intensity and reducing the carbon intensity of fuels have all been identified as opportunities for both passenger and freight transport to reduce their respective emissions. Travel avoidance might include the adoption of advanced information and communication technologies (ICT) (Sims et al., 2014), but demand for freight will be impacted by passenger travel avoidance techniques, particularly internet shopping and home delivery. Lower carbon technologies (e.g. vehicles and fuels) have also been recognised as important features of a low-carbon transition for the freight industry (Baker et al., 2009, Tavoni et al., 2012, McKinnon, 2015).

Rising demand for road-based freight is a particularly challenging environmental burden (Chapman, 2007). High dependence of freight movements on air and road modality has contributed to the *"need*

to break the relationship between the current preferred movements of passengers and freight with the most polluting modes" (Chapman, 2007: p357). While a variety of factors will affect the carbon emissions from home deliveries (e.g. type of vehicle, the specific run, and drop densities) (Chakravarty, 2014), Edwards et al. (2010) estimate that an average delivery van will emit 21.7kg of carbon dioxide for an 80 km (50 mile) trip. It has been argued that switching fuels, the adoption of efficient driving behaviours and the uptake of more efficient vehicles will be able to offset the projected growth in freight emissions in the short term (Sims et al., 2014). Reverse logistics (Bayles and Bhatia, 2000, Mukhopadhyay and Setoputro, 2004) has also been acknowledged as an opportunity for emissions reductions through the 'clean disposal of reverse product flows' (Aït-Kadi et al., 2012). Yet little is known about the change trends affecting the industry, and the actors within it, and how this might affect the industry's ability to contribute to a low-carbon transport transition. In this paper, we present a qualitative investigation of urban freight managers and drivers, to explore their everyday realities, and experiences of change.

In its broadest sense, freight is understood to be the transportation of goods in bulk from one location to another. This is often done by way of motorised transport (e.g. truck, train, boat, airplane), but can also be achieved by bicycle and other non-motorised modes. The movement of goods in the 21st Century is relevant to both urban and rural contexts, but presents different issues. In rural areas, questions relate to on-going service provision with declining populations and/or increasing costs, and the (home) delivery of goods (Milbourne and Kitchen, 2014). In urban centres, where space is often a scarce resource, congested transport infrastructure, and high population densities are some of the key issues (Wygonik et al., 2015). The research presented in this paper is focused on the latter, and builds a picture of the change trends and complexities facing *urban* freight companies and drivers (e.g. Taniguchi and Thompson, 2014). While we use the term 'urban freight' in this paper, a range of other terms have been used in the literature, including 'urban goods movement', to mean the movement of goods through the urban area, with a particular focus on package delivery.

Interest in the delivery of goods has historically been the domain of experts in logistics (Walker and Manson, 2014, Lin et al., 2014), demand forecasting (Nuzzolo and Comi, 2014) supply chain management (Chakravarty, 2014), policy (Gatta & Marcucci, 2014, 2016) and behavioural modelling (Gatta & Marcucci, 2015). Yet realisation of its connectedness to social lives, particularly through geographies of consumption has drawn the attention of the social sciences. Socio-technical changes that are likely to impact upon the delivery of goods include ICT and online shopping (consumption) and 3D printing (production). For example, Birtchnell & Urry (2013) consider the future of manufacturing and the transportation of goods in light of just-in-time printing machines, ultimately removing the need for the urgent couriering of such items from producer to consumer (often via an intermediary). While 3D printing is likely to affect global chains of freight movement, particularly between producing nations (e.g. China) and consuming nations (e.g. UK), the role it will have on urban freight mobilities is not yet clear.

From a social science perspective, the movement of goods has received greater attention at an international scale, particularly relating to shipping (Martin, 2014, Anim-Addo et al., 2014), but has also extended across various disciplines and sub-disciplines. Social research into; the relationship between smart urban growth and goods movement (Wygonik et al., 2015), home delivery (Visser et al., 2014), consolidation centres (Marcucci & Danielis, 2008), and the impact of city centre parking and pricing policies on urban deliveries (Marcucci et al., 2015) have identified wide ranging negative externalities arising from infrastructure, and affecting businesses (e.g. delays in deliveries, stress and fines), and wider society (e.g. congestion, noise, greenhouse gas emissions).

There has been somewhat of a consensus amongst the general public, academics and industry, that online shopping and home delivery are environmentally beneficial since these practices reduce personal travel demand (Royal Mail, 2007, Rotem-Mindali and Salomon, 2007, Edwards et al., 2010). A review of international evidence on traffic volumes associated with home delivery found highly variable outcomes, but a general trend for decreased car trips for shopping (Cairns, 2005). For grocery delivery, Siikavirta et al. (2003) modelled GHG reductions of up to 87% (dependent on the home delivery model used), and Wygonik & Goodchild (2012) report greater opportunities for emissions reductions in areas with low customer density. Nevertheless, Siikavirta et al. (2003) concede that *"to be able to achieve significant reductions in GHG emissions, system-level innovations and changes are required"* (p.95). Moreover, modelling is often unable to account for the embodied experience of grocery shopping (Paterson, 2006), and trip chaining behaviours (Primerano et al., 2008).

Furthermore, there appears to be a consumer perception of sustainable online consumption. A 2010 report by the Royal Mail found that 42% of customers think home shopping is better for the environment than other forms of shopping, and a third would consider offsetting the carbon associated with home delivery (Royal Mail, 2010). Yet nearly 30% of products brought online are returned, for reasons including product choice, damage, or changing needs (Chakravarty, 2014). Thus rather than substituting individual private travel, online shopping may result in multiple freight journeys and/or private travel to return the item. The additional environmental and societal issues related to increased consumption compound these concerns. Thus, in terms of carbon emissions, despite claims to the contrary (Edwards et al., 2010), the capacity of home delivery to contribute to deep emission reductions is not yet well substantiated.

It has been claimed that *"freight business operators have a strong incentive to reduce energy intensity, since fuel typically accounts for around one third of operating costs in the road freight sector…"* (Sims et al., 2014: p.618), however under the 'owner-operator' model, which has existed in the freight industry since the 1930s (Stinson and Booth, 2015), procurement of vans, fuels and other material items are the responsibility of the individual contracted driver rather than the freight business-at-large. Thus the freight drivers, as well as business operators are responding to external pressures including fuel prices, and social norms, which may contribute to a reduction in fuel consumption, and associated GHG emissions reductions. Nevertheless, owner-operators are often working on tight financial margins, with little capital for investment. In terms of technologies, demand-side transitions from document delivery to parcel delivery have changed the requirements of freight drivers, instigating a transition from bicycles and cars to van-based delivery. In some areas, however, the development of e-bikes has motivated a resurgence of interest in the ability of two-wheeled vehicles to negotiate the urban environment. E-bikes offer a partial solution for urban freight delivery to negotiate the massive congestion experienced in many cities across the world (Lia et al., 2014).

This research contributes to the existing literature in 3 ways. First, we present a qualitative lens to the typically quantitatively understood issue of urban freight deliveries. Second, we provide an insight into the daily, lived experiences of freight managers and drivers, to highlight the issues with which they contend and under which decisions which may influence the carbon-intensity of the industry are made. Finally, we view these experiences through a lens of carbon constraint and question how carbon reductions might be achieved by the urban freight industry, particularly relating to what they have, think and do (Stephenson et al., 2015, Stephenson et al., 2010). The research responds to two main questions: How has urban freight delivery changed over time, and how is it expected to change into the future? And what are the implications of change trends for achieving the required carbon reductions?

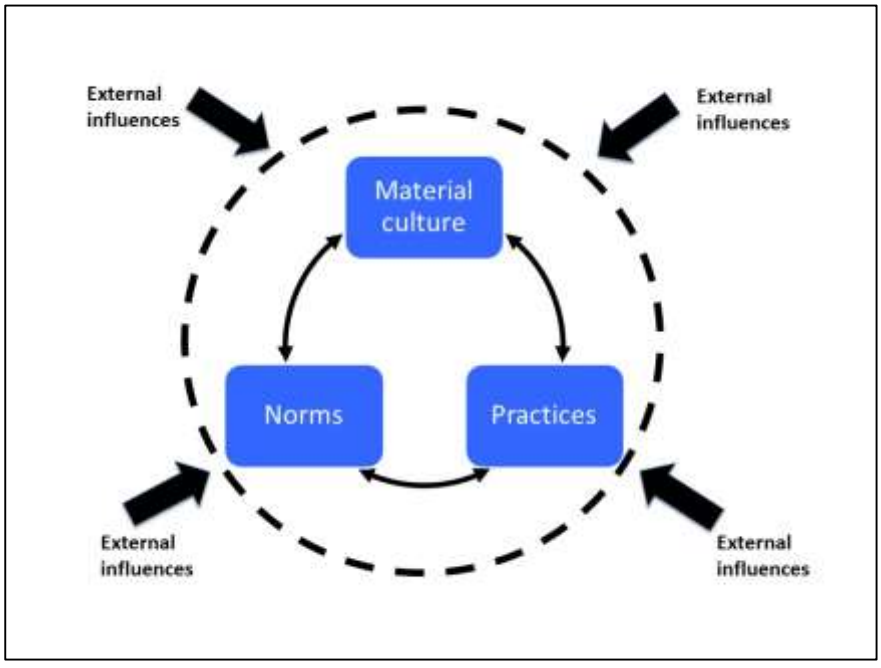
2. METHODS & APPROACH

2.1 Energy Cultures Framework

First introduced by Stephenson et al. (2010), the Energy Cultures Framework can *"assist in understanding the factors that influence energy behaviour, and to help identify opportunities for behaviour change"* (p.6120). It has been used to examine home and business energy use, as well as in the transport context (Hopkins and Stephenson, 2014, Stephenson et al., 2015). As an interdisciplinary framework, it has been advocated for its ability to understand individuals' actions to lower GHG emissions (Young and Middlemiss, 2012), such as energy efficient behaviours. The framework is made up of four key elements, material culture, norms, practices and the external context (Figure 1). The have-think-do triad are within the control or agency of the actor or group of actors under examination. The external context, on the other hand, is beyond the actor's control, but still impacts their capacity to behave in a particular or preferred way. For a more detailed presentation of the framework, readers are directed to Stephenson et al. (2010, 2015).

In the current research, we used the Energy Cultures Framework to guide both the development of the interview questions, and the subsequent analysis. The Energy Cultures Framework provides a clear and comprehensible approach for engaging with industry actors to discuss their everyday reality. We found each of the concepts; material culture, practices, norms and external context, to be readily understandable for the research participants, and a valuable tool for thinking through how actors at different levels of the freight industry (e.g. office-based management, drivers) interpret the industry, change trends, and responsibilities.

FIGURE 1 The Energy Cultures Framework, From: Stephenson et al., 2015



2.2 Study area: Aotearoa New Zealand

This study was conducted in Aotearoa New Zealand (New Zealand hereafter), a highly urbanised country of 4.6 million people, situated in the South Pacific, just over 2,000km to the east of Australia. Approximately 86% of New Zealanders live in urban centres, a similar level of urbanisation as Sweden, Denmark and Brazil (United Nations Department of Economic and Social Affairs Population Division, 2014), yet urban centres are of a comparatively low population density. There are 16 main urban

areas with over 30,000 people (Statistics New Zealand, N.D.), and a large number of mid-sized towns and cities, across two main islands. Four urban areas were selected for inclusion in the study; Auckland (A), Tauranga (T) and Wellington (W) on the North Island, and Dunedin (D) on the South Island (Figure 2). Auckland is New Zealand's largest city, with 1.4 million residents, and a strong rate of population growth from both internal and external migration. Tauranga is a growing city, 200km south east of Auckland, and has a population of 120,000. It has New Zealand's second largest port and is forecast to grow substantially over the coming decades. Wellington is New Zealand's capital city, and home to the New Zealand parliament and over 200,000 people. Dunedin is a mid-sized city on the lower South Island, with a relatively static population of around 130,000. All cities are coastal, with operational ports and varying transport infrastructure.

In general, New Zealand's transport system is dominated by road infrastructure, with funding prioritised for the so-called 'roads of national significance' (New Zealand Transport Agency, 2016). There is limited metro rail in Auckland and Wellington, and a dated national rail network that offers tourist experiences and transports some national freight. The financial sustainability of the rail network in New Zealand is highly dependent on the freight industry since 75 % of KiwiRail's revenue is from carrying bulk commodities, import-export goods and domestic freight (Kiwi Rail, N.D.). Yet poor profitability has contributed to declining rail services and low investment in infrastructure upgrades, resulting in unsatisfactory delays for freight delivery (Kiwi Rail, N.D.).

FIGURE 2 Map of New Zealand with Four Sites Marked

2.3 New Zealand's freight industry

New Zealand's national freight industry transports approximately 50 tonnes of goods per year per capita (Ministry of Transport, 2014), amounting to 236 million tonnes in 2012. In 2014, the transport, logistics and distribution industry employed nearly 90,000 full-time equivalent workers (FTEs) across New Zealand, and contributed around 5.4% of New Zealand's Gross Domestic Product, valued at NZ $12.5 billion (Westpac, 2015). Over ninety percept of all freight is transported by road, with just 7% by rail, and 2% coastal shipping. When considered by tonne-kms, road transport is still dominant (70%),

however there is a slight increase in rail (16%) and coastal shipping (14%)(Ministry of Transport, 2014).There has been relatively little change in this modal split since 2006. However there has been a shift in the types of commodities being transported with liquid milk, dairy products, export logs and limestone cement fertiliser all increasing in terms of tonnage between 2006 and 2012.

New Zealand's urban freight delivery is reliant on motorised road transport. Since 2000, there has been a substantial decline in postal service employees, and a static employment rate for courier services (Ministry of Transport, 2015) with 12,900 FTEs of postal and courier workers in 2014. Unlike postal deliveries, demand for courier services in New Zealand is growing (Ministry of Transport, 2014), across business to business (B2B), business to consumer (B2C), and consumer to consumer (C2C) deliveries (Westpac, 2015). This growth is argued to be a key opportunity for the sub-sector (Westpac, 2015), with international alliances and joint ventures a key way to exploit these opportunities. Already the New Zealand Ministry of Transport (2014) is identifying a 'blurring' between 'pure' courier companies and regular transport companies who are catering to the online shopping market. Nevertheless, despite this growth, it has been reported that many owner-operator courier drivers in New Zealand earn below the minimum wage (Scoop Business, 2010).

Demand for home delivery is growing in New Zealand; in the year to June 2015, 49.3% of New Zealanders over the age of 14 made an online purchase in the 4 weeks prior to the survey, a 10% increase from 2011 (Roy Morgan, 2015). While many of these purchases were for services (e.g. travel (9%), tickets (6.1%) etc.) women's clothing was the second highest item at 7.9% of all online purchases. Books (5%) and men's clothing (4%) were also highly purchased. In 2013 online shopping accounted for 7% of total retail sales (Frost & Sullivan, 2013). These consumption patterns are forecast to continue, with online shopping expenditure predicted to reach $6 billion by 2017 (PWC, 2013).

2.4 A qualitative study: sampling, recruitment and interview approach

A qualitative research approach was adopted to investigate the everyday lived experiences of urban freight managers and drivers. Qualitative research has been advocated for this purpose, as it is able to provide in-depth and nuanced understandings of *"'what' they feel, and 'why' they feel that way. This will also incorporate 'who' feel the way they do, and 'where', 'when', and 'how'," thus it is the quality and richness of the response to a social situation"* (Basit, 2003: p. 151). And through this, we can find more about the multiple realities of the research participants (Guba & Lincoln, 1982), and their perceptions and experiences of urban freight delivery in New Zealand.

The sampling strategy was determined by the research aim for heterogeneity, thus to obtain a diversity of views on and experiences of urban freight delivery in New Zealand, participants were selected across the four cities described above and on the basis of business size (international, national, local). As the interviewers were only available for a predetermined period of time in each location, selection criteria included the availability of the participant during that period. Other selection criteria included the participant's position within the organisation (e.g. either a management role, or a driving role) and their willingness to participate. As a qualitative study, we sought an idiographic sample, the size of which was ultimately determined by saturation and redundancy (Lincoln and Guba, 1985, Eisenhardt, 1989). Thus interviews continued to a point where redundancy with regard to the information being gained, was achieved (Jennings, 2005). Freight drivers were rewarded with a NZ$20 supermarket voucher for their time. Freight management were not provided with a financial reward. All participants were provided with an information sheet and ethical consent form, in line with the ethical policies of the University of Otago.

Interview participants were recruited through an internet search of urban freight (courier) providers in each of the four locations. A purposive sampling approach (Mason, 2002, Patton, 2002) was adopted, in which all relevant businesses were contacted, either by email to the regional or branch manager, or telephone to the organisation where specific details were not available online. In Dunedin, the management interviews were used to recruit drivers from within the same freight companies, and a snowball sampling approach was adopted where necessary (Biernacki & Waldorf, 1981, Noy, 2008). All participants (both drivers and management) "self-selected" to participate in the research (Costigan & Cox, 2001). This is inherent in research where participation is voluntary, and can contribute to be more open, patient and interested than the general sample universe (Robinson, 2014). As voluntary participation is a key aspect of most qualitative research, self-selection bias cannot be overcome, but can and should be accounted for by the researcher, particularly considering the impact of self-selection on the findings.

Twenty five semi-structured interviews were conducted between June and September 2015, 15 interviews with freight managers (A, T, W & D), and 10 interviews with freight drivers (D) (Table 1). In total thirteen independent freight companies were interviewed, some national companies were interviewed in multiple locations at their regional offices. A semi-structured approach was adopted, which was content focused but allowed for flexibility in questioning (Dunn, 2005). Interviews were conducted face to face. Management interviews lasted between 39 and 65 minutes, averaging 52 minutes, while driver interviews lasted between 14 and 34 minutes, averaging 22 minutes. A prepared interview guide focused questioning on 5 primary themes: (1) Material Culture; (2) Practices; (3) Norms; (4) External Context; and (5) a SWOT (strengths, weaknesses, opportunities, threats) analysis. The processes of sampling, data generation and data analysis were both dynamic and interactive (Mason, 2002).

TABLE 1 Table of Interview Participants

Code	Participant pseudonyms	Payment model	Role	Freight company pseudonym	Interview location
1M	John	Contracted drivers	Branch Manager	Company A	Tauranga
2M	James	Contracted drivers	Branch Manager	Company B	Tauranga
3M	Kathryn	Contracted drivers	Regional Manager	Company C	Wellington
4M	Greg	Contracted drivers	National Operations Manager	Company D	Auckland
5M	Andrew	Contracted drivers	Regional Manager	Company E	Auckland
6M	James	Contracted drivers	Branch Manager	Company F	Dunedin
7M	Peter	Salaried drivers	Owner - Manager	Company G	Dunedin
8M	Nathan	Contracted drivers	Branch Manager	Company H	Dunedin
9M	Paul	Contracted drivers	Branch Manager	Company B	Wellington
10M	Hugh	Contracted drivers	Branch Manager	Company I	Auckland
11M	Tom	Contracted	Regional Manager	Company J	Dunedin

		drivers			
12M	Henrik	Contracted drivers	Branch Manager	Company K	Dunedin
13M	Graeme	Contracted drivers	Branch Manager	Company A	Dunedin
14M	Iain	Contracted drivers	Branch Manager	Company A	Auckland
15M	Nicolas	Contracted drivers	Regional Manager	Company E	Wellington
1D	Kevin	Contracted driver	Driver	Company L	Dunedin
2D	Luke	Contracted driver	Driver	Company M	Dunedin
3D	Benjamin	Contracted driver	Driver	Company F	Dunedin
4D	Jack	Salaried driver	Driver	Company G	Dunedin
5D	Liam	Salaried driver	Driver	Company G	Dunedin
6D	Mason	Contracted driver	Driver	Company I	Dunedin
7D	Isaac	Contracted driver	Driver	Company A	Dunedin
8D	Sebastian	Contracted driver	Driver	Company A	Dunedin
9D	Michelle	Salaried driver	Relief driver	Company M	Dunedin
10D	Dominic	Salaried driver	Relief driver	Various companies	Dunedin

2.5 Analysis & analytical framework

The qualitative methods and interpretive strategies employed in this research included semi-structured interviews, transcription of digital audio recordings, coding of interview material, and thematic analysis using Nvivo10 qualitative data analysis software. Thematic coding was used to interpret our empirical material, to understand the complexities of human experiences in particular places (Strauss, 1987, Corbin and Strauss, 1996), and to *"obtain the intricate details about phenomena"* (Corbin and Strauss, 1996: 11). Each interview was digitally recorded, fully transcribed, and coded using NVivo10 software. Coding involves reducing the research participant's thoughts into meaningful ideas linked to specific concepts (Bazeley, 2007). This involved a process of abstraction and interpretation (Spencer et al. 2014) where the researchers became immersed in the empirical material.

Coding in Nvivo10 was structured around a predetermined framework; the Energy Cultures framework. Thus a series of smaller themes were identified that related to one (or more) of eight overarching themes; "Material culture", "Norms", "Practices", "External context", "Strengths", "Weaknesses", "Opportunities", Threats". From here we looked across the themes to identify the interactions and overriding messages from the interviews. Multiple rounds of coding were required as new themes developed, and two researchers independently coded the empirical material, and to

validate the themes. An iterative process of interpretation and coding was used to account for the emerging patterns and to tease out underpinning attitudes, perspectives and values.

As a small scale study, with a non-representative sample specific to New Zealand, the four study areas, and the 13 freight companies, the findings presented in this paper are illustrative of the specific context and provide a depth of insight, but cannot, and should not, be interpreted as broad generalisations. A qualitative research approach will gather different types of empirical material than a quantitative research method. While the latter is focused on the numerical measurement of trends and statistical significance, qualitative approaches are more interpretive, nuanced and situated in their research findings. Qualitative research is often dependent on a small number of research participants, providing highly context-specific information. Therefore the findings are temporally and spatially specific, and not generalizable. Nevertheless, this is compatible with the research aims of qualitative research whereby population-level generalisations are not sought; rather the intent is to illuminate highly specific, detailed and nuanced social understandings. Credibility, transferability, dependability and confirmability (Lincoln and Guba, 1985) are useful principles in evaluating qualitative research which are analogous with quantitative standards of validity, generalizability, reliability and objectivity (Baxter and Eyles, 1997). The use of purposive sampling to recruit a specific sub-set of a population (e.g. urban freight management and drivers) and the recognition of multiple realities help to account for both credibility and transferability. Likewise triangulation can aid the dependability and credibility of the research since triangulation is one way to reduce "personal and methodological biases and enhance a study's trustworthiness" (Decrop, 2004: p.162). The use of Nvivo10 software helps to develop and maintain an audit trail of the analysis process that is then checked between multiple researchers for confirmability.

In the next section, we report and reflect on the analysis, and use a selection of quotes that are representative of participants' understandings and experiences, as well as illustrating themes and issues aptly and/or vividly. Pseudonyms are used to protect the research participants' anonymity as well as that of their associated company, as per the signed ethical consent forms.

3. FINDINGS

The analysis finds that the urban freight industry in New Zealand is responding to a rapidly changing context, particularly relating to the availability of new technologies, customer expectations and industry aspirations. Changes to the industry were articulated by a freight manager, in talking about their longest serving employee, who had been in the New Zealand freight industry for 43 years: *"It's crazy. At 43 years he's seen a certain amount of change. Not only in technology of what he's driving - no longer is the horse and cart and all that sort of carry on - but how our freight is presented to us, our customer's demands and expectations, and legislation"* (Paul, Branch Manager, Wellington). The findings presented in this section will explore the identified change trends drawing from the Energy Cultures Framework in terms of concepts; material culture, practices, norms, external context, and the interactions between these relating to an overarching theme. There are 4 main themes that are used to structure the empirical findings: 1. Online shopping and home deliveries, 2. Tracking and transparency, 3. New technologies, and 4. Meeting (changing) expectations.

3.1 The 'massive complexities' of online shopping and home delivery

Changes to consumption patterns, particularly resulting from the growth in internet shopping, rise of online trading sites such as Ebay and Trade Me[1], growth of small businesses run from residential addresses, and rise in just-in-time operations, have contributed to fundamental changes to the freight

[1] *Trade Me* is the dominant New Zealand peer-to-peer selling site.

delivery industry in New Zealand. Online retailing, it was stated, creates *'massive complexities' (Hugh, Branch Manager, Auckland)* for urban delivery, as they're required to move into different urban spaces (e.g. residential streets), deliver smaller quantities, and negotiate difficulties related to absent recipients. However these issues were couched as "industry wide problems" with "no easy fix" and therefore less of an individual concern for drivers or managers. The growth in home delivery as a proportion of overall freight business was clearly identified.

> *"A lot of people now are working out of homes… A lot [of businesses] are online now because you're online buying and stuff like that. Especially on the courier side, what we have seen a growth in is a lot of residential deliveries now which always makes it quite tough because they're always not home and when we deliver there you leave a card…The residential side of it has definitely grown in the last two to three years; it's now probably 30 percent of our deliveries which is huge, whereas in the past it used to be just to customer or to non-residential" (John, Branch Manager, Tauranga)*

Residential deliveries were argued to require *"more resources"* and *"a whole lot more administration*" (Iain, Branch Manager, Auckland) than commercial deliveries. This administration is mostly a function of re-deliveries and communication with customers but other issues relate more directly to the driver's position, where residential deliveries take longer, and under the current payment model, do not deliver the same financial returns as bulk deliveries to warehouses.

> *"If you're delivering to the warehouse you might have 10, 20, 30, 40, 50 items which may take up a quarter or half of your van load, but you do that bulk drop. So that might take you ten minutes. If you have 30, 40, 50 residential items its taking you probably three to four minutes per residential item to deliver" (Kathryn, Regional Manager, Wellington)*

From a driver's perspective, home deliveries were described as making the driver's life "hell". Driver's reiterated the management's sentiments, that home deliveries take longer and put greater demands onto the drivers.

> *"So all your business freight's done at the start of the day and then you leave your residential, your home deliveries that people shop online - the enemy - I don't like those people." Interviewer: "The online retailers?" "Yeah, the online people; because they make your life hell. You go on one here, one there; so you make over 100 deliveries. With business freight that may only take you an hour or so, 100 deliveries for business; but with residential it takes three hours to do in the afternoon" (Sebastian, Owner-Operator Driver, Dunedin)*

Nevertheless, benefits were identified of residential deliveries for urban freight companies. In particular, the business growth opportunities:

> *"If the person goes on the App or goes online, a courier has to deliver it. If you go into the shop the courier will deliver the product [to the shop] and he may deliver 60 items in one box, so that's 60 transfers of that product for that person walking into a shop to buy. Only one courier may have had 60 movements. When those 60 people buy online, that's 60 movements. So the courier companies quite like online shopping" (Nicolas, Regional Manager, Wellington)*

Therefore, internet shopping drives demand for urban deliveries, generating more freight movements but a lower income level for drivers. Consequently, residential deliveries are seen to be a growth opportunity by freight management resulting in new approaches to respond to residential deliveries, which may include a new material culture of smaller freight vehicles.

> *"In the last three years we've seen a massive growth in terms of residential deliveries and stuff like that. I can see that becoming bigger with people now buying and selling online and stuff like that. That I reckon will push forward in years to come. We'll try and prepare for that as well; like we're doing different things in Auckland now. I know that in Auckland they will use little runabout cars now to get into those residential areas" (John, Branch Manager, Tauranga)*

Yet this is counter to the main trend away from cars, and towards vans: *"I know even from when I started here we had 20 vans and 70 cars; we've now got 70 vans and 20 cars. So it's just the type of work has changed. So that's sort of reinvent ourselves"* (Greg, National Operations Manager, Auckland). Reinvention of the industry might also include changing delivery times to suit home deliveries: *"For us we'll start to see a change in the hours we operate so I think courier companies are probably going to start having to look at working up until 10 O'clock at night to get stuff to people"* (Greg, National Operations Manager, Auckland).

3.2 'Warts and all reporting': Tracking and transparency

The customer preference, and growing expectation for full transparency throughout the delivery process was identified by both driver and management participants, across the geographical contexts. When asked about the importance of information and communication technologies (ICT) and tracking technologies to the industry, one manager replied: *"Our customers love it. In the end, that's what we get judged by. We haven't got a widget to sell, we've got a service to sell… You can't show someone, you can perform it. You can't show 'this is what we are'. So when you give that customer the 'warts and all' reporting and functionality it's very important to them. Sometimes they're quicker than us in tracing their freight, which is great"* (Paul, Branch Manager, Wellington). Thus the transparency of the delivery process is perceived to be a critical opportunity to develop a point of difference, and opportunity to sell a particular, and differentiated, service.

However transparency and tracking has a duel function; it also protects freight drivers and companies relating to loss and damages, ensure that items in the care of the freight operator are visible throughout the process, *"we scan our depots three or four times a day to make sure the freight is in here and we always have track and visibility of where all the freight is"* (John, Branch Manager, Tauranga). Thus while these technologies will not change the pace at which the freight moves, it is perceived to add value to the service provided by the individual companies; *"the IT [information technology] side of it will definitely enhance a lot of stuff; it won't help us move freight any quicker but it will definitely help us to give customers a better way of moving their freight"* (James, Branch Manager, Tauranga). Yet there is a financial cost associated with new technologies, which is not yet incorporated into the price the customer pays for the service; *"So all that technology we have got to keep up with it; we've got to be at the forefront, we've got to be the so-called leader. It comes at a cost and a cost to the courier"* (Graeme, Branch Manager, Dunedin).

The cost to the courier was discussed in the driver interviews, and was viewed as an additional financial pressure for the owner-operators, "*You're a contractor so everything is your responsibility... It's huge, I think I paid about NZ$45 [thousand] for my van. Our scanners are worth about two and a half, three thousand [dollars]. And uniform and things like that, it's huge"* (Mason, Owner-Operator

Driver, Dunedin). And while there appeared to be some variability in expectations for vans amongst different companies (e.g. age, model), the purchasing of scanners was non-negotiable *"the scanners and things we don't have an option; you've got to buy it"* (Mason, Owner-Operator Driver, Dunedin).

The uptake of tracking and the importance of transparency throughout the delivery process is also driven by customer demand. This demand was articulated by Kathryn, who stated that: *"so our customers want to see, "Okay it's been scanned to the rural driver, what rural driver is it and he's going to get it on board and where's he delivered it to." So I think that technology is going to be the main thing of the future"* (Kathryn, Regional Manager, Wellington). This was supported by James, *"customers want to know within five or ten minutes of a delivery time of their freight which they can get on screen. If our drivers are doing their job properly, they scan it when they get it delivered and then the next day they can see the POD [proof of delivery] in their system showing who actually signed for it. That's what they demand now*" (James, Branch Manager, Tauranga).

And these demands have evolved over time, with increasing demands for transparency throughout the delivery process: *"So I think IT [information technology] is where it [change] is at. I think customer's demands are going to be, 'I want to see my item from A through to Z. I don't want to see A, B, C, Z. I want to see it all'"* (Kathryn, Regional Manager, Wellington).

3.3 'They're just not practical': New technologies

The ownership of material culture (e.g. vehicles, fuels, etc.) is intricately connected to the owner-operator model frequently adopted by freight delivery companies. In this model, drivers are self-employed contractors to the company, and therefore make semi-autonomous decisions relating to vehicle and fuel technologies, under the rules and/or guidance of the contracting companies. This model was recognised as *"a worldwide standard"* (Hugh, Branch Manager, Auckland), and justified as *"offering someone to have a little business of their own within the… group. They've got sound income, they're paid regularly and they've got a good company behind them with a vision out there"* (James, Branch Manager, Tauranga).

Hybrid vehicles and electric vehicles were viewed positively by most participants, particularly where they could reduce costs: *"I love it [hybrid vehicles] because our contractors, immediately their costs have gone down. Their cost has gone up for the vehicle but they've not got that fuel cost. I believe it's over half their fuel bill will disappear using the hybrid type vehicle"* (Andrew, Branch Manager, Auckland). However range anxiety was often articulated: *"It can only be for if you're going to do less than 115 km's at the moment. So if you want to drive to Auckland and there's no power points from here to Auckland; it's not good for that vehicle so it won't work"* (Nicolas, Regional Manager, Wellington). Interestingly, the hybrid and full-electric vehicles appeared to be viewed as the same technology, with the same limitations. For instance, range anxiety was associated with both electric and hybrid vehicles, indicating some confusion around the capabilities of these technologies.

> *"We trialled a hybrid vehicle there for two years. Yeah, great, they're fantastic! The problem we found with those is just the electrical vehicle is pretty much, you can't go over a certain distance. The battery only lasts a hundred and something kilometres. Most of our contractors are doing 200 plus kilometres a day so for an electric vehicle you need a small electric vehicle maybe around town" (Andrew, Branch Manager, Auckland)*

This was also articulated by Hugh, who argued that a hybrid van would be unable to perform courier services.

> *"They're just not practical in terms of their ability to perform, or we're carrying a high payload. They're just not practical. I mean, we've yet to see one that will actually work in this environment. It will come. I'm sure it will come. In some of our point-to-point businesses we certainly use hybrid cars, hybrid vehicles, but I've yet to see a hybrid van that's able to perform courier services" (Hugh, Branch Manager, Auckland)*

The progression of the industry to demand larger vehicles is also contrary to the perceived present capabilities of electric and hybrid vehicles, *"It's more the business deliveries; they're going into bigger vans"* (Kathryn, Regional Manager, Wellington) and participants identified involvement in decisions relating to vehicle sizes, from these conversations, it seemed that rarely would a vehicle reduce in size, with most changes for larger trucks:

> *"When it gets to the stage when either our customers or our business is starting to suffer because a trucks too small or whatever else like that, we work with that owner driver at that stage to say, 'maybe it's time to go a bit bigger' and nine times out ten the owner driver knows that and understands that, he's just waiting for that little push. You get a basic idea of what we need and I guess with freight mix, what capacity etc." (Paul, Branch Manager, Wellington)*

This also contradicts the need for smaller vehicles to achieve faster delivery times within the congested urban transport infrastructure. Opportunities may exist for companies who focus on small deliveries and use smaller vehicles, for example, Peter discusses the types of business they conduct as *"zip, zip, zip"* highlighting the temporalities of their delivery service, which is managed with small vehicles and for which 2-wheeled electric vehicles might become a viable alternative (Lia et al., 2014).

> *"Three station wagons, three hatches and a van, basically. We move the little stuff, the little stuff that sits on the front seat - zip, zip, zip. We have a van because sometimes they'll want us to go and pick up a van load of freight from the airport, but we don't use it a lot; we move the little stuff quickly" (Peter, Owner-Manager, Dunedin)*

In terms of the environmental credentials of low-emission vehicles, there was evidence to suggest consumer demand for companies to take account for the emissions produced by their service, particularly from overseas customers, *"the customers that we are dealing with overseas, part of their demand is what we go as far as the fuel emissions and all that sort of stuff."* (James, Branch Manager, Tauranga). Nevertheless, environmental responses appeared to be non-fuel related actions including recycling: *"We are very strong on environmental. We have our recycling bins and all that sort of stuff. We collect water off the roof to put into tanks for our truck wash; so all that water is recycled and things like that"* (James, Branch Manager, Tauranga).

Thus the attraction to low-emission vehicles is more heavily related to lowering costs, and vehicle performance, than environmental concerns. This was articulated by Iain, who stated that:

> *"If you're going to put more food on your table or earn more money or you're going to drive to save the environment, I know which one is going to win out every time… if somebody could come up with a good vehicle hybrid situation and the performance would be there which they are, I think that's the way to go" (Iain, Branch Manager, Auckland)*

Due to the owner-operator model, decisions relating to fuels and vehicles sit with the drivers under the often stringent guidance of the freight company. This was articulated by Greg, who stated that*: "At the end of the day it's their call. So as they're business owners; the decision is theirs"* (Greg, National Operations Manager, Auckland). Cost appears to be the most important factor contributing to fuel related decisions. And while there appeared to be little interest in, or knowledge of biofuels for freight vehicles, fleet company cars were often hybrid vehicles: *"In terms of the trucks I'm not aware of biofuels may be available in that space. In terms of the vans it's just so much cheaper for them to run a diesel compared to a petrol operated vehicle. Like company managers, those that provide company cars; most of us have hybrids"* (Tom, Regional Manager, Dunedin)

An oft-stated concern relating to fuels was the impact of variability for the owner-operators and freight businesses. Instability relating to the NZ dollar, and overseas currencies was highlighted by multiple freight managers as an issue the industry needed to be aware of, and prepare for:

> *"You do need to keep an eye on that [fuel prices]. I just have an interest anyway and we talk about it at a management level. It's the same old thing, you budget for it. I'm not really worried about the price of fuel at the moment, it is okay but there's no guarantee it's going to stay that way. There's a lot of instability over here and the US dollar. Three months ago we were 84 or 85 cents on the US dollar and we're 64 today. That's all well and good for people who want to come here but difficult going the other way" (Hugh, Branch Manager, Auckland)*

When asked about technologies of the future, discussions centred on drone technologies. While there appeared to be some interest in these technologies and their capabilities to transform the freight industry, a range of issues were identified: *"If it's windy you can't use it, if it's raining you can't use it. You can't fly it 2 k's near an airport. You can't fly it over a motorway. You can't fly it over a school. If it's got a camera on it you've got privacy issues. It's just, it's fanciful. It's pie in the sky"* (Greg, National Operations Manager, Auckland). And while the capacity of drones to achieve timely delivery was acknowledged, it was broadly agreed that it would be the public and the customers, who would eventually decide if this technology would be adopted by the industry; *"Yeah they flew a drone; they put a parcel underneath a drone and it took say maybe five minutes and it took a van driver 22 minutes and it was just to go not far in Auckland city like in the industrial part... I guess it's up to the people really isn't it?"* (Nathan, Branch Manager, Dunedin).

3.4 'Not a timely way of moving freight': Meeting (changing) expectations

Participants discussed customer demands for efficiency and fast delivery times, juxtaposed with tight financial margins. This contributes to the difficulty in recruitment as being a freight driver becomes a less desirable occupation. A temporal dimension to delivery demand was also spoken of in terms of using the national rail system to move freight goods. Rail was described as a 'greener' way of moving freight, but its use was restricted by the customer demands for fast delivery. Paul argued that rail freight "is just not a very timely way of moving freight":

> *"Years ago rail freight was the exact way to go... It's a greener way of moving freight, it's a more efficient way of moving freight, it's just not a very timely way of moving freight and with the demands of our customers stating that 'yes, we'll have it overnight to you'" (Paul, Branch Manager, Wellington)*

This view was supported by Tom, who identified the negative impact of reliance on large freight trucks for intercity freight movements: *"There's a lot of trucks travelling up and down the countryside and it must have a huge impact on the roading"* (Tom, Regional Manager, Dunedin). James went on to

argue that while reliability of freight is still a concern, trains are *"by far the best option to have for long-hauls."* (James, Branch Manager, Tauranga). This view was also supported by John, who articulated an inevitability around transitioning to rail freight in New Zealand.

> *"I'm not quite sure what's going to happen in the future to be honest, but I suppose road vehicles will become a thing of the past. In years going down the track a lot of it will be railed hence the reason why we've bought buildings here with rail lines out the back, we can jump into rail when we want" (John, Branch Manager, Tauranga)*

While these national freight movements are not explicitly part of the urban freight delivery rubric, the speed at which deliveries move around the country can have implications for expectations within the urban context as well as impacting upon urban freight logistics.

In considering how the industry has changed, one participant reflected that the primary purpose of the industry hasn't changed over time, rather the technologies and expectations of customers have changed and in turn affected how the industry operates: *"It hasn't changed a lot other than the technology and some of the timeframes but the contractor still gets in his vehicle, still goes and picks up something and takes it and delivers it"* (Andrew, Branch Manager, Auckland). This, it was suggested, relates to new generations and different customers who are demanding faster delivery services, particularly relating to online purchases: *"The generation 'Y' coming through as consumers, they're more impatient. When they buy something they want it straight away"* (Greg, National Operations Manager, Auckland). This was reiterated by a freight driver*, "I think people's expectations have probably changed as well. People want things now. We are a very 'now' society; 'I ordered it two days ago and it said it would be here in two days and it is not here'"* (Dominic, Salaried Driver, Dunedin).

The temporalities of delivery was further expanded upon by another participant, who found that the expectations of customers were forcing the industry to become more efficient in their practices:

> *"It has put more pressure on us to get stuff delivered on time; there's no two ways about that. Going back a few years, if our delivery performance was probably around the 90 percent mark or a little bit higher, then people would be happy. Now we have got to get 98 or 99 or we have complaints. That's just the demand now; that's just what it is… So that's put pressure on us but our efficiencies within our business and what we demand of ourselves, have also put that on ourselves, and the customers now expect that and we have to perform or the questions are asked" (James, Branch Manager, Tauranga)*

Such efficiencies could be achieved through collaborations within the industry, to ensure that trucks are filled. *"I think we probably need to be working a lot closer together… for example: the trucks that come south are generally pretty full, the trucks that go north half of them will be empty. So, is there some way that we as transport operators can share some of those services going back?"* (Tom, Regional Manager, Dunedin), which could also have environmental benefits.

Another response was through the slowdown of services, in order to ensure expectations are met. Where geography, congestion or other features affected the capacity of the freight drivers to meet deadlines, some companies increased the minimum delivery time: "*What we saw was a slowdown of services to meet the customers' expectations in terms of delivery expectations, or delivery performance… we do a lot of car parts for big major businesses, and what happens there is that they've got demanding customers. Car parts is a really interesting one because you've got mechanics*

ordering parts who have got a car sitting up on hoists; they want it there quickly" (Andrew, Branch Manager, Auckland). Kathryn highlighted the changing customer expectations and stated that *"what was acceptable back in 2000 is not acceptable now*." (Kathryn, Regional Manager, Wellington), and this is related to strong competition in the market and expected to continue into the future with greater demands, "*It's pretty hard, it's definitely getting more and more - I know Australia, in Melbourne, you could order stuff online and it's got a three hour delivery time, so they've got to distribute it and get it to wherever it's going… so no doubt it will make it here" (Mason, Owner-Operator Driver, Dunedin).*

This competition was also identified as a cause of reduced rates and profitability of freight delivery: *"I think part of that is competition, is that the rates have been driven down. When I was here in 2000 our rates were at a much better premium and our margin was at a much better premium."* (Kathryn, Regional Manager, Wellington). This was also supported by Andrew, who identified pricing as the "*biggest weakness in the industry"* and that *"sometimes that spiralling down of rates is dangerous for the industry*" (Andrew, Branch Manager, Auckland). In sum, it was widely agreed that *"to try and make a 10 percent profit in road transport is pretty hard"* (James, Branch Manager, Dunedin). Consequently, aspirations for the future frequently related to increasing the profit margin:

> *"One of my hopes is that our margin can get better, our margin is very tight. Freight people want everything moved for next to nothing, not everyone but customers do. And I understand that, it's a competitive market and if we don't move it for a reasonable rate then our competitor next door will. So I would like to see better margins for the courier company" (Kathryn, Regional Manager, Wellington)*

Due to the decline in freight driver income, some companies will now offer a daily minimum in order to attract drivers. The recruitment of drivers was viewed as a particular challenge for the industry, *"We've probably got 75 percent of our fleet now on a daily guarantee. That was never the case previously. We didn't need it, we didn't need to attract it and there was a lot more money to be made in courier"* (Kathryn, Regional Manager, Wellington). The changes to margins and profitability has impacted upon recruitment of freight drivers, with one participant stating that the responses nowadays can be 'mediocre', as the income is not sufficient to attract good candidates.

> *"Recruitment definitely became harder since 2000, absolutely. In 2000, you would advertise around and you'd probably get 20 to 30 applicants. Of those 20 to 30 applicants three-quarters of them would meet our expectations so we would have waiting lists… Nowadays we can recruit and sometimes we'll get a mediocre response, so we might get half a dozen" (Kathryn, Regional Manager, Wellington)*

While the service is improving, particularly in terms of investments in new technologies, the price of the service has not increased.

> *"The cost, it's definitely the cost, I don't think it has kept up with the resource that we've had to put in the way with technology, with scanning. You can go on now, punch in your tracking number, each parcel's got a unique number, you can see exactly where that parcel is, then you can google map it, you can see where the van is, where we've delivered it. That's basically cost millions of dollars in technology, where I don't think the cost of sending that parcel has kept up with the technology that we've had to put in" (Iain, Branch Manager, Auckland)*

In terms of the external context affecting the industry, and its ability to react to customer demands, a series of factors were identified, these included; traffic congestion, parking provisions, and adverse weather.

> *"Weather, traffic and vehicle break downs of course. Those are the three main things that are out of my control" (Iain, Branch Manager, Auckland)*

> *"The other impact weather-wise is the northern motorway. If that gets snowed out, you have five or six huge truck and trailer units sitting on the other side of the hill with all our product that we can't reach" (Tom, Regional Manager, Dunedin)*

It was broadly agreed that weather was the main issue outside of the branch manager's control that had a negative effect on their ability to deliver freight. *"It's not a lot other than weather outside your control but everything else is basically in our control, in the branch manager's control"* (James, Branch Manager, Tauranga). Other factors included the decisions made by council that would affect the movement of freight vehicles in the urban environment: "*Council bylaws, the parking availability, that's out of your control.*" (Andrew, Branch Manager, Auckland). Parking was identified as a particularly troublesome issue for freight drivers, particularly where parking had been removed. This directly affected delivery times and made the job more stressful for the driver.

> *"You've got all those players, all those other guys wanting to park their courier van first thing in the morning because everybody wants their freight first thing in the morning and how can that courier van be at that end of town and that end of town trying to delivering the same stuff to the same point. Then he's got to go around the block trying to get a park. Of course if you fall out with meter-maids and meter-men" (Graeme, Branch Manager, Dunedin)*

This was supported by freight drivers, who found transport infrastructure (e.g. traffic lights, road works), and parking spaces to be critically important to achieving the timely deliveries demanded by the customers; *"I find especially in town there are probably not a lot of authorized spots for delivery trucks and that. That can really hold you up if you have to circle the block again, we're on quite tight timeframes"* (Liam, Salaried Driver, Dunedin).

4. DISCUSSION

Our qualitative inquiry reveals much about the change trends in urban freight deliveries, as experienced by freight drivers and managers in Aotearoa New Zealand. Section three has empirically responded to research question one: How has urban freight delivery changed over time, and how is it expected to change into the future? Following a discussion of these findings, our attention will turn to the second research question: the implications of change trends for achieving the required carbon reductions. The Energy Cultures Framework, introduced in section 2.4, will be used as an analytical tool to identify particular 'mobility cultures' (Hopkins and Stephenson, 2014) amongst the themes identified above. The four themes identified in this research are highly interconnected, and the Energy Cultures Framework offers a way of thinking through these relationships.

The qualitative material provides evidence of a shift in the mobility culture of the urban freight industry in New Zealand. This emerged through 'the good old days' narratives from both drivers and managers which depicted a time of less technological development (e.g. internet, tracking, GPS), but also lower demand-side expectations. Lower delivery time expectations contributed to reduced stress and pressure for fast-paced movements around the urban space, and a lower frequency of home deliveries kept delivery drivers concentrated in the urban business districts. This suggests perceptions

of a 'simpler' mobility culture with lower demands, but greater profitability. Consequently recruitment and retention of drivers was less problematic for management, and the job offered financial security for drivers. This is in many ways in stark contrast to the present-day mobility culture for urban freight, which appears to be focused on financial constraints, required technological investments (e.g. GPS units for tracking), increasing customer demands, and unprofitable freight runs (e.g. residential). These complexities could result in a more strained environment for adapting to future change including evolving customer expectations, and low-carbon transitions.

Practices of freight delivery appear to be dictated by pressures, particularly tight timeframes for deliveries, which is driven by the expectations of customers, and impacted by the infrastructural decision making of local councils and planning services, for example the removal of parking spaces in city centres and increasingly congested infrastructure, particularly in Auckland. This can result in increased fuel consumption and GHG emissions as the driver's search for free parking, or illegal parking practices (Jaller et al., 2013). The flows of freight in and around the four urban centres included in the research are changing, in volume, type and destination. This is drawing freight drivers increasingly into residential areas, or mixed purpose spaces (e.g. industry and residential) and away from the typical 'hub' of the Central Business District (CBD). These new geographies for urban freight delivery are impacted by and equally impact upon transportation planning decisions, parking regulations, and new residential developments. Therefore the evolving ways that products are purchased (e.g. online) and delivered (e.g. home delivery, parcel deliveries) needs to be included in transportation and urban design policy and planning.

Customer expectations for transparency throughout the delivery process is also changing, and these demands are adding additional financial constraints on owner-operator contract drivers, for whom changing patterns of freight delivery are most clearly experienced. The use of tracking services can provide security to freight drivers by providing real-time accounts of delivery, yet industry norms and expectations are placing pressures on owner-operator drivers that can ultimately constrain their ability to make energy efficient choices (e.g. in material culture and practices) in lieu of speed related and time saving behaviours.

There are clear implications of the change trends identified in this research for carbon reduction. For instance, there appears to be an appetite for low-carbon vehicles, particularly due to the lower running costs for electric and hybrid vehicles compared to traditional internal combustion engine (ICE) vehicles, aided by the rapidly declining costs of battery packs for electric vehicles (Nykvist and Nilsson, 2015). However the oft-cited barrier of range anxiety (Feng and Figliozzi, 2012, Tran et al., 2012) was present in this research. This appeared to be somewhat problematically related to both full electric and hybrid vehicles. While there is exciting research underway to overcome the range issues associated with electric vehicles (Van Noorden, 2014, Ball, 2016), research has suggested that for households, average daily travel can be achieved with current battery capabilities (Deloitte, 2011). The distance needs of urban freight delivery drivers is undoubtedly far greater, however their research does suggest that range anxiety is a product of perceived distance and requirements than actual battery performance. Moreover there appears to be a lack of understanding relating to the capabilities and performance of electric vehicles and hybrid vehicles. This could align with a well-reported misunderstanding of the differences between battery electric vehicles and plug-in hybrid electric vehicles in terms of purchase price, expected fuel and maintenance savings, and battery range (Axsen & Kurani, 2008, Browne et al. 2012, Krause et al. 2013). A synergy between types of electric/ hybrid vehicles (e.g. small to medium sized vans) and the requirements of the freight industry is also required to achieve systemic uptake of low-carbon vehicles.

Due to increasingly small margins on freight delivery, and increasing pressures for freight drivers to invest in ICT scanning technologies, decisions relating to fuels and other material culture will be more closely aligned to financial considerations and transport efficiency than environmental concerns. However where these can be mutually supportive; there are opportunities to reduce the carbon intensity of the freight industry. It has previously been reported that CO_2 and cost "trend together" and therefore increasing the cost of fuel is an effective approach to encourage freight companies and drivers to limit their emissions (Wygonik & Goodchild, 2011). Transitioning away from road transport for urban freight deliveries seems unlikely, yet for national delivery, rail could provide a low-carbon option, but the current climate for time sensitive deliveries, along with a lack of political support for rail, might hamper the reintroduction of freight as a major national freight delivery mode in New Zealand. There was evidence of support for rail-freight, and trains appear to be viewed as a low-carbon option for national freight distribution, but also at odds with current expectations on freight delivery times. These temporalities may limit the capacity of the freight industry in New Zealand to adopt low-carbon modes.

While engagement with the "slow" movement (Movimientoslow, 2008 [e.g. 'Slow Food', see: Slow Food, 2010; 'Slow Tourism, see: Heitmann et al. 2011, 'Slow Fashion', see: Pookulangara & Shephard, 2013]) may be a radical departure from the current pace-driven freight industry, it could also provide critical insights into realigning freight delivery to ensure deliveries are timely, but also able to adopt low-carbon modes where available. The demands on the industry can create pressures that promote inefficient or wasteful practices such as empty/ below-capacity vehicles (e.g. McKinnon & Ge, 2006), and inefficient driving behaviours (Zanni & Bristow, 2010), such as idling (Arvidsson et al. 2013), all of which were noted by our research participants. Norms within the industry have evolved through time-pressured and time-sensitive customer expectations, thus rethinking the demand and supply of freight services to fit within the needs of a low-carbon society might result in decreasing delivery speeds.

5. POLICY IMPLICATIONS

This article raises a number of issues related to the regulation and governance of urban freight in Aotearoa New Zealand. Filippi et al. (2010) present four classes of measures: 1. Freight traffic regulation (e.g. parking, loading/ unloading regulation), 2. Physical infrastructure (e.g. urban distribution centres), 3. Intelligent Transportation Systems (ITS) (e.g. route optimisation), and 4. Loading units and vehicles (e.g. standards for loading units and unconventional vehicles – electric vehicles, metro rail etc.). In the research presented in this paper, specific policies were not explicitly discussed with participants; nonetheless, some of these issues did arise from the interviews. This is not to imply elevated importance to those discussed, or reduced relevance for the measures that did not feature, however we will now examine some of the key policy implications arising from this research.

The movement of goods through urban space contributes substantially to on-going congestion, local air pollution and GHG emissions. While the industry appears to have opportunities for growth that were also acknowledged by research participants, little of this appears to be benefitting owner-operator drivers. In this context, and under growing demand for fast delivery - either from the customer or from the driver's need for more deliveries to increase income – drivers appear to be frustrated and disengaged with the urban environment, and other road users. Transportation policy was signalled as an area external to control, and in many situations input from the industry. Greater collaboration between the industry and the governing authorities could contribute to higher acceptance of and obedience to transport regulations. Parking and loading bays appear to be a source of contention for delivery drivers, and which create tensions between couriers and other drivers, and

this demands further analysis. Calls for pedestrianisation in some urban centres in New Zealand could further exacerbate these concerns, yet pedestrianisation offers potential for decarbonising the urban environment. These tensions require detailed investigation.

Urban distribution centres were not discussed in this project, but also offer clear opportunities, particularly in Auckland, for increasing the efficiency of urban delivery, particularly if this is coupled with collaborations between freight providers. Support for the uptake of electric and hybrid vehicles, including relevant physical infrastructure, could also aid a low-carbon transition in the urban freight industry. Motorised vehicles are likely to feature strongly in any future transport system, particularly as shopping becomes increasingly internet-based. Reducing the carbon intensity of the industry through technological innovations as well as collaboration-based efficiencies could go a long way towards reducing urban freight emissions.

6. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

The freight industry will be a critical part of any meaningful low-carbon transport transition. The way goods are produced and consumed is likely to continue to change into the future, with innovative technologies and expectations changing both the supply of and demand for freight services. The owner-operator model places responsibility for low-carbon decisions (e.g. vehicle and fuel decisions) with drivers, rather than the freight businesses themselves, therefore the experiences of drivers provide unique insights into the mobility cultures of urban freight delivery in New Zealand, as well as current and potential change trends. The driver's capacity to make low-carbon decisions may, however, be restricted by industry norms and customer expectations which will require systemic transitions supported by freight businesses, local councils, urban transportation planning, and freight customers.

Building on the findings presented in this paper, there are a number of fruitful avenues for future research. Research examining under-researched geographical locations can provide new and interesting insights, and in these locations patterns across the industry can help to describe and quantify different characteristics. Nevertheless, it is clear that qualitative research has much to contribute to the literature on freight more broadly, and urban freight in particular. This research intersects with geography sub-disciplines including urban geography and transport geography, as well as topics including consumption and sustainable mobilities. The interactions between the freight industry and policymakers requires closer attention, specifically relating to the impacts of 'sustainable' transport policies, and other decision making that impacts upon freight deliveries.

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