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Exploring the relationship between urban freight demand and the purchasing behaviour of a University

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Abstract

Introduction This research was focused on the 'receiver' end of the supply chain that has, in recent years, emerged as a novel area of investigation by European urban freight researchers. The paper explores the importance of procurement policy and mechanisms in a higher education establishment in order to drive a sustainable approach to inbound logistics. There is little known of the purchasing behaviour at individual level within such organisations. A localised city logistics Delivery Service Plan, within a 'coherent campus strategy' for an academic campus was established at Newcastle University, located at the centre of a medium size British city.

Method Purchasing data and interviews with the purchasing manager demonstrated the current state of purchasing practice at the University, relative to the benchmarks established in the literature. In order to better understand the relationships between delivery services, the urban environment, and staff attitudes, a questionnaire was conducted with Newcastle University staff, addressing the purchasing of all goods to be delivered to the workplace.

Result Multivariate analysis of cross-sectional data, as well as qualitative analysis, shows that variable frequency in demand can be explained by: job type; the different ways to raise a purchase order (PO); type of goods purchased; expected delivery times; and from where the PO originates. The findings suggest that training within specific staff roles would benefit the University's urban freight coordination and management. We can also see that a very small core of people raise most of the orders and that, through them, it should be possible to influence the majority of orders. Lastly, demonstrating to the University's Executive that employee views on private purchasing directly influence the practice, has convinced the board that changing purchasing behaviour towards freight efficiency is a feasible option for a sustainable institutional organisation.

Conclusion The key contribution of this paper is demonstration of the important role of logistics receiver can make in delivering sustainable city logistics. This is especially true for large organisation with multi-sited and multi-level management (central vs local) that require multi-type of logistics in a city-centred bound historic built environment University. This paper shed light on identifying the key determinants of freight demand at University that can be managed and act as catalyst for accommodating urban freight in city planning.

Keywords Urban freight · Sustainability · City logistics · Purchasing behaviour · Academic institution · Freight delivery · Receiver-led initiative

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1 Introduction

Clean urban freight, within the domain of urban mobility, is a key part of European Union (EU) policy to enable environmentally sound, socially inclusive and economically viable cities. In addition it is expected to contribute to a 60% reduction in greenhouse gas emissions (GHG). Over 60% of the EU population currently lives in urban areas, contributing circa 85% of the GDP [1]. The 2011 European Commission's Transport White Paper set ambitious scenarios and a vision of future urban freight transport to "halve the use of 'conventionally-fuelled' cars in urban transport by 2030, phase them out in cities by 2050 [and] achieve essentially CO_2-free city

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logistics in major urban centres by 2030" [2]. Some of the scenarios include minimising the number of freight movements and the distance over which they are carried out; using low emission vehicles/trucks; and making maximum use of intelligent transport systems (ITS) to increase delivery efficiency.

However, these scenarios and most previous policy and research have focused on the transport chain operators and the initiatives of shippers and/or suppliers of goods. Only in recent years has a conceptual model focused on the 'receiver' end of the supply chain been discussed amongst European urban freight researchers [3–5]. A few examples have emerged of the practical implementation of this approach, the most influential being the adoption by Transport for London (TfL) of Delivery and Servicing Plans (DSP) in the London Freight Plan. DSPs were used at their Palestra Offices in Southwark [6] and later on a macro scale, for the 2012 Olympics. A DSP is the management and organisation of multiple operations of last mile deliveries from a demand based perspective, optimised by efficient freight planning from the perspective of the receiving organisation [5]. It provides a framework to better manage freight movement, by adjusting the conventional working methods of urban freight stakeholders to meet both the inbound logistics needs of the receiver and wider sustainability objectives. It may be more effective than previous interventions at the transport operator link in the chain, since the delivery company is usually carrying out the express wishes of their customer – in most cases the supplier of goods or services. The supplier, in turn, is executing a supply to meet the express wishes of their client - usually the receiver. Whilst purchasing for large organisations does certainly have a documented and often regulated sustainability agenda [7, 8] and Newcastle University does indeed have sustainability targets in its procurement policy, the relationship between an institutional organisation and that organisation as a freight receiver bears further investigation.

Despite the potential for freight 'receiver' stakeholders to play a key role in managing urban freight demand, very little is known about which factors influence their freight demand. This is especially true of a large organisation with demand generated by multiple departments and groups. Understanding the drivers that influence freight demand generation, in a large public organisation such as a University, would help inform the decision-making process to improve urban freight management towards a sustainable freight system.

In this research, we aimed to examine the relationship between urban freight demand (in the form of purchase order (PO) demand made at organisational level) and the purchasing behaviour of staff, using a Newcastle University as a case study. The study was expected to bring new insights to understand the differences underlying the purchasing behaviour of staff. The University had at this time over 80 buildings, holding 144 schools/departments/institutes, any of which could raise purchase orders via 466 expert buyers and 1058 shoppers (also known as requisitioners).

Focussing on the 'receiver' role raises multiple research questions about purchasing, both formal and private, and inbound deliveries at Universities. For example:

- What are the drivers of purchasing: do they represent institutional, or private demand?
- Was the the workplace the final or an intermediate delivery location?
- Was purchasing planned, or ad hoc, and to what extent are buyers proxies for other users?
- Do different goods types noticeably create different demands?
- How was the required timing of demand for goods generated, versus the actual need for the goods?
- In what manner and in what packaging were goods delivered to the end user?
- To what extent did institutional strategy affect change that is noticeable or memorable?
- How did people feel about purchasing, inbound deliveries, private purchasing at work, and about freight and freight activity in general?
- To what extent was the expressed demand of a University conscious or unconscious, at the individual buyer level, and at the institutional level?

This study used a mixed research methods approach, including interviews with the procurement manager and questionnaire surveys of all staff. The interview with procurement manager was needed to better understand the policy and practice of purchasing at the organisation level, and then used to inform the design of the questionnaire. The questionnaire was purposed to gain a better understanding of the relationship between freight activity and purchasing, both formal and private. It was distributed via the Human Resources (HR) staff mailing list and the staff website. The design of questionnaire included buying behaviour (e.g. frequency, time, type of product, value of goods), opinions on the University coherent campus strategy, environmental issues, and socio-demographic characteristics. A better understanding of the relationship across these variables was expected to lead the University to embrace policies to better manage inbound delivery flows to the campus, reducing the visual, safety, congestion, economic and operational impacts. It was not assumed that the University wished to prevent private purchasing at work, and the possible economic, social and environmental sustainability benefits of such practice were looked for, as equally as the disbenefits.

2 Literature review on sustainable purchasing behaviour

Recent studies addressing urban freight issues have begun to highlight the relative importance of the role of 'receiver', as

opposed to 'carriers', in improving the sustainability of the logistics supply chain. Logistics is an induced activity and derives from purchases. Sustainable purchasing is the pursuit of sustainable development objectives through the purchasing and supply chain process, incorporating social, environmental and economic aspects [7, 8]. Therefore it would be rational to explore the linked activities, to see the extent to which sustainable inbound logistics can be enhanced by the procurement practice that induces it.

The strategic importance of the purchasing function in the business environment, notably in the private sector, has been acknowledged and recognised to contribute to economic advantages [9]. Management, company image, customers, carriers and the public policies are some of the identified key drivers of sustainable purchasing, within the private sector. In the public sector, sustainable purchasing practices also include explicit factors such as environment, diversity, human rights, philanthropy and safety - key drivers to this sector [10]. The identified key principles of public sector procurement are transparency, accountability, and achieving value for money for citizens and taxpayers.

A benchmarking exercise on improving sustainable purchasing practices within the private sector has demonstrated eleven key activities in engaging suppliers, as can be seen in Table 1:

The importance of training and education was highlighted in private sector business practice [11], however purchasing decisions about third party logistics (3PL) are still made mainly based on traditional criteria such as price, quality and timely delivery [12]. A study looking at the 3PL consideration on adopting green initiatives demonstrated that government support, management and the entrepreneurship are the key drivers, while a well-defined regulations framework and financial incentives were the barriers [13].

A number of recent studies, mainly Swedish based, used the process approach to investigate the anticipated change. For example, the role of environmental (management) standards (e.g. ISO 14001) towards the public sector's sustainability agenda [14]; the role of stakeholders in shaping municipal energy and climate planning processes [15, 16]; and the role of public procurement in setting up a coordinated freight distribution of municipal goods [17, 18]. The potential use of invoice data as a proxy for delivery, or using traffic counts as indicators, is discussed in Zunder et al. [5] and Aditjandra et al [19]. In addition, it is notable that the adoption of green public procurement has long been promoted within the EU [20] and that the UK professional Chartered Institute of Purchasing and Supply includes sustainability using such standards as the SA8000® Standard in its education and training materials [21, 22].

Coordinated freight distribution as discussed above is a concept of city logistics that incorporates the use of an urban consolidation centre (UCC) in combination with other measures, including encouraging the procurement function (of municipalities) to engage in-house operation of last-mile distribution and to use smaller or clean energy vehicles. The impact on the procurement function is the potential change in contract cost and in the agreement between the public authorities and suppliers/service providers (3PL), as product and logistic costs can be seen differently when last mile logistics is done in-house.

It is logical that the importance of procurement in both private and public sectors has the drivers, factors and corporate importance to drive a sustainable approach to inbound logistics through the mechanism of purchasing. There is however very little known of the purchasing behaviour at individual level within a large organisation. This paper addresses just that question, to gain a better understanding of the mechanism of purchasing that influences delivery activity and to better explore the degree to which sustainable procurement policy is being translated to sustainable logistics.

Modelling latent variables at individual level using multivariate analysis (such as regression) in transport policy research has long been recognised as a robust way to gain insights into understanding relationships between multidimensional issues. This method employs statistical control which explicitly accounts for the influences of attitudinal behaviours, by measuring and including them in the behaviour equation and thereby moving them from unobserved to observed [23, 24]. Some example of these works are able to shed light on the mechanisms of behaviour change with regard to sustainability in transportation research [23, 25–28].

The above approaches are in contrast to common transport demand modelling that would rely heavily on analysis of vehicle movement behaviour within designed transport network; where for freight, vehicle trip/cargo weight is typically modelled as dependent variable of urban freight demand [29]. This analysis is typically followed with transport operation/assignment modelling framework that address optimisation of vehicle routing problems [30]. Recent development in this type of modelling package includes creation of additional module that can model 'pick-up' and 'delivery' operation of an establishment to characterise end consumer goods movement generation [31]. The agent of analysis used on those papers is vehicle trip activity based as opposed to individual activity that relates to attitudinal behaviours that may effect changes in freight trip demand as this paper attempt to address.

3 Interviews with the University procurement team

Newcastle University lies at the heart of a city with a population of around 300,000 within a conurbation of around 900,000, which lies on the North side of the river Tyne in the North-East of England. At the time of this work, the University had over 144 schools/departments/institutes and over 80 buildings. The University main campus is integral to, but separated from, the main city, and there are other campuses and sites integral to the city. Steady and flat volume of purchasing (averaging around

Table 1 Corporate Social Responsibility - purchasing benchmark activities and brief description (source: [11])

Engaging suppliers key activities	Description
1 *The use of code of conduct (CoC)* (e.g. the United Nations' declaration of human rights and convention on the rights of the child; the International Labour Organization's declaration of fundamental principles and rights at work; the Rio Summit declaration of environment and development)	CoC sets guidelines on a range of principles and issues, whose purpose is to: - state the values of the purchasing company and the expectations placed on suppliers; - improve the social responsibility performance of a company; and - influence business partners and provide a set of expected standards.
2 *Internal training and education* (for a successful corporate social responsibility (CSR) performance)	Linked to the implementation of the CoC described above, training among co-workers is important to the development of understanding and capability.
3 *Integrate CSR in management* (through for example: ISO 14000 and different forms of green labels to integrate the environmental dimension of CSR in business management)	Also linked to the implementation of the CoC above, integration of CSR does not stop at business strategy and policy but is also in the management system, the organisational processes and the culture of the entire staff (not only the managers) which affect daily life.
4 *Report the CSR performance* (i.e. communication of the achievements to stakeholders; reports of management of suppliers and purchasing)	Documents such as supply chain policies and general information about companies' progress regarding social (and environmental) responsibility were used to measure the CSR performance. Examples of the reporting framework can be seen in the Global Reporting Initiatives (GRI)[a] established since the late 1990s to integrate sustainability into an organisation's decision making.
5 *Monitor suppliers* (through for example: questionnaires and factory inspections/audits)	This key activity aims to investigate if the suppliers comply with the CoC or other expectation sets. Physical inspection and audits at suppliers' facilities, a documentation inspection, interviewing management and workers, and a second inspection to monitor progress, are some of the key activities.
6 *Draw up improvement plans* (e.g. ways to support local supplier development; written statements from the buyer and or the supplier; including suppliers in the design of the improvement plan)	The improvement plan includes information regarding practices that need to be changed within a particular time frame and, in some cases, how improvements have to be carried out.
7 *Reject suppliers*	If suppliers do not comply with the CoC, termination of the relationships could be conducted.
8 *Educate/inform/support suppliers* (through for example: training programmes, workshops, and meetings)	Dialogue with suppliers is central to successful implementation of any principle across a supply chain. This is especially the case in addressing the CSR issues. It is important for the trainer to have good knowledge of the local specifications of where plant is located.
9 *Use rewards for compliance*	This key activity is useful in combination with the use of the CoC.
10 *Supplier collaboration* (i.e. collaborative suppliers/buyers meeting, collaborative audits)	Addressing CSR in a collaborative way has been discovered by many companies to be best practice, as both buyer and supplier can learn from each other while strengthening the relationship.
11 *Restructure relationship* (i.e. co-operation, trust, mutuality, power/dependence, and intensity)	One strategically important task for the purchasing function is to create and maintain good relationships with suppliers. By restructuring the relationship with suppliers, both the social performance and the business can potentially benefit.

[a] www.globalreporting.org

300 purchase orders (PO) each day) was evidenced from over 2700 vendors (suppliers) throughout the academic year 2011–2012 [32]. A drop in demand at Christmas was also reported, as well as no weekend working. 70% of POs staff raised were for goods and 20% for services, the balance financial activities or large scale capital infrastructure.

Interviews were held with the procurement team, to better understand University purchasing policy and practice. Both were highly decentralised, with the purchasing team taking the Pareto rule that 80% of spend will be with 20% suppliers and that these, plus the legal regulations on the spending of public money, should be where their efforts are focussed. We cross checked with the University's Head of Procurement the key sustainable purchasing practices drawn from the literature, to explore the extent to which this hybrid private-public institution correlates with a nominal sustainable procurement profile. Table 2 summarises that interview, examining the current purchasing practice at the University. Generally speaking, the University only partly matches the full profile of practice and policy, notably in the areas of improvement, collaboration and relationships. The use of a Code of Conduct, supplier monitoring with a compliance awards scheme, and the general endeavour towards integrating corporate social responsibility in management, were evident from the interview.

Table 2 Sustainability purchasing practices in the Newcastle University purchasing function, applying the benchmark tool by Björklund [11] (source: this study)

No	Sustainable purchasing practices	Newcastle University (purchasing function)
1	The use of Code of Conduct	Yes for contract suppliers and large tenders (compulsory); but No for low value transactional suppliers.
2	Internal training and education	No
3	Integrate corporate social responsibility in management	A little; mainly in catering contracts; it is a priority to expand this.
4	Report the corporate social responsibility performance	No
5	Monitor suppliers	Yes for large suppliers and contract suppliers. Monitored using CIPS* Sustainability Index.
6	Draw up improvement plans	No, but see no 3 above
7	Reject suppliers	Not yet but haven't had cause to, rather than not looking to do this.
8	Educate/inform/support suppliers	No
9	Use rewards for compliance	Yes supplier awards scheme
10	Suppliers collaboration	No
11	Restructuring relationship	No

*Chartered Institute of Procurement & Supply (www.cips.org)

Despite the insight gained from the top-level purchasing activity data, there is still very little known about how this purchasing activity is generated. Some POs represent a single item of medical equipment that is delivered with ten others on the same vehicle; on the other hand 'blanket' orders that cover a month's deliveries to multiple sites were also discovered. In other words, there is little clarity of the relationships between POs and deliveries with 'one to one' and 'one to many' relationships existing but proving unclear in the data.

4 Survey methodology and descriptive analysis

4.1 Survey design

Following the interviews with the procurement team and some information gathered from the procurement data characteristics, it was possible to design a model of relationships between delivery services, the urban environment, staff attitudes and purchasing behaviour. The design of the questionnaire included buying behaviour (e.g. frequency, time, type of product, value of goods), coherent campus strategy, environmental issues and socio-demographic characteristics. The objective of the design was to gain insights into how and why purchasing demand is generated, so as to better understand inbound deliveries and achieve a sustainable campus environment, as illustrated in Fig. 1. We consulted with the University procurement manager and piloted the survey among those of our research team able to raise a requisition for goods. The survey was conducted in March 2014, targeting c5000 Newcastle University staff and addressing the purchasing of all goods to be delivered at the work place, whether for University or private use.

With the framework illustrated in Fig. 1, examination of the relationship between urban freight activity, purchasing behaviour, socio-demographic and environmental attitude characteristics from individual (staff) was carried out.

The survey was created and carried out using Surveymonkey, in line with current best practice, using the HR mailing lists but explicitly separating and distancing the questionnaire from line management and assuring anonymity. Completion of the questionnaire was voluntary, but an attractive random prize was offered (and won) as an incentive to invite as many respondents as possible to complete the survey. The collection of data for the draw was 'blinded', and impossible to connect to any single response. In total, 735 valid responses were received. At 14.70% overall, this was a high response rate, and the responses were skewed towards

Fig. 1 Illustration of possible key drivers of (private) purchasing behaviour & impact on urban freight activity

administrative staff – a total population of somewhere between 900 and 2000, depending on definition – which makes the response rate for that key segment even higher. A much lower response rate was received from academic staff, who are far less likely to place a PO. Individual question response rates varied; this is shown below in the Tables, where relevant.

4.2 Descriptive analysis

4.2.1 Commodity types

Results indicated that the majority of the goods types given in the survey were not bought by the majority of the respondents, but typical commodities purchased could be summarised as in Table 3. The 'other' category includes equipment, external consumables, material items, services and training. Further scrutiny of the data demonstrated that the majority of the 'other' POs were non-delivery goods or services (37%), followed by laboratory/teaching consumables, and domestic goods.

4.2.2 Expected delivery time

The majority of goods deliveries were expected to be received 'as soon as possible', including the top commodities purchased as shown in Table 3: 'travel tickets or documentation'; 'books, literature, etc.'; 'repair or maintenance services'; and 'ICT equipment. For 'catering', 'food and beverages' and 'furniture', the expected delivery was on a 'specified date'. The only goods that have mostly 'next day' delivery expectations were 'office stationery' and 'travel tickets and documentation', while goods with the lowest incidence of critical delivery time were 'books, literature, etc.'. A significant number of responses indicated that 'office stationery' and 'ICT equipment' delivery times were not actually critical - contradicting

the required and fast delivery often stated on the PO. It can be concluded that the characteristics of goods determined the way that they are expected to be delivered. Whatever the expected delivery time characteristics drawn from the survey however, it is notable that the University SAP-based ordering system defaulted to 'next day delivery'.

4.2.3 Value of goods ordered

The majority of respondents reported typical values, for all goods types, of between £100–£499. The exception was 'ICT equipment' (computers, printers, etc.), valued at between £500–£2499. The lowest value goods types were 'office stationery' and 'food or beverages (as opposed to catering)', where the majority reported either less than £25, or between £25–£49. 'Repair or maintenance services' were reported with unknown value, by the majority of respondents, as were 'other' (basically non-delivered goods or services) and 'furniture'.

4.2.4 How the goods are delivered

The majority of goods (almost all those categorised in Table 3) were reportedly delivered in a box or boxes, or in trays that can be carried by a single person. Exceptions are 'travel ticket or documentation' and 'books, literature, etc.' delivered in envelopes, or packets. The respondents reported working in 77 different locations across the University buildings, more or less corresponding to the expected delivery location.

4.2.5 Private purchasing behaviour

Eighty-nine respondents (5.8% of the target population, maybe 1.7% of all staff) reported purchasing goods for personal use, to be delivered to the workplace. Typical of the majority

Table 3 Typical purchase order (PO) of Newcastle University staff (N-507*) (source: this study)

Answer Options	% Responses	RANK
Travel tickets or documentation	59%	1
Catering (prepared food service)	46%	2
Office stationery	45%	3
Books, literature, videos, software, music (but not downloaded content)	42%	4
Repair or maintenance services	40%	5
ICT equipment (computers, printers, mice, but not software)	37%	6
Other	27%	7
Laboratory consumables	25%	8
Food or beverages (non-service, as opposed to catering)	24%	9
Chemicals (hazardous or otherwise)	23%	10
Furniture	21%	11
Clinical or medical supplies (incl. Biological reagents)	17%	12
Bulk gases, oils, fuels, etc.	8%	13

*A number of respondents did not register their answers in the questionnaire because they do not normally raise POs

were 'books, literature, videos, software, music (but *not* downloaded content)', 'clothing', and 'travel tickets or documentation'. The frequency of private orders raised was typically less than twice a month. Some of the most stated reasons for having private goods delivered to work included: 'there is no-one at home' and 'because travelling to collect a failed delivery is inconvenient'. Some qualitative data reported by the respondents pointed to the fact that private purchasing was deemed 'unusual' or 'unacceptable' practice, although some comments were made to illustrate the usefulness of being able to deliver private goods to work.

Respondents were asked to indicate to what extent they agree with (private) purchasing related statements, on a four-point scale from 1 ('strongly disagree') to 4 ('strongly agree'). Table 4 shows the respondents' agreement with (private) purchasing statements in order, from the most endorsed (with highest mean), to the least endorsed (lowest mean). The respondents reported the importance of environmental awareness as the main driver influencing purchasing behaviour, with the highest mean value, as can be seen in Table 4. In contrast, the least appreciation was given to the statement that conveys a restriction on private purchasing activity, for delivery to work.

4.2.6 Coherent campus strategy

The survey asked the respondents a series of questions to judge the degree to which the University's coherent campus strategy had led to noticeable or memorable change for staff. Respondents were asked to indicate how true they believe statements about the improvement in the built environment characteristics of the campus to be, in the last 5 years, on a four-point scale from 1 ('not at all true') to 4 ('entirely true'). The respondents generally agreed that the campus has improved in the last 5 years, in terms of consistency of signage, paving and landscaping; coherence – different spaces but a sense of unity; no through traffic; and slopes, no steps, on pedestrian walkways. Another question was used to measure the current level of freight traffic. The increased pedestrianisation has been noticed as creating less freight

traffic (33% respondents) although the majority of the respondents (42%) didn't know if this was the case (note: a minority of University buildings are located outside the main campus location which has seen the biggest change in terms of pedestrianisation following the coherent campus strategy).

4.2.7 Qualitative remarks: the survey reported by respondents

Over 80 qualitative responses were recorded in the survey. The main issues drawn from the qualitative remarks were twofold: first, the perception of staff that private purchasing delivered to work is a restricted activity and secondly, the potential improvement the University can make with regards to reducing goods delivery. Collective qualitative responses demonstrated that private purchasing practice is not legitimate. Additionally, the survey respondents who made qualitative remarks are either those who mainly carry out purchasing administration as their job, or managers in authority who have their preferences met by others. However, at this time, delivery of private goods to the workplace was not forbidden or condoned in any University policy. Please see Aditjandra and Zunder (2015) for further discussion.

5 Modelling staff purchasing behaviour

Referring to Fig. 1, the urban freight activity variable is represented by purchasing order (PO) frequency; the reported response scaled from 1 'once a fortnight or longer' to 4 'every day'. The purchasing behaviour variables measured include yes/no and multiple choices (elaborated as dummy variables in the model) on ways to raise a PO, type of goods ordered, expected delivery time, etc. Socio-demographic variables include gender, age and job role. Environmental attitude variables were measured using Likert scale statements related to built environment characteristics and purchasing activity. Since all of these variables were collected through the questionnaire survey of individuals, latent variables data are the basis for the multivariate analysis, as later discussed. Table 5

Table 4 Statements measured on private purchasing behaviour (source: this study)

Behavioural statements measured	N	Min	Max	Mean	Std. Dev.
It is important to raise environmental awareness for every activity that we do (as part of the university), including purchasing/ordering.	455	1.00	4.00	3.0286	.61305
It is important to allow personal deliveries at work in a way that minimises the impact of freight on campus.	455	1.00	4.00	2.9011	.68744
I view the University more positively if they allow personal goods/services to come to my work address.	451	1.00	4.00	2.8670	.84855
It is good that my workplace address is an address that I can rely on to have my personal purchase/order delivered.	448	1.00	4.00	2.8304	.81801
When placing an order my choice is affected by how the goods will be delivered.	453	1.00	4.00	2.5519	.77293
The environmental credentials of suppliers affects who I purchase services/goods from.	453	1.00	4.00	2.4216	.72939
The University should actively prevent all personal deliveries to work.	456	1.00	4.00	1.9123	.76531

Table 5 Variables' descriptive statistics included in the final regression estimation

	Variables	N	Min	Max	Mean (% pop.)	Std. Dev.
DV*	Frequency of purchase order (PO)	424	1	4	1.6580	.97172
Socio-demographic	Female	424	0	1	.6274	.48408
	Administrative and Professional (e.g. Library, Clerical, Administrative, Managerial)	424	0	1	.5943	.49160
	Specialist, Technical and Professional (e.g. Technicians)	424	0	1	.1226	.32841
	Operational Services (e.g. Ancillary, Cleaning and Catering, Porters, Farm Workers, Grounds Staff, Maintenance, Security)	424	0	1	.0189	.13622
Freight type	Raised PO for "Chemicals (hazardous or otherwise)'	424	0	1	.2783	.44869
	Raised PO for "Bulk gases, oils, fuels, etc."	424	0	1	.1462	.35375
	Raised PO for" Furniture"	424	0	1	.2642	.44140
Purchasing behaviour statements	I make purchases using a University purchasing card	424	0	1	.2170	.41268
	I (and maybe others) collect all our needs together and place an order once or twice a week)	424	0	1	.0495	.21722
	I don't order goods with any regular repeating pattern	424	0	1	.6038	.48969
	Expected delivery by next day	424	0	1	.3090	.46261
	Expected delivery by as soon as possible	424	0	1	.4953	.50057
	Location based: King's Gate (Main Central Administration office of the University)	424	0	1	.2193	.41429
Private Purchase	Do you order goods or services for HOME and have them delivered to a WORK address	424	0	1	.1910	.39358
	Composite of standardised (private) purchasing behaviour related statements	424	0	1	.0033	.44839

*Dependent Variable

demonstrates descriptive statistics of the variables included in the final estimated model. Since the data analysis was carried using SPSS, standard default descriptive frequency analysis was produced. The mean values in Table 5 for the dummy variables are simply the percentage of the sample population. We can see that over 60% of the sample are female and ordering goods without any regular repeating patterns.

Pearson correlation analysis for all possible pair of coefficients were also estimated and showed some significant (one-tailed) correlation at $p < .05$ with weak to moderate level (small to medium effect) of relationships between variables as can be seen in Table 6.

The highest significant relationship reported in Table 6 is between frequency of PO and individual behaviour who ordered goods without any repeating pattern ($r = -.425$), this figure effectively says that as the number of individual who ordered goods without repeating pattern goes down, frequency of PO goes up. In the next section we assess the causation of this relationship.

6 Multivariate analysis

While significant differences are noted, descriptive statistics do not explain why these differences might exist. The next step of the analysis is to examine whether differences in Purchasing Order (PO) frequency can be related to the factors which have been described above. A cross-sectional model of PO frequency was developed, to examine the relationship between purchasing activities, type of goods purchased, socio-demographic and attitude towards private purchasing.

A Multiple Linear Regression (Ordinary Least Square) model was constructed, using PO frequency as the dependent variable and a number of factors (column 1 Table 7) identified as explanatory variables. The model initially included all variables identified as important: job types, ways to raise PO, type of goods purchased (some were dropped due to high correlation), expected delivery times, location of PO, gender, age, and private purchasing related behaviour. Insignificant variables above the 10% level were dropped, except for some variables of interest (e.g. private purchasing behaviour) and the model re-estimated.

In multiple regression, multicollinearity is always a potential problem. As well as screening for high linear correlation between the independent variables, Table 7 reports both variance inflation factors (VIF). VIF provides a measure of the effect of the inter-correlation of the regressors on the variance of the least squares parameters estimates. It has an ideal value of 1 (and hence the ideal value of the tolerance factor is also 1). VIF values in excess of 10, or with tolerance (1/VIF) of less than .2, are a cause of concern [33–36]. The reported VIF and tolerance figures in Table 7 suggest multicollinearity is not a concern here.

The specialist, technical and professional (e.g. technician) job type significantly raised the demand via a PO, with the highest standardised coefficient ($\beta = .245$) (Table 7). Similarly, (in terms of β magnitude), having a University purchasing card significantly raised the likelihood of demand via

Table 6 Pearson correlation coefficient of all variables with small to medium relationship effect included in the regression.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Frequency of purchase order (PO)	1.000															
2	Administrative and Professional (e.g. Library, Clerical, Administrative, Managerial)	-.049	1.000														
3	Specialist, Technical and Professional (e.g. Technicians)	.235	-.453	1.000													
4	Operational Services (e.g. Ancillary, Cleaning and Catering, Porters, Farm Workers, Grounds Staff, Maintenance, Security)	.102	-.168	-.052	1.000												
5	I make purchases using a University purchasing card	.321	.248	-.022	-.031	1.000											
6	I collect all our needs together and place and order one or twice a week	.248	.034	-.019	.048	.038	1.000										
7	I don't order goods with any regular repeating pattern	-.425	.126	-.123	.041	-.065	-.237	1.000									
8	Raised PO for 'chemicals (hazardous or otherwise)	.360	-.398	.265	-.009	.018	.077	-.293	1.000								
9	Raised PO for 'bulk gases, oils, fuels, etc.'	.194	-.161	.293	-.057	.041	.090	-.129	.577	1.000							
10	Raised PO for 'furniture'	.277	.016	.086	.035	.139	.134	-.149	.273	.358	1.000						
11	Expected delivery by next day	.267	.012	.077	-.018	.180	.130	-.199	.063	.113	.294	1.000					
12	Expected delivery by as soon as possible	.252	-.162	.018	-.033	.177	.143	-.229	.111	-.036	.048	.062	1.000				
13	Do you order goods or services for HOME and have them delivered to a WORK address	-.020	-.087	.074	-.023	-.008	-.028	-.011	-.034	.020	-.005	.052	.047	1.000			
14	Female	.095	.297	-.217	-.144	.110	.064	-.116	-.098	-.054	.041	.093	.081	-.060	1.000		
15	Composite of standardised (purchasing behaviour related statements)	-.083	-.001	.027	-.067	-.033	.005	.030	-.122	-.010	.073	-.035	.009	.226	.062	1.000	
16	Location based: King's Gate	-.213	.415	-.181	-.074	.108	.010	.138	-.227	-.106	-.150	-.206	-.183	-.142	.090	.066	1.000

☐ = significant (one-tailed) $p < .05$; N=424

Table 7 OLS Regression for PO frequency on Newcastle University staff

Variable Factors	Std. coefficient (β)	t-test	Sig. (p-value)	1/VIF	VIF
(Constant)		8.801	.000		
Administrative and professional (e.g. Library, Clerical, Administrative, Managerial)	.210	4.038	.000	.494	2.024
Specialist, Technical and Professional (e.g. Technician)	.245	5.637	.000	.704	1.421
Operational Services (e.g. Ancillary, Cleaning and Catering, Porters, Farm Workers, Ground Staff, Maintenance, Security)	.158	4.114	.000	.909	1.100
Purchases made using a University purchasing card	.224	5.590	.000	.830	1.204
PO made collectively once or twice a week	.124	3.215	.001	.902	1.109
PO made with irregular repeating pattern	−.235	−5.723	.000	.795	1.259
Type of goods: chemicals (hazardous or otherwise)	.285	5.543	.000	.504	1.986
Type of goods: bulk gasses, oils, fuels, etc.	−.092	−1.905	.058	.575	1.740
Type of goods: furniture	.070	1.662	.097	.752	1.330
'Next day' expected delivery	.075	1.856	.064	.818	1.222
'As soon as possible' expected delivery	.102	2.538	.012	.832	1.201
Location: King's Gate (Main Central Administration office of the University)	−.145	−3.395	.001	.735	1.360
Female	.068	1.707	.089	.847	1.180
Private purchased delivered to workplace	−.022	−.565	.572	.909	1.100
Composite attitudes towards private purchasing behaviour	−.024	−.620	.536	.892	1.121

$N = 424$, $R^2 = .456$, Adjusted $R^2 = .436$ (significant with p-value of .000).

Dependent variable: Purchase Order (PO) frequency.

a PO (β = .224). In contrast, purchasing made with an irregular repeating pattern is negatively associated with PO frequency (β = −.235) and purchasing made once or twice a week is positively associated with increased PO frequency (β = .124).

The factor for 'type of goods: chemicals (hazardous or otherwise)' had the highest standardised coefficient, with significance at a 10% level (β = .285). This shows the high level of demand using PO frequency for this type of goods. We also note that the 'chemicals' goods type is highly correlated with other variables dropped from the final reporting: 'laboratory consumables' and 'clinical and medical supplies (including biological reagents)'.
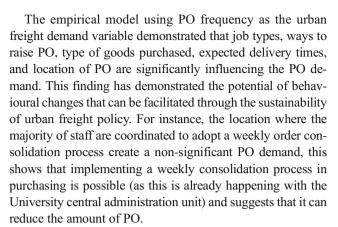
The factor for 'expected delivery type: as soon as possible' showed significant increased PO based demand, with a frequency of β = .102. In contrast, the location where the majority of administration staff are based, showed a negative association with PO frequency demand of β = −.145. Following this up with face to face discussion, we discovered that the administration staff there adopted a weekly order consolidation process, showing that one of the central administration units of the University is not a key driver of PO based demand.

The private purchasing behaviour variables are not significantly associated with PO demand. However, its negative association can be noted; thus the more private purchasing behaviour adopted, the lower the level of PO demand created. This negative association deserves further qualitative follow-up.

7 Conclusion

This paper contributes to our understanding of a University as 'receiver' – and therefore an inbound logistics freight generator – and the role of both purchasing policy and practice, the role of the end user as the driver of a requisitioner and, to some extent, that of the employee as generator of private purchasing delivered to work. As a large organisation with a sustainability agenda, it had a corporate interest that is not necessarily driven by bottom line cost imperatives. This research contributes to the growing body of work in the receiver-led point of view that draws potential optimisation of city logistics initiatives [37] from the inbound logistics perspective, and also informs the wider discussion about the locus of power in supply chains [38]. The purchasing data and interview with the University Head of Procurement drew insights into how the University practices sustainable purchasing, though not to the same degree as the benchmark practice within the private sector.

The staff survey carried out was intended to explore the degree to which institutional policy and actual purchasing behaviour are in alignment. This first survey and the preliminary analysis raise more questions than answers, but we can reach a few conclusions, albeit they will require further investigation.

The empirical model using PO frequency as the urban freight demand variable demonstrated that job types, ways to raise PO, type of goods purchased, expected delivery times, and location of PO are significantly influencing the PO demand. This finding has demonstrated the potential of behavioural changes that can be facilitated through the sustainability of urban freight policy. For instance, the location where the majority of staff are coordinated to adopt a weekly order consolidation process create a non-significant PO demand, this shows that implementing a weekly consolidation process in purchasing is possible (as this is already happening with the University central administration unit) and suggests that it can reduce the amount of PO.

Staff who are administrative, technical, specialist, or operational, or with a University purchasing card, have significantly higher demand expressed though PO. This finding could have policy implications towards behavioural change, in that the frequency of PO could be reduced by decreasing the number of purchasing cards, or by reducing and centralising the number of staff able to initiate purchasing, with a view to consequently consolidating goods or services and improving the University's purchasing sustainability.

The manner of goods delivery demonstrated in Table 8 would suggest logistics delivery in small parcel vans and light goods vehicles, and indeed previous surveys have shown 82% of all delivery vehicles to the campus to be light goods vans [5]. The main University campus site at this time attracted or generated more than 50% of city traffic In Newcastle, primarily in light good vans, which while less polluting, contribute more to network congestion [27].

From a qualitative analysis we can see that this 'buying' population feel that they should not buy private goods for workplace delivery, but that it would be very helpful and welcomed. We also found that this belief had no basis in University policy but appeared entirely cultural, it would be worth comparing this to the student purchasing behaviour reported at the University of Southampton, a different cultural group [39]. Those that have ordered goods for private use, did so because 'there is no-one at home' and because 'travelling to collect failed delivery is inconvenient'. The respondents also were well informed and made positive suggestions about improving freight deliveries, which shows that ideas for intervention in this area are widespread and not restricted to experts [32]. We see this as confirmation that bottom-up stakeholder led interventions have a strong body of innovative ideas to call upon (for further discussion, please see [40–42]). We cannot show that the nature of the respondents, who were primarily administrative staff, made them more compliant with the perceived view that private purchasing is not allowed. This, however, would merit further investigation among academic and non-clerical staff, not least because there is *no formal prohibition on private purchasing at the University*. Indeed one of the immediate impacts of this

Table 8   Summary of research questions answered with the study

Research questions	Descriptive analysis (after [32])	Regression analysis
Drivers of purchasing	A small core of buyers raising most of the orders whereas the majority order once a fortnight or longer.	Job type, ways to raise PO, type of goods purchased, expected delivery times and location of PO are significantly influencing PO frequency.
Key determinants of purchasing behaviour in a large institution (i.e. Newcastle University)	Very few respondents have a weekly repeating pattern which suggest that most cases the demand is of the modern 'pull' basis and would generate 'just in time' demand on suppliers.	Being administrative, technical specialist, or operational services staff, with a University purchasing card are significantly increases PO frequency.
Required timing of demand for goods generated, vs the actual need for the goods	Ad hoc nature of ordering, for most population, is being expressed as 'as soon as possible' or 'next day'.	Certain goods types, such as chemicals, bulk gases and furniture, are significantly influencing PO frequency.
Purchasing demand of different goods types and how are goods delivered to the end users	Most goods ordered are delivered in boxes and trays, save for those delivered in envelopes and packets.	No significant relationship exist.

research was that it informed the University Executive's decision to support private purchasing at work, and plans to introduce locker banks on campus for such private deliveries.

We asked a very broad question: is the changing behaviour of purchasing towards freight efficiency a feasible option for a sustainable institutional organisation? Here we can only move ahead slightly, in regard to that question. We would draw out that the qualitative surveys show willingness amongst the buying population to both suggest and embrace alternative ideas. On the other hand, the quantitative model demonstrated key determinants of PO demand. The most significant staff roles, such as 'technical' 'specialist', 'administrative staff', and 'operational services with a University purchasing card' could be trained to engage in a city logistics initiative, such as Delivery and Servicing Plan (please see [3, 43] for references), so that urban freight delivery can well be managed. We can see that a very small core of people raise most of the orders and therefore it should be possible to influence the majority of orders through them. We should be concerned that the high frequency core orders may generate the most efficient inbound logistics and it may be the low repetition, low efficiency orders that should be addressed - a much wider pool of people, for whom this is not a core activity. We can also show that the University has the basis for sustainable procurement policy and practice, but there is an opportunity for development, and that policy development could be aligned with a sustainable inbound logistics practice. Lastly, demonstrating to the University's Executive that employee views on private purchasing directly influence the practice, has convinced the board that changing purchasing behaviour towards freight efficiency *is a feasible option for a sustainable institutional organisation*.

The key contribution of this paper is demonstration of the important role of logistics receiver can make in delivering sustainable city logistics. This is especially true for large organisation with multi-sited and multi-level management (central vs local) that require multi-type of logistics in a city-centred bound historic built environment University. This paper shed light on identifying the key determinants of freight demand at University that can be managed and act as catalyst for accommodating urban freight in city planning.

As a postscript we wish to note that in 2016, partially in response to this and associated research, the University centralised all purchasing into a new hub, with the intention of reaping the benefits of consolidated purchasing power. The policy on private purchasing delivered to the workplace has not been changed, indeed several senior managers have explored the addition of locker banks to the campus to facilitate it.

References

1. European Commission (2007) GREEN PAPER Towards a new culture for urban mobility (No. COM(2007) 551 final), COM(2007) 551 final, Brussels. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0551:EN:HTML:NOT

2. European Commission (2011) 2011 WHITE PAPER Roadmap to a Single European Transport Area. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN. Accessed 20 Nov 2017

3. Browne M, Allen J, Nemoto T, Patier D, Visser J (2012) Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. Procedia - Soc Behav Sci 39:19–33

4. Verlinde S, Macharis C, Witlox F (2012) How to Consolidate Urban Flows of Goods Without Setting up an Urban Consolidation Centre? Procedia - Soc Behav Sci 39:687–701

5. Zunder TH, Aditjandra PT, Carnaby B (2014) Developing a Local Research Strategy for City Logistics on an Academic Campus. Int J Urban Sci 18(2):262–277

6. Transport for London (2009) A Pilot Delivery Servicing Plan for TfL's Palestra Offices in Soutwark: A Case Study, London: Transport for London. Available at http://www.tfl.gov.uk/microsites/freight/documents/London-Freight-Plan.pdf. Accessed 1 Jul 2014

7. Hoejmose SU, Adrien-Kirby AJ (2012) Socially and environmentally responsible procurement: A literature review and future research agenda of a managerial issue in the 21st century. J Purch Supply Manag, Elsevier 18(4):232–242

8. Walker H, Brammer S (2009) Sustainable procurement in the United Kingdom public sector. Supply Chain Manag Int J 14(2):128–137

9. Björklund M (2011) Influence from the business environment on environmental purchasing - Drivers and hinders of purchasing green transportation services. J Purch Supply Manag 17:11–22

10. Brammer S, Walker H (2011) Sustainable procurement in the public sector: an international comparative study. Int J Oper Prod Manag 31(4):452–476

11. Björklund M (2010) Benchmarking tool for improved corporate social responsibility in purchasing. BIJ 17:340–362

12. Wolf C, Seuring S (2010) Environmental impacts as buying criteria for third party logistical services. Int J Phys Distrib Logist Manag 40:84–102

13. Evangelista P (2014) Environmental sustainability practices in the transport and logistics service industry : An exploratory case study investigation. Res Transp Bus Manag 12:63–72

14. Emilsson S, Hjelm O (2009) Towards sustainability management systems in three Swedish local authorities. Local Environ 14:721–732

15. Fenton P, Gustafsson S, Ivner J, Palm J (2015) Sustainable Energy and Climate Strategies : lessons from planning processes in fi ve municipalities. J Clean Prod 98:213–221

16. Fenton P, Gustafsson S, Ivner J, Palm J (2016) Stakeholder participation in municipal energy and climate planning – experiences from Sweden. Local Environ Int J Just Sustain 21(3):272–289

17. Björklund M, Gustafsson S (2015) Toward sustainability with the coordinated freight distribution of municipal goods. J Clean Prod 98:194–204

18. Moen O (2014) Co-distribution of Municipal Goods in Sweden – Procurement from a New Standpoint. Procedia - Soc Behav Sci 125:484–495

19. Aditjandra PT, Galatioto F, Bell MC, Zunder TH (2016b) Evaluating the impacts of urban freight traffic: application of micro-simulation at a large establishment. Eur J Transp Infrastruct Res 16(1):4–22

20. Day C (2005) Buying green: the crucial role of public authorities. Local Environ 10:201–209

21. Baily P, Farmer D, Jessop D, Jones D (2005) Purchasing principles and management, Ninth edn. Pearson Education Limited, Harlow

22. SAI. (n.d.). Social Accountability International. Available at: www.sa-intl.org. Accessed 20 Nov 2017

23. Kitamura R, Mokhtarian PL, Laidet L (1997) A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area. Transportation 24:125–158

24. Mokhtarian PL, Cao X (2008) Examining the impacts of residential self-selection on travel behavior: A focus on methodologies. Transp Res B Methodol 42(3):204–228

25. Aditjandra PT (2013) The impact of urban development patterns on travel behaviour: Lessons learned from a British metropolitan region using macro-analysis and micro-analysis

in addressing the sustainability agenda. Res Transp Bus Manag 7:69–80

26. Aditjandra PT, Mulley C, Nelson JD (2013) The influence of neighbourhood design on travel behaviour: Empirical evidence from North East England. Transp Policy 26:54–65

27. Aditjandra PT, Cao X, Mulley C (2016a) Exploring changes in public transport use and walking, following residential relocation: A British case study. J Transp Land Use 9(3):1–19

28. Handy SL, Cao X, Mokhtarian PL (2005) Correlation or causality between the built environment and travel behavior? Evidence from Northern California. Transp Res Part D: Transp Environ 10(6):427–444

29. Holguín-Veras J, Jaller M, Sanchez-Díaz I, Campbell S, Lawson CT (2014) Freight Generation and Freight Trip Generation Models. In: Tavasszy L, de Jong G (eds) Modelling Freight Transport. Elsevier Inc., Amsterdam, pp 43–63

30. Musolino G, Polimeni A, Vitetta A (2016) Freight vehicle routing with reliable link travel times: a method based on network fundamental diagram. Transp Lett. https://dx.doi.org/10.1080/19427867.2016.1241040

31. Gonzalez-Feliu J, Toilier F, Routhier J (2010) End consumer goods movement generation in French medium urban areas. Procedia Soc Behav Sci 2:6189–6204

32. Aditjandra PT, Zunder TH (2016) Understanding the Purchasing Behaviour of a Large Academic Institution and Urban Freight Demand. Transp Res Procedia 12:728–738

33. Chatterjee S, Price B (1991) Regression Analysis by Example. John Wiley and Sons, New York

34. Field A (2005) Discovering Statistics Using SPSS, Second edn. SAGE Publication Ltd, London

35. Menard SW (1995) Applied logistic regression analysis. SAGE, Thousand Oaks

36. Myers RH (1990) Classical and modern regression with applications, Second edn. Duxbury, Boston

37. Holguín-Veras J, Sanchez-Diaz I (2016) Freight Demand Management and The Potential of Receiver-Led Consolidation Programs. Transp Res A Policy Pract 84:109–130

38. Crook TR, Combs JG (2007) Sources and consequences of bargaining power in supply chains. J Oper Manag 25(2):546–555

39. Cherrett T, Dickinson J, Mcleod F, Sit J, Bailey G, Whittle G (2017) Logistics impacts of student online shopping - Evaluating delivery consolidation to halls of residence. Transp Res Part C Emerg Technol 78:111–128

40. Österle I, Aditjandra PT, Vaghi C, Grea G, Zunder TH (2015) The role of a structured stakeholder consultation process within the establishment of a sustainable urban supply chain. Supply Chain Manag Int J 20(3):284–299

41. Zunder TH, Aditjandra PT, Carnaby B, Islam DMZ (2013) Conceptual Model for Efficient and Environmentally Friendly Urban Freight Movements. In: WCTRS (ed) Proceedings of the13th World Conference on Transport Research. World Conference on Transport Research Society, Rio de Janeiro, pp 1–12

42. Zunder TH, Aditjandra PT, Schoemaker JT, Vaghi C, Laparidou K, Oesterle I (2016) Engaging city stakeholders to achieve efficient and environmentally friendly urban freight movements. In: Blanquart C, Clausen U, Jacob B (eds) Towards Innovative Freight and Logistics Vol. II. John Wiley &Sons, Inc., Paris, pp 275–287

43. Leonardi J, Browne M, Allen J, Zunder T, Aditjandra PT (2014) Increase urban freight efficiency with delivery and servicing plan. Res Transp Bus Manag 12:73–79