Aditjandra PT, Zunder TH.

Developing a multi dimensional poly parametric typology for city logistics.

In: The 10th International Conference on City Logistics.
14-16 June 2017, Phuket Island, Thailand: Institute for City Logistics.

Conference website:

http://citylogistics.org/2017-2/

Date deposited:

26/06/2017

32

Developing a Multi Dimensional Poly Parametric Typology for City Logistics

Paulus Aditjandra, Newcastle University, UK
Thomas Zunder, Newcastle University, UK

Keywords: city logistics, typology, urban freight, land use, sustainability, transport

Abstract

This research explored the extent to which urban freight policies and measures/ interventions, can be determined via the city logistics typologies and objectives studies developed from past work, comprehensively reviewing almost all European city logistics cases from the 1970s to the current day. Using EU, national, local and private sources, we collected over 260 cases from 60+ projects involving 121 cities. We reviewed urban freight typologies, based on land use, type of transport policies/measures, urban freight markets and traffic flows, city logistics problem/objectives, and other attributes, integrating cases with typologies, and validating our analysis through a panel of city logistics experts. This has created a new, comprehensive inventory that is modular and extensible. From this, and literature review, we have developed a novel, multi-dimensional, poly parametric typology for city logistics, that has multiple uses in analysing and selecting interventions.

Introduction

One of the major problems in selecting urban freight transport (urban freight) solutions for future implementation, is choosing – from many available options – those that meet the needs of a given city (via key urban freight stakeholder demand), that are compatible with the agreed stakeholder goals. Browsing through good practice catalogues, and thoroughly analysing each option, takes time and is, in practice, difficult and challenging. This is particularly true when options are analysed during working meetings with urban freight stakeholders, without which many measures and concepts fail during implementation (Macharis & Kin 2016). Research efforts to engage urban freight stakeholders have led to a better understanding of the needs of quality partnerships and more effective engagement (Lindholm & Browne 2013; Ballantyne & Lindholm 2014; Gammelgaard 2015) and some fruitful outcomes have been evidenced (Österle et al. 2015; Zunder et al. 2016), though some limitations for use needed to be applied (Gatta & Marcucci 2016). Meanwhile, recent urban freight studies discuss the importance of early accommodation of freight planning in the process of city redevelopment (CIVITAS WIKI consortium 2015), strategic freight planning being essential to a favourable urban freight implementation (Zunder et al. 2014).

To INDEX

City authorities are deemed to play a key role in supporting business to adopt sustainable urban freight solutions alongside other (non-freight related) transport solutions (Wainwright 2016). Many urban freight cases are specific and have been applied uniquely to certain geographical boundaries (see for example: Aditjandra et al., 2016; Browne et al., 2011; Muñuzuri et al., 2012; Quak and Koster, 2007; Tozzi et al., 2014).

The question then is: is there a general common framework that can be used, by all significant urban freight stakeholders, to adopt or to agree upon the uptake of urban freight solutions? What has been learned from previous EU funded urban freight projects? Is there a typology that can characterise a sustainable city distribution? The intent of this research is twofold: first, to collect a comprehensive inventory of city logistics interventions in a coherent, standardised, and modular manner, cross linking that typology to the impacts, validated by an expert panel, for use by the authors and, as importantly, by the wider city logistics research community for further inductive research. Secondly, to analyse and construct a city logistics typology as a methodological and theoretical tool for deductive work in the future, within the tradition of systems thinking and other research methods.

LITERATURE REVIEW

Efforts to define a city typology for city logistics is not new; a number of previous studies have been reported in the proceedings of the international conference of city logistics, e.g. (Quak et al. 2008; Benjelloun et al. 2010). Another study used previous city logistics projects to create a framework of components and criteria to define a so-called 'taxonomy', embedding five key components: description, business model, functionality, scope, and technology, to classify them (Benjelloun et al. 2010). In each of these components, several sub-level criteria were defined and, below that, a further sub-level of items, to characterise the reviewed projects. The taxonomy study demonstrated a comprehensive list of city logistics project characteristics.

Other efforts to employ typology studies focused on types of city logistics measures used. A 'what if' (or 'ex-ante assessment') framework (Russo & Comi 2016) defined city logistics measures into four types: material infrastructure (e.g. new building, such as urban consolidation centres); non-material infrastructure (e.g. ITS, traffic monitoring); equipment (e.g. loading standards); and governance (e.g. time windows). Another study reviewed EU funded projects to assess their impacts on sustainability dimensions (economy, environment, society and (transport) customer service), showing that city logistics measures can be typified into five clusters: regulatory; cooperative; infrastructure development; new business models; and technological (Papoutsis & Nathanail 2016). The 4 A's approach is essentially a measures typology, splitting intervention into 'Awareness', 'Avoidance', 'Act & Shift' and 'Anticipation', with a potential fifth A: 'Actor involvement' (Macharis & Kin 2016).

One study employed a system thinking approach to structure city logistics into 18 top-level indicators (Kunze et al. 2016) and establish their interdependencies. They include: urban service transport; urban person transport; logistics operations; economic performance; shopping behaviour; urban population structure; transport network; logistics locations; traffic; environment quality; legal regulations; transport technologies; *Treibstoff*-costs (similar to utility costs); and citizen needs.

Our research is a further attempt to characterise city logistics projects. Having seen from previous studies that land use is less discussed as part of the basic characteristics of city logistics, we began our review from that perspective. In spatial research, typology approaches are used to describe, model, benchmark and monitor built environment, with respect to buildings, (transport) infrastructure, and the urban structure (Blum & Gruhler 2011).

To INDEX

METHODOLOGY

This work is inductive, developing theoretical structures from the collected and analysed data of a large population of city logistics cases, and is part of the theory building activity still nascent in the city logistics domain. We view city logistics as a socio-technical system, meeting the classic criteria for this: a purposeful system, open to influences from and in turn influencing, the environment (social, economic, demographic, political, legal, technical); the actors who must collaborate to make it work properly; and successful implementation through jointly optimising its social, economic and technical factors (Trist 1978).

The methodology adopted for this research comprised the following stages:

- Exhaustive inventory of all EU projects and their urban freight cases of intervention:
  - categorised by all typologies and parameters
  - categorised by impacts, harmonised with peer researchers
- Exhaustive inventory of every typology developed for urban freight;
- Evaluation and Analysis of pre-existing typologies:
  - identifying gaps
  - developing novelty
- Validation and enhancement of the inventory by a panel of city logistics experts
- Development of new multi-dimensional multi parametric typology:
  - filling gaps with newly developed parameter standards
  - preliminary statistical analysis to see if indicative correlations can guide design.

This research is aligned with EU clean urban logistics policy and as such shall default to adopting clear policy tools or outcomes from that body of research and associated policies.

This domain of city logistics is new; recent literature reviews show most academic articles originate from 2010 (Macharis & Kin 2016) but political and practical activity in the field dates back to the early 1970s. We have adopted a clear objective and methodological standpoint to collect all possible data and augment them with expert opinion but, wherever possible, this shall not replace or simulate existing data from which other researchers may, in the future, yield insights not yet apparent. The same applies to typology development, further discussed later.

EVALUATION AND ANALYSIS

Inventory of all EU projects

The scope was expressly European, though cases captured do include some outside continental Europe. Projects were fully reviewed and had a variety of purposes. Those dealing with city logistics fell primarily into three groups: a) where a coordination support action (CSA) facilitated networking, sharing knowledge among key stakeholders through workshops and meetings that drew city logistics best practice from EU cities; b) projects, usually research and innovation actions (RIA), that facilitated more traditional research, where data from a specific case study were used to answer a research hypothesis alongside practical intervention and innovations in local policy and practice, with implications at a pan European level; and c) projects focused on regional development embedded in a specific geographical European region, e.g the Mediterranean; the Alps. The 60 projects are shown in Figure 1 below:

To INDEX

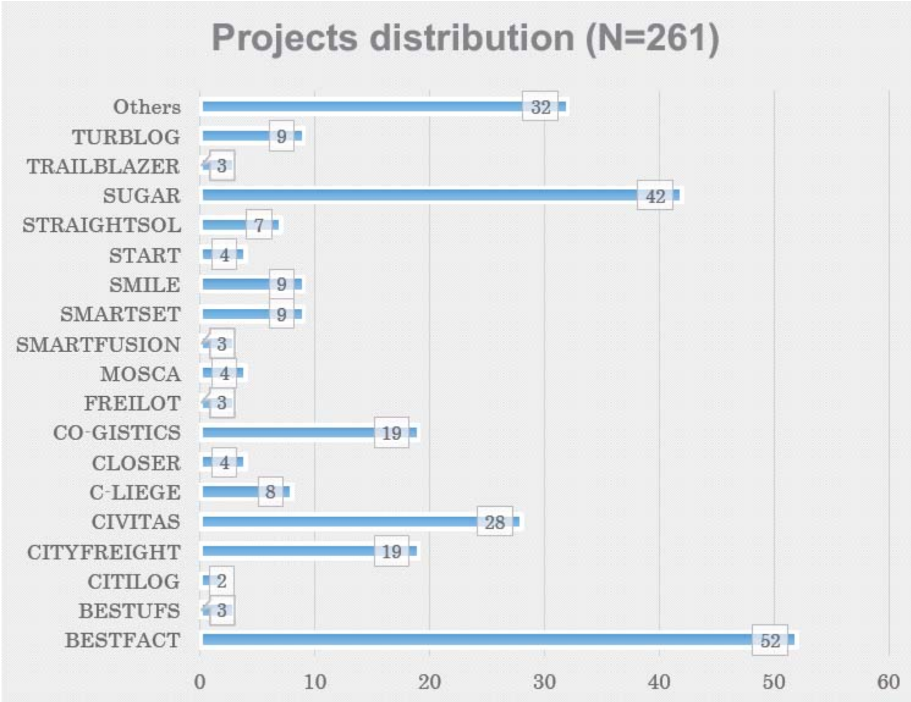

Figure 2: Projects reviewed and cases recorded

The cases were recorded in a database, noting details recorded per *every* classification, typology, parameter, and qualitative data recorded in the project reports.

Inventory of typologies

Typology is: "The study of classes with common characteristics; classification, esp. of human products, behaviour, characteristics, etc., according to type; the comparative analysis of structural or other characteristics; a classification or analysis of this kind."[1] From the research we identify key types of typology considered appropriate to the domain of city logistics: land use typologies, measures typologies, urban freight markets, traffic flows, and impacts.

Land use typologies

Typologies of the built environment offer a consistent set of (pre-) defined representative buildings, blocks of buildings, street layouts and urban structures, that have specific properties regarding issues such as embodied resources, energy demands, typical land coverage, and infrastructure demands, as well as the consumption of resources. Building typologies, for example, classify buildings in terms of construction periods and technologies. Urban structure types classify basic urban spatial units that have a morphological and functionally homogenous character, defined by characteristics structures and development patterns of buildings, infrastructures, and open space.

A UK study addressing the 'Green Logistics' agenda, in 14 selected urban areas of the UK, identified one parameter influencing freight distribution journeys as commercial and industrial land use patterns, and thus location (Allen et al. 2012). A study of 19 French cities demonstrated that the size of the urban area, settlement density, urban morphology relative to the location of urban consolidation/distribution centres, development of the city, street design, and housing type (collective versus individual) are all likely to influence last mile delivery (Ducret 2014).

[1] http://www.oed.com/view/Entry/208394

To INDEX

A case study from Parma, Italy showed that land use characteristics such as narrow streets, limited on-street parking, and a high number of intersections, all significantly influence the performance of freight urban tours, despite the short distance range between an urban consolidation centre and its delivery stops (Tozzi et al. 2014). A hypothetical study to assess the impact of geometrical configurations (e.g. circular, rectangular and elliptical morphology) on urban consolidation/distribution centres, found circular morphology relatively most effective and efficient, with rectangular the worst (Faure et al. 2015).

A study from Angers, France, used a mixture of land use and socio-economic data to classify different types of land use characteristics (Ducret et al. 2015). A follow-on study connecting the above zone's typology with freight demand estimation, demonstrated no correlation between spatial typology and freight trip generation patterns (Ducret & Gonzalez-Feliu 2015). This confirms the argument made at the TRB 2016 Freight Day, that Land Use does not produce trips but economic activity does. For example, a restaurant's square meterage tells us nothing about the number of deliveries it will require. This argument was based on the latest US research on urban freight, demonstrating that 45% of commercial establishments are in freight intensive sectors and responsible for about half the employment involved (Holguín-veras 2016). The model estimation of the above figure is solely dependent on economic data, particularly on employment by industry sector. However, this does not necessarily mean economic activity is the only variable explaining trip generation. Another US study demonstrated that vehicle trip rates - as promoted by the national standard (ITE Trip Generation Manual) – were overestimated when assessed at residential transit-oriented development (Handy 2015).

TURBLOG, a reviewed EU city logistics project, introduced a land use typology 'Logistics Profile', to identify urban freight characteristics and characterise urban land use and logistics and delivery requirements. The concept was based on the hypothesis that it was possible to identify, for some well-defined *areas inside a city*, reasonably homogenous groups of logistics needs, based on three key points:

- The urban characteristics of the area;
- The requirements of the logistics agents (i.e. concerning the type of delivery); and
- The characteristics of the products being transacted.

Despite the arguments, there is still scope to explore the case that land use and urban form characteristics explain the differences in urban freight delivery. Whilst the TURBLOG approach is well thought through, it is 3 different sets of characteristics and subsumes land use into goods types and operators. The clearest approach comes from Hesse (Hesse 2008), who identifies logistics land use (the role of land use function and location) in 3 categories:

1) Location planning for industrial and commercial sites;
2) Location planning for logistics firm sites; and
3) Mixed use site planning.

Measures typologies

Many EU funded urban freight projects specifically aimed to collect cases as best practices and some also developed urban freight typologies to fit into their research objectives. The SUGAR project typology centred on the role of the city authority and promoted the exchange, discussion and transfer of policy experience, knowledge and good practices through policy and planning levers in the field of urban freight management, between and among Good Practice and Transfer sites.

To INDEX

This typology has 9 types of measures/field application category and most cases, if not all, contain a multiple: (1) administrative, (2) planning, (3) governance, (4) awareness, (5) infrastructure, (6) ITS & technical, (7) modelling, (8) supply chain, and (9) information.

The C-LIEGE project typology centred on soft/hard and push/pull measures within a mobility management (MM) encompassing freight transport and measures. At the core of MM are "soft" measures, like information and communication, organising services and coordinating activities of different partners. “Soft” measures most often enhance the effectiveness of "hard" measures within urban transport, do not necessarily require large financial investments, and may have a high benefit-cost ratio.[2] A “push” measure is one that is imposed on operators with a view to influence delivery or operational practices. These can be divided into financial instruments (e.g. higher parking charges and road tolls) and technical and regulatory constraints (e.g. access restrictions). “Push” measures are closely related to more efficient and equitable transport pricing, which seeks to require transport users (including freight operators) to bear a greater proportion of the real costs of their journeys, including pollution, accidents and infrastructure. A “Pull” measure is designed to encourage more sustainable and energy-efficient freight traffic, by offering operators or shippers various additional services (e.g. improved mapping), facilities (e.g. preferential access to loading bays for “clean” vehicles), or incentives (e.g. access to priority lanes). In many cases, the measures are combined with information and publicity campaigns designed to further reinforce the good practice measures. “Push” and “Pull” measures involve a combination of the two, aimed at providing incentives for good practice and simultaneously using fiscal or technical tools to deter unwanted practices.

The CIVITAS initiative (Cleaner and Better transport in Cities), established a typology of urban freight measures in the CIVITAS policy note (CIVITAS WIKI consortium 2015) on urban freight. The measures selected have been presented as a toolkit, offering a variety of solutions to be implemented by local, small-to-medium sized European cities, in order to ‘reduce the use of conventionally fuelled vehicles in urban traffic and to achieve essentially CO_2-free city logistics in major urban centres by 2030’, as set out in the EU transport White Paper (European Commission 2011). The approach categorises measures into 6 top level categories, with sub clusters -, a feature we found particularly interesting.

[2] The Definition of Mobility Management and the Categorisation of Mobility Management Measures as approved by the MAX-consortium and EPOMM, 2009.

To INDEX

Table 1:Urban Freight Measures (CIVITAS)

Measures cluster	**Sub-cluster**	**Measures cluster**	**Sub-cluster**
Stakeholder engagement	Freight Quality Partnership	**Land use planning and infrastructure**	Adapting on-street zones
	Freight advisory boards and fora		Using building code regulations for off-street delivery areas
	Designation of a City Logistics Manager		Nearby delivery areas
Regulatory measures	Time access restriction		Upgrading central off-street loading areas
	Parking regulation		Integrating logistics plans into land use planning
	Environmental restrictions		Collect points
	Size/load access restrictions		Urban consolidation centres
	Freight-traffic flow management	**Eco-logistics awareness raising**	Anti-idling
Market-based measures	Pricing		Eco-driving
	Taxation and tax allowances		Modal shift (water, rail, cycle, walk)
	Tradeable permits and mobility credits		Staggered work hours
New technologies	Dynamic routing		Recognition and certification programmes
	Real-time information systems		
	Traffic control		

Urban freight Markets

One way to classify different forms of urban freight is by market sector served. The market is important, as the sectors represent the sources of supply and demand for urban freight, in terms of the main, observable urban distribution practices. A well-established typology, based on a study funded by EC DG MOVE, reported by (MDS Transmodal & Centro di recerca per il Trasporto e la logistica (CTL) 2012) and promoted by the CIVITAS urban freight logistics Policy note (CIVITAS WIKI consortium 2015), divided the urban freight market into the 5 sectors, shown below. CIVITAS (CIVITAS WIKI consortium 2015) notes 2 further intertwined sectors, described as 'offices' and 'service-related trips'.

Figure 3: Urban Freight Markets (DG Move)

Markets	**Sub-cluster**
Retail	City distribution; food products; milk deliveries; bakery products; goods on pallets; and beverages

Express, courier and post	Postal and package deliveries; city distribution; parcels; goods on pallets; and money deliveries
Hotel, restaurant and catering	Food products; beverages; fast food deliveries; and laundry services
Construction and road services	Waste disposal services; utility services; and gardening services
Waste	Waste disposal services; and recycling materials

Traffic flows typology

The projects reviewed did not identify traffic flows or congestion in the categorisation, in a systematic way, so we looked at the normal methods to do so. One well-known qualitative unit of measure for traffic congestion is Level of Service (LOS), used to analyse highways (the main backbone of the urban transport network, with access types such as residential district, industrial district, commercial district, office and business district), by categorising traffic flow and assigning quality levels, based on performance measures such as speed and density of vehicles relative to road capacity. This rating is used to define transportation problems and prioritise system improvements, resulting in resources being directed at highway expansion (VTPI, 2015[3]). Transportation engineers often produce maps showing roadway links and intersections considered to have excess traffic congestion, then used to prioritise roadway expansion projects. LOS standards have been established in the Highway Capacity Manual and in the AASHTO (American Association of State Highway and Transportation Officials) Geometric design of highways and streets, using the letters A through F, with A being the best and F the worst.

While the unit was introduced in the USA, the adoption of such measures has entered global use, since transport network modelling frameworks are commonly used in cities across the world to simulate traffic congestion problems and forecast traffic growth. This methodology is criticised as technically flawed and biased, as it ignores other transportation problems, such as parking congestion, traffic accidents and the tendency to increased vehicle traffic volume and the negative impacts of wider roads and increased vehicle speeds on walking and cycling (VTPI, 2015). Nonetheless, we included the typology in our database, pending further elaboration.

Impacts

CIVITAS (CIVITAS WIKI consortium 2015) acknowledged the high level of complexity of urban freight with economic, environmental and social consequences known as impacts - as cities are confronted with more traffic, congestion, noise and pollution derived from various sources including inadequate road infrastructure; inefficient logistics from low load factors; long dwell times; and high numbers of individual deliveries. The relevance of these impacts varies per city area and associated scale, with differences between large conurbations and small- or medium sized cities. CIVITAS described impact typologies as fourfold: economic (road congestion; inefficiency, wasted resources); environmental (pollutant emissions; use of non-renewable fossil-fuel, land and aggregates; waste production); social (physical consequences of pollutant emissions on public health; traffic accidents; noise; visual intrusion; other quality of life issues); and impacts of scale (few resources; lack of co-operation; fewer policy considerations; few logistics providers based in cities; little infrastructure). Since we wished to make a preliminary exploration of any potential correlations between measures and impact, this approach is in line with EU policy and likely to yield standardised data over time.

[3] http://www.vtpi.org/tdm/tdm129.htm

To INDEX

Table 2: Impacts Typologies (CIVITAS 2015)

Impacts	**Unit measured**
Environmental	CO_2 emissions
	Noise pollution
Economic and Energy	Costs
	Energy consumption
Social	Number of accidents
	Service level
Transport and mobility	Traffic reduction
	Vehicle kms
	Load factor

Gaps

We identified several key gaps in the typologies and categorisations within the reviewed projects, which we attribute to the lens through which urban freight issues were viewed. Most viewed the issues from the perspective of one stakeholder, e.g city transport planners, or logistics operators, thereby adopting the dominant categorisation and structures of the group(s) viewed as the 'end user'. We identified the following gaps and, using the extensive data to hand, compiled novel and explicitly multi-actor categories and parameters to cover problems, objectives, stakeholders and level of implementation.

Table 3: Problems and Objectives shortlisted parameters developed

Standardised Problems		**Standardised Objectives**
A: Congestion (time & money)		A: Increase efficiency of operations
B: Uncoordinated delivery (environment, including (low) loading/unloading activities)		B: Coherent built environment (coordinate delivery; suppress illegal parking; reduce time searching for delivery space; and optimise the use of street space)
C: Historical town (environment)		C: Sustainable city (no congestion or air pollution; and increase economic performance)
D: Sensitive areas (environment, including local up to city scale level)		D: Environmentally friendly (no noise; and no air pollution)
E: Specified case (e.g. waste management, route optimisation)		E: Experiment (e.g. data collection)
F: Data (time, efforts and cost)		
G: Last mile solutions (sustainability)		
H: Administrative (governance)		

In the case of implementation level, we considered whether a case had progressed beyond plan to pilot, from pilot to a successful implementation, and from there to an ongoing, free-standing commercial basis.

To INDEX

VALIDATION AND ENHANCEMENT OF THE INVENTORY

This section describes the way the above theoretical typologies, *and more importantly the parameters within them*, were used to populate the database of city logistics cases. In the light of the number of typologies involved, an Excel based data collection framework was developed, for assessment and validation of each case by the expert panel. All typologies, pre-existing and new, were included in the data collection framework, together with additions such as qualitative information about a particular measure/intervention in a specific case; socio-demographical information about a case study city (e.g. city size, population, land use information and other socio-economic indicators); period of demonstration; other remarks that could not be included within the typologies selected; and a link to the information source (e.g. website, report, contact). This database was populated first by the authors, during the review of the source data and additional information (primarily deliverable and report documentation retrieved online). Some information reported was not always clear, or comprehensive, or did not address categorisation developed after the case had ended. An expert panel of 14 European city logistics experts was formed, many of whom had first-hand experience of the cases, to validate and extend the data.

PROPOSED TYPOLOGY

Approach

The transportation system may be depicted as a socio-technical system mainly organised through three inter-related sub-systems consisting of:

- the society of actors involved (stakeholders)
- the ensemble of techniques (measures) and
- the environment in which the system exists or will exist (city area).

The first step is to identify the actors and to inter-relate their respective goals and the techniques and environment in which the system is to operate. (Zunder & Dellinger 2005). Reviewing the city typologies described above, it becomes clear they were defined to serve different purposes and different user groups. For instance, land use typologies were defined to characterise land use in the context of urban freight. While this typology seems useful for the public sector (regional authority) to categorise its urban freight land use within its territory, it may not necessarily be helpful for city logistics managers, or the private sector (shippers, forwarders, 3PLs, etc.) to understand their problems, or design objectives and solutions. There is also a dichotomy between the definition of place, as seen by receivers, residents and shippers, and that of activity, as seen by shippers and, to a lesser extent, cities.

We can conclude that typologies for city logistics can be constructed for specific audiences and that the choice of parameters[4] making up those typologies has been key and well developed within urban freight typology to date. What is clearly missing, is a typology intended for use by the widest range of interested stakeholders. Rather than losing the combined knowledge of previous research, we build upon the achievements of the past and utilise the parameters and their attributes[5] to build a new, poly parametric city typology, containing the most appropriate parameters, and develop new ones previously missing. Referring to the three basic areas of analysis for the development of a clear city typology, the **city structure** (including city morphology) and its existing **infrastructure** can be represented with land use typologies.

---

[4] Land use, measures, type of intervention, etc...

[5] For example, an attribute of the TURBLOG Logistics Profile parameter is "A: Cluster of shops..."

To INDEX

For urban goods flows and freight demand generated, urban freight markets and traffic flow typologies would serve the purpose well; but further assessment was required to ascertain which parameter set to adopt. **Measures** were assigned parameters in various typologies, but we needed to identify the most appropriate. Problems, **objectives**, and **impacts**) are not standardised in previous research; we have harmonised these as novelties, based on the previous research.

The relationship between a city's specific characteristics and its current and future needs, with measures that consider the anticipated degree of improvement (or deterioration) has yet to be widely addressed by urban freight projects. In this research, a poly-parametric toolkit was proposed, to provide a single window on city logistics and enable information and experience sharing, advising and reporting.

We determine from our research and expert knowledge that, in city logistics and urban freight R&I at EU and local level, typologies have been both single and multi-tiered, often with a variety of parameters making up an overall typology and each parameter having defining attributes. In some cases, these attributes are subdivided into sub-clusters. We therefore define typology as poly-parametric: made up of one or more parameters, each defined by attributes which may also be further divided by sub cluster, as illustrated in Figure 4.

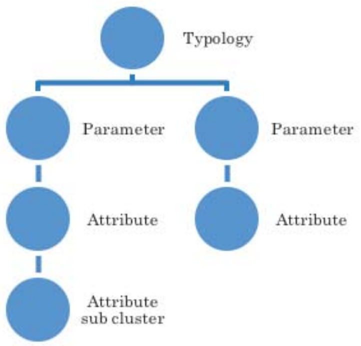

Figure 4: Structure of a Poly-parametric Typology

Based on the research, inventory, associated reading of the literature, and the combined expert knowledge of the panel and the authors, we have developed a clear, pragmatic poly-parametric city logistics typology, based on 30+ years of urban freight research, the database collected from all previous R&I work, and the typologies that preceded it. We propose the typology be five dimensional, with the dimensions sequenced in a logical flow for use by actors:

- **Why?** What problems do we have, and what are our objectives?
- **Where?** What is the physical shape of the spatial area we are addressing in a city?
- **Who?** In an approach that defines actors by the nature of the supply chains in which they operate, we aim to understand who is involved in this process and with whom.
- **What**? Which measures shall we undertake? Will this be a mixture of hard and soft measures, or will soft measures be part of the next section?
- **How?** Will this be a process of regulation, of voluntary co-operation?

With these 5 dimensions we can construct a guidance tool for practitioners, to allow localised solutions derived from local problems within local societies, and informed by the body of knowledge built up over the last two decades.

Dimension: Why

In all productive endeavour, it is good practice to understand why the activity is being carried out. In city logistics, which faces many challenging problems including high levels of traffic congestion, negative environmental impacts, high energy consumption and a shortage

To INDEX

of labour, the perceived problems are complex, multi-layered and seen very differently through the lens of different stakeholders. As evidenced in the Smartfusion project (Österle et al. 2015), a first step should be to agree the problems to be solved and the objectives to be measured, so success can be determined in a mutually agreed fashion. Previous research shows little standardisation of the **Why**, often since it was self-evident and uncontested, but also since many localised stakeholder approaches generate localised definitions and common understandings. This can be commended, but it requires a pan European toolkit to have a novel approach. Therefore, we developed the Problems and Objectives parameters of this dimension and populated above.

Dimension: Where

Where an intervention will take place is crucial in the complex geo-political landscape of the long developed European cityscape. It is not just the geography of the land, the urban layout of streets, but also the politics and cultures of the people who dwell and work in, as well as visit and deliver to, an urban area. With any urban area of note, where it is important to talk of the 'area' of interventions, it is impossible to apply a meaningful category to the mosaics that form cities new or ancient.

The context for where means distinguishing cities in certain profiles, to include:

- density of economic activity: represented by infrastructure density, and density of GDP (or suitable proxy) per capita in the city
- degree of integration of freight-generating activity, such as the presence of a few large employers in a city
- political culture (generate differing degrees of regulation and compliance)
- culture, e.g. night time activities (not applicable to all communities)
- degree of logistics sprawl
- legal and regulatory framework, local constraints.

To build on past successes and previous good R&I practice, we have chosen to adopt the HESSE city morphology. This land use approach needs to be complemented with a parameter that defines the activity being carried out in a place, and we have adopted the UFT Logistics Profile parameter developed by TURBLOG. Use of the ASSHTO service-level parameter was considered; however it is often criticised and introduces an element of 'when in the day' into the dimensions - a parameter difficult to assess in the source data.

Dimension: Who

The construction of typologies has been informed by the audiences for whom they were developed and, in many cases, by whom. City decisions are political, the interplay of different stakeholders being a significant factor. The best way to parameterise the supply chains in our data, was to adopt the CIVITAS WIKI UFT Markets parameters. The extensive and wide ranging parameters could derive a series of nuanced attributes for this dimension, but since the purpose of the toolkit is to *commence* the process of research and analysis, the broader brush attributes better fit the purpose. We feel it is important that the typology incorporate a standardised parameter for stakeholders and we therefore use the one defined above.

Dimension: What

A clean coherent parameter is needed to define the **What**. The obvious choice is the multi layered CIVITAS WIKI parameter Measures, sub-layered with attributes and within attribute sub-clusters. It is likely that for the toolkit the measures will be an output of the enquiry, but for ongoing analysis and development it shall be a key parameter for analysis.

To INDEX

Dimension: How

There are many ways to implement change, and the C-LIEGE project was most concerned with how city logistics could be changed using the language and methodologies of wider mobilitymanagement. We would promote the core definitions adopted by C-LIEGE, but less so the categorisation of measures in the project's final databases. Our interest being in the core definitions, we adopt the idea that interventions can be Push/Pull, or Soft/ Hard. At this stage these are a coherent set, but we recognise that future work may reveal or suggest variant attributes, where they do not duplicate or reduce the clarity of the typology.

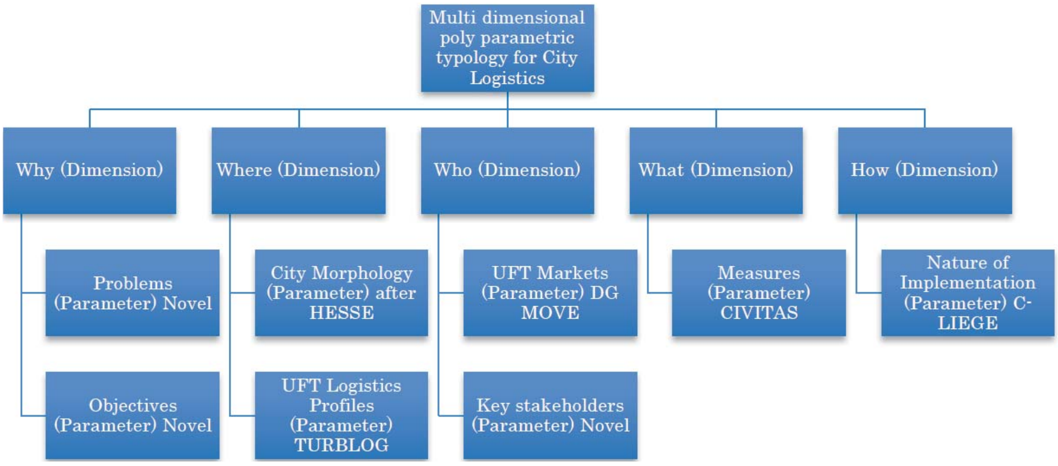

Figure 5: Multi-dimensional poly parametric typology for City Logistics

REFLECTIONS

It is possible that the future reinstatement of a traffic flow parameter may yield benefit in more quantitative work and discussions are already in place to add 'business models' as a potential parameter to the **What** dimension. A guidance toolkit for practitioners is under development that shall include functionality for registered experts to add or amend the inventory.

CONCLUSION

Our research is innovative and has been revelatory in developing a comprehensive inventory of proposed new, comprehensive theoretical typological structures that incorporate all data from previous cases and, unlike before, adopt the views of all stakeholders. We have identified gaps and filled them with new parameters e.g. Problems/Objectives; the typology and database are open for development; and new European and global data can be added whilst preserving the historic. The typology can be expanded with new parameters, e.g. business models in the **How** dimension. In addition to expansion, subsets can be used for future specific needs and research, when the full breadth of the typology is redundant, or time and data suggest a narrower view is productive. The inventory and further details behind the typology are available for shared use within the city logistics community and we welcome collaborations to expand the inventory and also to develop deductive research to test this new proposed theoretical typology.

ACKNOWLEDGEMENTS

This work was partially funded by the EU H2020 project NOVELOG Grant Agreement 636626. We thank the members of the expert panel for their work on this research, particularly Alexander Stathacopoulos of CERTH/HIT.

To INDEX

References

Aditjandra, P.T. et al., 2016. Evaluating the impacts of urban freight traffic: application of micro-simulation at a large establishment. *European Journal of Transport and Infrastructure Research*, 16(1), pp.4–22. Available at: http://www.tbm.tudelft.nl/fileadmin/Faculteit/TBM/Onderzoek/EJTIR/Back_issues/16.1/2016_0 1_01.pdf.

Allen, J., Browne, M. & Cherrett, T., 2012. Investigating relationships between road freight transport, facility location, logistics management and urban form. *Journal of Transport Geography*, 24(September),pp.45–57.Availableat: http://linkinghub.elsevier.com/retrieve/pii/S0966692312001615 [Accessed July 24, 2012].

Ballantyne, E.E.F. & Lindholm, M., 2014. Identifying the Need for Freight to be Included in Local Authority Transport Planning. In J. Gonzalez-Feliu, F. Semet, & J.-L. Routhier, eds. *Sustainable Urban Logistics: Concepts, Methods and Information Systems*. EcoProduction. Berlin, Heidelberg, Heidelberg: Springer Berlin Heidelberg, pp. 37–48. Available at: http://link.springer.com/10.1007/978-3-642-31788-0 [Accessed September 24, 2013].

Benjelloun, A., Crainic, T.G. & Bigras, Y., 2010. Towards a taxonomy of City Logistics projects. *Procedia - Social and Behavioral Sciences*, 2(3), pp.6217–6228. Blum, A. & Gruhler, K., 2011. Typologies of the Built Environment and the Example of Urban Vulnerability Assessment. In B. Müller, ed. *German Annual of Spatial Research and Policy 2010*. Berlin Heidelberg: Springer-Verlag, pp. 147–150.

Browne, M., Allen, J. & Leonardi, J., 2011. Evaluating the use of an urban consolidation centre and electric vehicles in central London. *IATSS Research*, 35(1), pp.1–6. Available at: http://linkinghub.elsevier.com/retrieve/pii/S038611121100015X [Accessed January 29, 2013].

Campagna, A. et al., 2015. *NOVELOG D2.1: Framework for Data, Information and Knowledge Collection for Urban Freight and Service Demand Understanding*, Rome.

CIVITAS WIKI consortium, 2015. *Making urban freight logistics more sustainable*, www.eltis.org. Available at: http://www.eltis.org/resources/tools/civitas-policy-note-making-urban-freight-logistics-more-sustainable.

Ducret, R., 2014. *Nouvelles organisations de la distribution urbaine des colis sur le dernier kilomètre : innover par une approche spatiale de marchandises en ville*. Ecole Nationale Superieure des Mines de Paris.

Ducret, R. & Gonzalez-Feliu, J., 2015. Connecting demand estimation and spatial category models for urban freight : First attempt and research implications. In E. Taniguchi & R. G. Thompson, eds. *The 9th International Conference on City Logistics*. Tenerife: Institute for City Logistics, pp. 154–168.

Ducret, R., Lemarie, B. & Roset, A., 2015. Cluster Analysis and Spatial Modeling for Urban Freight: Identifying Homogeneous Urban Zones based on Urban Form and Logistics Characteristics. In E. Taniguchi & R. G. Thompson, eds. *The 9th International Conference on City Logistics*. Tenerife: Institute for City Logistics, pp. 358–373.

European Commission, 2011. *2011 WHITE PAPER Roadmap to a Single European Transport Area*,

Faure, L., Burlat, P. & Marques, G., 2015. Evaluate the Viability of an Urban Consolidation Centre with regards to Urban Morphology. In E. Taniguchi & R. G. Thompson, eds. *The 9th International Conference on City Logistics*. Tenerife: Institute for City Logistics, pp. 412–421.

Gammelgaard, B., 2015. The emergence of city logistics: the case of Copenhagen's Citylogistik-kbh D. Britta Gammelgaard, Professor Günte, ed. *International Journal of Physical Distribution & Logistics Management*, 45(4), pp.333–351. Available at: http://www.emeraldinsight.com/doi/10.1108/IJPDLM-12-2014-0291#.Vk8nK_b_yJM.email [Accessed December 1, 2015].

Gatta, V. & Marcucci, E., 2016. Stakeholder-specific data acquisition and urban freight policy evaluation: evidence, implications and new suggestions. *Transport Reviews*, 1647(September). Available at: http://dx.doi.org/10.1080/01441647.2015.1126385.

Handy, S., 2015. Trip generation : Introduction to the special section. *The Journal of Transport and Land Use*, 8(1), pp.1–4.

Hesse, M., 2008. *The City as a Terminal: The Urban Context of Logistics and Freight Transport*, Ashgate Publishing Ltd, Farnham.

Holguín-veras, J., 2016. Accomodating What Freight? In TRB 95th Annual Meeting. Washington D.C.: The National Academy of Sciences, Engineering, and Medicine.

To INDEX

Kunze, O., Wulfhorst, G. & Minner, S., 2016. Applying systems thinking to city logistics: A qualitative (and quantitative) approach to model interdependecies of decisions by various stakeholders and their impact on city logistics. In E. Taniguchi & R. G. Thompson, eds. *The 9th International Conference on City Logistics*. Tenerife: ELSEVIER Procedia - Social and Behavioral Sciences, pp. 692–706.

Leonardi, J. et al., 2014. Increase urban freight efficiency with delivery and servicing plan. *Research in Transportation Business & Management*, 12, pp.73–79. Available at: http://dx.doi.org/10.1016/j.rtbm.2014.10.001 [Accessed September 9, 2015].

Lindholm, M. & Browne, M., 2013. Local Authority Cooperation with Urban Freight Stakeholders: A Comparison of Partnership Approaches. *European Journal of Transport and Infrastructure Research*, 13(1), pp.20–38.

Macharis, C. & Kin, B., 2016. The 4 A's of Sustainable City Distribution: Innovative Solutions and Challenges ahead. *International Journal of Sustainable Transportation*, 11(June), pp.59–71. Available at: https://www.tandfonline.com/doi/full/10.1080/15568318.2016.1196404 [Accessed February 8, 2017].

McLeod, F. et al., 2015. Sustainable procurement for greener logistics in the Highere Education sector. MDS Transmodal & Centro di recerca per il Trasporto e la logistica (CTL), 2012. *DG MOVE European Commission : Study on Urban Freight Transport Final Report*,

Muñuzuri, J. et al., 2012. City logistics in Spain: Why it might never work. *Cities*, 29(2), pp.133–141. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0264275111000394 [Accessed July 18, 2012].

Österle, I. et al., 2015. The role of a structured stakeholder consultation process within the establishment of a sustainable urban supply chain D. Gary Graham, ed. *Supply Chain Management: An International Journal*, 20(3), pp.284–299. Available at: http://www.emeraldinsight.com/doi/full/10.1108/SCM-05-2014-0149 [Accessed April 20, 2015].

Papoutsis, K. & Nathanail, E., 2016. Facilitating the selection of city logistics measures through a concrete measures package : A generic approach. In E. Taniguchi & R. G. Thompson, eds. *The 9th International Conference on City Logistics*. Tenerife: ELSEVIER Procedia - Social and Behavioral Sciences, pp. 679–691.

Quak, H., Duin, J. Van & Visser, J., 2008. City logistics over the years... Lessons learned, research directions and …. *Innovations in City Logistics:* …. Available at: http://www.citylogistics.org/CityLogistics2007/Presentation/3_Hans.pdf.

Quak, H.J. & Koster, M.B.M. De, 2007. Exploring retailers' sensitivity to local sustainability policies. *Journal of Operations Management*, 25(6), pp.1103–1122. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0272696307000162 [Accessed January 29, 2013].

Russo, F. & Comi, A., 2016. Urban Freight Transport Planning towards Green Goals: Synthetic Environmental Evidence from Tested Results. *Sustainability*, 8(4), p.381. Available at: http://www.mdpi.com/2071-1050/8/4/381/htm [Accessed June 23, 2016].

Tozzi, M., Corazza, M.V. & Musso, A., 2014. Urban goods movements in a sensitive context: The case of Parma. *Research in Transportation Business and Management*, 11, pp.134–141. Available at: http://dx.doi.org/10.1016/j.rtbm.2014.03.003.

Trist, E., 1978. On socio-technical systems. *Sociotechnical systems: A*. Available at: http://sistemas-humano-computacionais.wikidot.com/local--files/capitulo:redes-socio-tecnicas/Evolution_of_socio_technical_systems.pdf [Accessed February 8, 2017].

Wainwright, I., 2016. Building Freight into London's Strategic Transport Plan. In *TRB 95th Annual Meeting*. Washington D.C.: The National Academy of Sciences, Engineering, and Medicine.

Zunder, T.H. et al., 2016. Engaging city stakeholders to achieve efficient and environmentally friendly urban freight movements. In C. Blanquart, U. Clausen, & B. Jacob, eds. *Towards Innovative Freight and Logistics Vol. II*. Paris: John Wiley &Sons, Inc., pp. 275–287.

Zunder, T.H., Aditjandra, P.T. & Carnaby, B., 2014. Developing a Local Research Strategy for City Logistics on an Academic Campus. *International Journal of Urban Sciences*, 18(2), pp.262–277.

Zunder, T.H. & Dellinger, J.-C., 2005. City freight: evaluation methodology for urban freight transport. In G. Ambrosino et al., eds. *Systems and Advanced Solutions for eLogistics in the Sustainable City*. Rome: ENEA Italian National Agency for New Technologies, Energy and the Environment, pp. 299–309. Available at: https://goo.gl/uHv6P0.

To INDEX