DEVELOPMENT OF CITY LOGISTICS MATURITY MODEL FOR MUNICIPALITY PERFORMANCE MEASUREMENT

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Abstract

Municipalities play an important role in tackling city logistics related matters, having many instruments at hand. However, it is not self-evident that all municipalities use these instruments to their full potential. A method to measure city logistics performance of municipalities can help in creating awareness and guidance, to ultimately lead to a more sustainable environment for inhabitants and businesses. Subsequently, this research is focused on a maturity model as a tool to assess the maturity level of a municipality for its performance related city logistics process management. Various criteria for measuring city logistics performance are studied and based on that the model is populated through three focus fields (Technical, Social and Corporate, and Policy), branching out into six areas of development: Information and communication technology, urban logistics planning, Stakeholder communication, Public Private Partnerships, Subsidisation and incentivisation, and Regulations. The CL3M model was tested for three municipalities, namely, municipality of Utrecht, Den Bosch and Groningen. Through these maturity assessments it became evident the model required specificity complementary to the existing assessment interview, and thus a SWOT analysis should be added as a conclusion during the maturity assessment.

1. Background

City logistics is a challenging process for logistics companies and organizations. The government and society put pressure on supply networks to innovate in order for cities to become safer, less noisy and less polluted (Topsector Logistiek, 2017). According to the World Economic Forum the number of delivery vehicles in cities is set to grow with 36% in the 100 largest cities in the world, and with that emissions are estimated to grow with 32% and congestion with 20% (World Economic Forum, 2020).

Adding to economical and societal development, and the disruption caused by the pandemic, there is also an environmental factor that plays a role on city logistics. Many actions are taken to stop global warming through initiatives deriving from the Paris agreement. As such city logistics also takes its part in reducing emission. As part of the Dutch Green Deals many companies and municipalities are working together to realize 'Zero Emission City Logistics'. The goal of the government is for a minimum of 30 municipalities in the Netherlands to establish a Zero Emission (ZE) zone by 2025 (GreenDeal, 2018). The figure 1 puts this green deal into perspective.

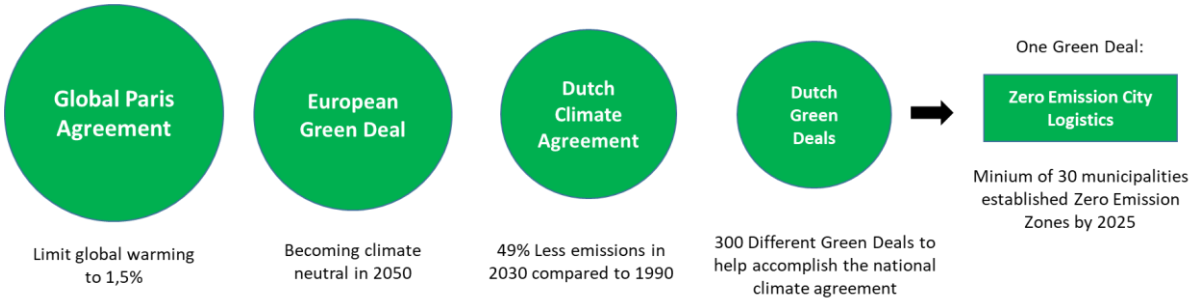

Figure 4: Overview of Global to Local Climate Goals

Before describing these particular challenges, it is important to note that although most large municipalities are aware of the needed changes in city logistics, knowledge platform CORW (2016) states that many smaller municipalities are not aware of the problems of city logistics and thus show no involvement. Unmanaged city logistics causes the following issues (CROW , 2016):

- 60% of NOx and particular matter emissions and noise comes from logistical traffic
- Most social complaints on traffic towards municipalities are caused by logistics traffic
- Heavy trucks cause damage to the infrastructure in cities
- 25% of deaths in traffic are caused by logistical traffic
- An excess of logistical movement has negative impact on the attractiveness and quality of living in a city

Besides the relative obvious issues listed above, the lack of city logistics management by municipalities halts the effort on innovation coming from businesses. A research program on the use of light electrical vehicles in cities conducted by the Amsterdam University of Applied Sciences concluded that even if light electrical vehicles were fully adapted by businesses, there is a significant lack of infrastructure and policy from the municipalities, which is needed for the full implementation of these innovations (Ploos van Amstel W. , et al., 2018). Another stakeholder that expresses its needs towards the government and municipalities is logistical branch organization TLN, who states the sector requires more clarity on the policy around zero emission zones, for example on the availability of subsidization and charging infrastructure, the privileges for zero emission vehicles ,and the need for shared city hubs (TLN, 2021).

The problem faced is that there is no holistic approach to measuring progress on sustainable city logistics. Although many municipalities have established action plans on sustainable city logistics, there is no universal way of measuring progress. A maturity modelling tool could be beneficial for municipalities to provide insights into their current 'level' of their strategy and organization around city logistics. This tool can show a municipality how it is currently performing in city logistics so businesses can continue to operate in a sustainable and profitable manner, environmental impact is kept to a minimum, and inhabitants live in a safe and healthy environment.

The objective of this research is to develop a maturity model which be used and applied to Dutch municipalities to measure their current level on sustainable city logistics. This includes finding out what

pillars are key for sustainable city logistics, what role municipalities have in this environment and establish a uniform method of assessing maturity. The outcome of the research will be a conceptual maturity model framework. The rest of the paper is organized as following. Section 2 explored literature related to maturity model in general and important factors to measure maturity of city logistics process management. Section 3 describes the development process of City Logistics Maturity Model for Municipality (henceforth also CL3M). Finally, conclusion and learning from this research are explain in section 4.

2. Literature review of criteria for evaluating city logistics perfomance

During a congress held by the City logistics Italia association in Rome in 2006, the association determined that separate and regional measures do not lead to a sustainable and competitive urban logistics system. The association stated that the integration of four important measures were needed to progress towards sustainable urban logistics system on a national level: Regulatory policies (restrictions or incentivized), information and communication tools, contributions in infrastructure, technology or civil engineering, and partnerships between public and private enterprises (Gonzalez-Feliu, 2018).

To enhance capabilities within urban logistics, 17 partners from 10 different European countries have together created a public association called Sustainable Urban Goods Logistics Achieved by Regional and local Policies, known as SUGAR. SUGAR states there are four categorized policy leverages: transport, environment, space and territory, and harmonization (SUGAR, 2011). SUGAR analyzed 44 best practice initiatives taken by public authorities and categorized these into nine different categories of measures. Smart Freight Centre, an organization that, among other activities, works on catalyzing sector-wide proven cost effective technologies and solutions on urban freight conducted a review of worldwide good policy practices taken by municipalities. The research included case studies from a global perspective, including London, New York, Tokyo, Paris and California. In this study 11 categories of urban freight development were listed (Smart Freight Centre, 2017).

Table 1. City logistics evaluation critiea in different studies

(Gonzalez-Feliu, 2018)	**(Smart Freight Centre, 2017)**
Regulatory policies	Vision
information and communication tools	Emission targets
contributions in infrastructure, technology or civil engineering	Infrastructure
partnerships between public and private enterprises	Restrictions on freight mobility
(SUGAR, 2011)	Trucks
Administrative	Operations
Urban Planning	Technology
Governance	Freight Partnerships
Awareness	Data

Infrastructural	Finance
ITS Technical	Recognition schemes
Modelling Tools	**(Ducret, Diziain, & Plantier, 2015)**
Supply Chain Management	Formalisation of the freight policy
(Russo & Comi, 2020)	Quantitative diagnosis
Supply management measures	Public-private consultation or partnership
Demand management	Political support and commitment
Infrastructure	Traffic and parking regulations and the efficiency of the control system
Technology (ICT/ITS)	Urban planning regulations
Environment-friendly vehicles	Delivery bays' number, location and design
Public - private collaboration	Human and financial resources allocated to the policy
Reverse logistics	

A study conducted by the department of Enterprise Engineering of the University of Rome investigated the effect of city logistics measures on the economy. An efficient urban logistics system is different to one that is not set in an urban environment. Russo and Comi (2020) state that the difficulty comes from managing the various stakeholders and the constraints related to the urban landscape. The paper concluded that seven different categories of measures could be applied to achieve objectives in city logistics. A French study focusing on the evaluation of local public urban freight policies looked at case studies to determine strengths, weaknesses, threats and opportunities. In total, 18 different French cities were part of the research. After conducting the case studies, the researchers found there were eight criteria to be key for the evaluation of public urban freight policy (Ducret, Diziain, & Plantier, 2015). Table 1 shows criteria based on the literature discussed in above paragraphs.

A research from Concordia University in Montreal conducted a hybrid research approach to evaluate urban logistics initiatives, namely the following: vehicle size restriction, congestion charging schemes, urban distribution center and access timing restrictions (Awasthi & Chauhan, 2011). The hybrid approach included the use of an affinity diagram, AHP and fuzzy TOPSIS method. An affinity diagram groups generated data based on their relationship to each other. The result of using this method by the researchers was the creation of four main criteria (technical, economic, environmental and social) with sixteen sub criteria. The AHP multi criteria decision making technique used showed that the environmental category was most important for urban logistics initiatives. A full overview of all criteria and their values can be found in appendix 3. Lastly, using fuzzy TOPSIS the research concluded that timing restrictions is the most effective city logistics initiative based on the selected criteria.

In the context of planning and evaluation of city logistics Gonzalez-Feliu (2018) states sustainable development is essentially an organizational matter and generally categorized into three spheres that require cohesion: economic, environmental and social. Furthermore, Gonzalez-Feliu applied these three spheres to the concept of city logistics. The economic sphere translated to reduce lead times and

increase service while keeping costs down. From an environmental point of view city logistics reducing emission is now seen as a necessity instead of an opportunity. City logistics has impact on a social level to society and the working environment and is usually formulated as corporate social responsibility (CSR). The research further used a co-constructive consensus method to establish indicators and a dashboard for the evaluation of sustainable urban logistics. Overall, a group of 25 field experts listed 95 different indicators. After this a list of 16 indicators supported by at least two experts were listed. All indicators were spread out over three types: economic, environmental and social.

A meta-analyses from the University of Hull identified the results of multiple studies on applied criteria and sub-criteria for sustainable city logistics initiatives and combined these results into common criteria (Jamshidia, Jamshidia, Ait-Kadi, & Ramudhin, 2018). The combined results include eleven research papers conducted in eight different countries from the year 2000 until 2017. The outcome of the research shows that there are five common criteria used in sustainable city logistics initiatives: economic, technical, environmental, social, and services.

As a conclusion to the state of art criteria for evaluating city logistics, we saw that there are many criteria available for evaluating city logistics performance. This research use these criteria as a base to create categories and level for city logistics maturity model for municipalites.

3. City logistics maturity model for municipalities

The literature review created solid knowledge base for maturity model development. Based on the knowledge about maturity model development steps and criteria for evaluating city logistics measure, steps are carved for developing city logistics maturity model for municipalities. The strategy of this research is to follow existing methodology for maturity model development as the main guideline by Bruin et. Al., (2005). In this research, phases upto test are accommodated.

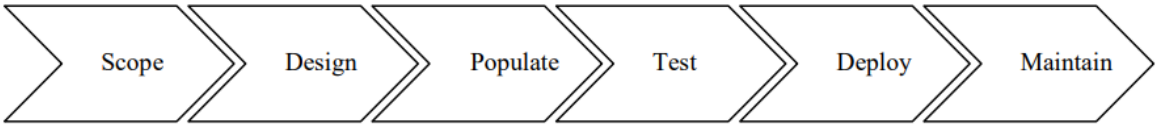

Figure 2: Phases of model development. Source: (Bruin, Freeze, Kulkarn, & Rosemann, 2005)

3.1 Scoping and design of CL3M

The scoping and design of CL3M includes decision about criterion about focus of model, stakeholders involved in development, audience for which the maturity model is used for, model application method, motivation (driver) for application, respondent (who will provide information for evaluation) and application entities. Table 2 shows these criteria, choices made for city logistics maturity model for municipalities and respective explation.

Table 2. Criteria and respective choice for CL3M characteristics

Criterion	Characteristic of CL3M	Reasoning
Focus of the model	Domain specific	Focused only on city logistics domain
Development stakeholders	Combination of academia, practistioners and government	Development initiative by academia researcher (primery) but input is taken from practitioners and government (secondary)
Audience	External	Applied to external audience who is not primary developer of the model
Method of application	Third party assisted	Assisted by municipality employee
Respondent(s)	Municipality employee	The employee working closely with city logistics related activity will be consulted
Application	Multiple entities/regions	The model can be applied to single or multiple municipalities

Lastly, before moving to the phase of populating the maturity model it is important to pre-determine the stages of maturity within the model. This choosing how many stages of maturity the model includes, what they are called and a definition of each of the stages. The amount of stages used in the model can vary, however a common practice is to establish five stages ranging from 1 to 5, with the addition of stage, where there is no awareness on the topic or process (Bruin, Freeze, Kulkarn, & Rosemann, 2005). Since many municipalities are still not incorporating city logistics in its urban planning, they are unaware of specific city logistics initiatives and thus falls under "Oblivious" level. It is self-evident that the levels 2 to 5 are closely connected with stages of PDCA cycle and thus a closed plan-do-check-act (PDCA) cycle is associated with theses levels. With this logic, total 6 levels are considered for CL3M as shown in table 3.

Table 3 Levels and explanation for city logistics maturity model for municipality

Level	Label	Explanation of level
0	Oblivious	There is no knowledge on the specific maturity topic. Typically a municipality in this category has no awareness of the role it plays regarding logistics.
1	Awareness	There is a general sense of knowledge on the topic, however there is no development yet. Municipalities in this category do not have an interest in actively taking part in increasing the sustainability of city logistics in their region.
2	Interest	When reaching this level, a municipality is aware of the value it can add towards sustainable city logistics and has plans to take action. However, no measurements are currently in place. In regards to the PDCA cycle, this level could be considered the 'plan' phase.
3	Managed	A municipality reaching a managed level of maturity is active in taking measurements towards sustainable city logistics. On the other hand, the municipality has not gotten to a point where it has full control or knows if the measurements in place have reached the desired result. In regards to the PDCA cycle, this level could be considered the 'do' phase.
4	Establised	Reaching an established level means measurements in place are developed to a degree where there is a clear positive impact and stakeholders are satisfied. In regards to the PDCA cycle, this level could be considered the 'Check' phase. The municipality is checking the results of its measurements and thus knows the impact exactly.
5	Optimized	An optimized level means being at the forefront of development. All activity around city logistics is about continuously improving. There clearly is a closed PDCA cycle. This level also includes having a detailed strategic planning, anticipating future needs and playing a leading role in sustainable city logistics development for all stakeholders involved.

3.2 Populating CL3M

Populating the maturity model answers the question as to 'what' needs to be measured. The important factor here is that the elements used to measure need to be mutually exclusive and collectively exhaustive, meaning there is no overlap and that the model includes all aspects to determine maturity in city logistics.

In total 38 areas of measures used for urban logistics development based on the literature review (refer table 1). Use of multiple sources shows the reliability and consistency of the measurs. Next, these measuers are used to define categories for CL3M based on the categories defined by Awasthi & Chauhan (2011) and (Jamshidia, Jamshidia, Ait-Kadi, & Ramudhin (2018). The decision was made to categorize the measures used for urban logistics development under the technical, social and corporate, and policy categories. Other criteria mentioned by Awasthi and Chauhan (2011) were environmental and economic, but the decision has been made not to categorize within these criteria for two reasons. The first reason being they are underlying goals to be achieved by taking action on technical, social and policy measures, which means by taking action on a policy level, urban logistics should become more environmentally friendly and economically viable. The second reason was to keep the number of categories down to streamline and simplify the process. Furthermore, the category policy was not mentioned, however while compiling results it is evident that this category needed to be established as 13 measures (34% of total) were measurements of policy.

As a conclusion three focus field have been established to continue the process of determining the specific areas of development and to clarify further, below a description of each of these focus fields is given in table 4.

Table 4 Focus fields and description for city logistics maturity model for municipality

Technical	Under the technical aspect falls any measurement that is related to either technology (ICT) or anything physical in the public atmosphere, such as: transport hubs, loading/unloading areas or road signs.
Social and Corporate	The social and corporate focus field in the context of this research is aimed at measurements that are based on external involvement such as: creating awareness, education or entering a public private partnership.
Policy	The policy field includes any measurements such as rules and regulations to guide or enforce processes. Examples are: vehicle restrictions or incentivisation schemes.

Six areas of development

After establishing the focus fields mentioned in the previous sub-chapter the results can be categorized. To establish these categories the measures taken by public entities found in the research have been analyzed and clustered together based on their similarities, an overview of all measures and their categorization is already given in table 1. In total, six areas of development were established: Information and communication technology, urban logistics planning, Stakeholder communication,

Public Private Partnerships, Subsidisation and incentivisation, and Regulations. Figure 3 shows how the measures found in literature are distributed across the six areas of development.

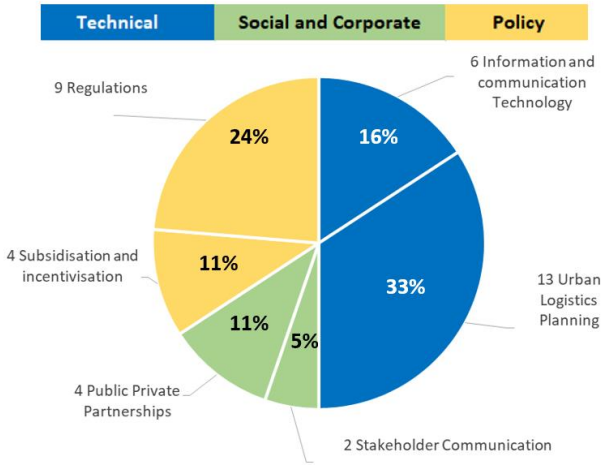

Figure 3: Categorising the measures found in literature

What is important to consider when developing this specific maturity model is that a public entity like a municipality has a very different role compared to a business. A municipality does not have operations to run like shippers and carriers do. Instead, a municipality has the following five roles: regulating and enforcing, facilitating, stimulating, coordinating, and experimenting. To put this into perspective the correlation between the six areas of development and the five municipal roles is shown in the figure 4. This shows that there is a strong connection between developing a model that measures maturity on sustainable city logistics for municipalities and the general role municipalities have, as each of the roles are connected to one or more areas of development.

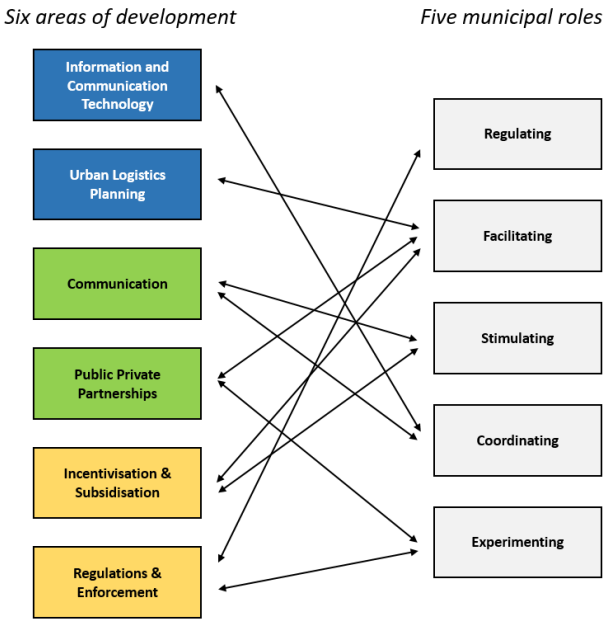

Figure 4: The relation between performance measurements areas and the role of municipalities

Taking into account the measurements found in literature and the five municipal roles, below a definition is given on what exactly is each of the area of development entails.

Information and communication Technology

ICT within city logistics is about traffic management, where traffic is regulated to create less congestion and increase safety (Drop & Garlinska, 2021). Besides this ICT can also be used to enforce regulations by gathering traffic data that allows officials to see which vehicles enter a restricted area within the city. Another area where ICT comes to use is measuring progress on emission or congestion goals, where sensors could detect the amount and type of vehicles. The key here is to coordinate.

Urban logistics planning

This category is focused on the integration of city logistics into urban planning. Meaning sufficient research and planning has been done on what the exact needs are for specific areas around the city. These needs could be: city hubs, loading or unloading areas, electric charging stations (Gonzalez-Feliu, 2018). The role of the municipality here is to facilitate by including logistics in all urban planning

Communication

The communication category entails the communication of developments within city logistics, which could be the (re)designing of urban space or the introduction of new policies (SUGAR, 2011). This category is mostly linked to the coordination role, however communication can also be used to stimulate by sharing best practices and connecting stakeholders through a communication community.

Public private partnerships

Public private partnerships is linked to facilitating city logistics activities. These partnerships can occur in the form of pilot concepts (CE Delft, 2020), but also through signing a covenant (Gemeente

Rotterdam, 2019), which brings together multiple stakeholders and thus facilitating the interaction created. Through these partnerships municipalities can also experiment with new concepts.

Subsidisation and incentivisation

This category also is related to facilitating as urban logistics planning and public private partnerships also are, although subsidizing and creating incentives does this in a more direct manner. By creating recognitions schemes (Smart Freight Centre, 2017) municipalities can both facilitate and stimulate the development of sustainable city logistics practices.

Regulations and enforcement

Regulations have no basis if there is no enforcement policy in (Ploos van Amstel, 2021). This category focusses putting in place the needed regulations and enforcements, which could be restrictions on vehicles or allocating time frames for logistical traffic in specific streets (Ducret, Diziain, & Plantier, 2015). Besides this category falling in line with the regulatory role of municipalities, regulations could also act as a form of experimentation.

The establishment of a ZE zone is also a regulatory matter, but the choice has been made not to include this topic into the maturity model. The reason for this is that the ZES platform has an action plan to help municipalities establish a zone (ZES, 2021) and besides this, municipalities can take part of the SPES program during which their progress is evaluated with the use of a specific method (Hoogma, 2021). Assessing the progress (maturity) on a zero emission zone can thus best be done with the use of the SPES method, making the inclusion into the maturity model obsolete.

After the developing first version of CL3M, practitioner and municipality authorities were contacted to get their feedback on the model. Suggestions and feedback from two external advisors to different municipality and one municipality employee were incorporated in the model to prepare the current final version of city logistics maturity model for municipality. Table 5 shows the current final version of CL3M.

Table 5 City logistics maturity model for municipality (CL3M)

Focus Field		Technical		Social & Corporate		Policy	
Area of Development		**Information and communication Technology**	**Urban Logistics Planning**	**Stakeholder Communication**	**Public Private Partnerships**	**Subsidisation & incentivisation**	**Regulations & Enforcement**
Definition		The development of ICT to support traffic management	The planning of city hubs, Infrastructure, loading and unloading areas, roadway use, public charging stations, etc.	Communication on new policies, planning, infrastructure, etc.	Partnerships between public and private entities to promote and run pilots with new technologies and concpets.	The subsidisation and incentivisation of sustainible urban logisitcs operations	Regulations to minimize congestion and pollution, and increase safety
Level							
0	**Oblivious**	There is no awareness or knowledge about ICT systems used in city logistics	There is no awareness on integrating logistics activities into urban planning	There is no communication channel for city logistics	There is no awareness of the added value of public private partnerships	There is no awareness of the concept of incentivisation or subsidisation	There is no awareness of urban logisitics regulatory policies
1	**Awareness**	There is some knowledge about ICT however there are no plans to implement a system	There is awareness on urban logistics planning although little thought is given to the topic as it is not a part of urban planning	The municipality is aware of the need to share information, although there currently is insignificant communication	There is awareness of public private partnerships although no action has taken place	There is awareness of the concept of subsidisation and incentivisation but possibilities are not explored	There is awareness of regulatory polocies, although none are officially in place or enforced
2	**Interest**	There is a good knowledge on ICT and means/systems are currently being investigated and/or are part of future plans	Logistics are a part of urban planning. There is no strong link between planning and doing, as different actors express their own will regarding urban planning	Newsletters and surveys are send out to some concerning stakeholders	One or more pilots have taken place with public private partnerships, although with little to no actual benefits	There is knowledge on what subsidies and incentives are proven effective and there are plans to roll out these measures	The municipality has a plan on how to regulate congestion, pollution and safety to an acceptable level for all stakeholders
3	**Managed**	ICT is in place and some data is gathered, but this data does not consistantly loop back into the process of managing traffic flow. Traffic management is still mostly an ad-hoc activity	Urban logistics planning is realized according to a plan. Decision making actors are alligned within this process. However the 'check' is missing, there is a lack of measuring improvements or stakeholder satisfaction.	The municapality communicates if possible through branch organisations as much as possible. However there are multiple windows through which communication on city logistics takes place	A few (1-3) pilots have been successful and are now permanent operations. Public private parnerships are still mostly an ad-hoc activity	A few (1-3) local subsidisation and incentivisation schemes are in place. However, the exact result these measurements have on social, economic or environmental levels for the city is not known.	The regulations mentioned in the plan are in place, but there is a lack of enforement policy. The municipality is unaware if regulatory policies are well functioning
4	**Established**	ICT is used to a greater extend. Traffic management is an established process with the gathered data being integrated into the decision making process on a tactical level (1-5 years)	Measurements sush as loading/unloading areas and city hubs used with high satisfaction levels from stakeholders, who are involved in continuous improvement and tactical planning (1-5 years)	A community for news regarding city logistics is setup, which is active in organizing congresses or similar events. The municipality shares best practices and new methods/technologies which could help businesses	The municiality has a taskforce established to manage public private partnerships. Multiple (3+) public private partnerships are in place and have proven positive impact on social, economic or environmental levels	Multiple (3+) subsidisation and incentivisation schemes are active and have proven to contribute positively towards the goals for which they were established	Regulations and enforcement is established to a point where the policy plan is 'checked'. Results are proven to positively impact congestion, pollution and safety
5	**Optimized**	ICT is continuously improved with a closed plan-do-check-act cycle. The data gathered is used to plan traffic management on a strategic level (5+ years)	Future needs are already anticipated. City hubs are the standard for deliveries. The grid is sufficient and all public EV charging needs are fulfilled. There is a continuous plan-do-check-act cycle with strategic planning (5+ years)	All concerning stakeholders are active in the city logistics community and the municipality has a clear one-single-window through which communication on city logistics takes place	Public private partnerships are a go-to solution and a task force is permanently active to evaluate existing operations and research future possibilities	The plan-do-check-act cycle is complete. At the end of subsidisation and incentivisation scheme periods the results are analyzed and new ittirations of schemes are continuously improved	Regulations and enforement measures are continuously improved by analyzing results and adjusting policy so goals towards sustainible city logistics are reached. There is a full plan-do-check-act cycle

3.3 Testing CL3M

The goal of testing the validity and reliability is to seek an agreement with a selected group of domain experts through a maturity assessment interview. The CL3M was tested on three municipalities, namely, municipality of Utrecht, Den Bosch and Groningen. A quick scan interview followed by detail semi-strcutred interview was conducted to get information to generate maturity levels. Figure 5 shows the result of outcome.

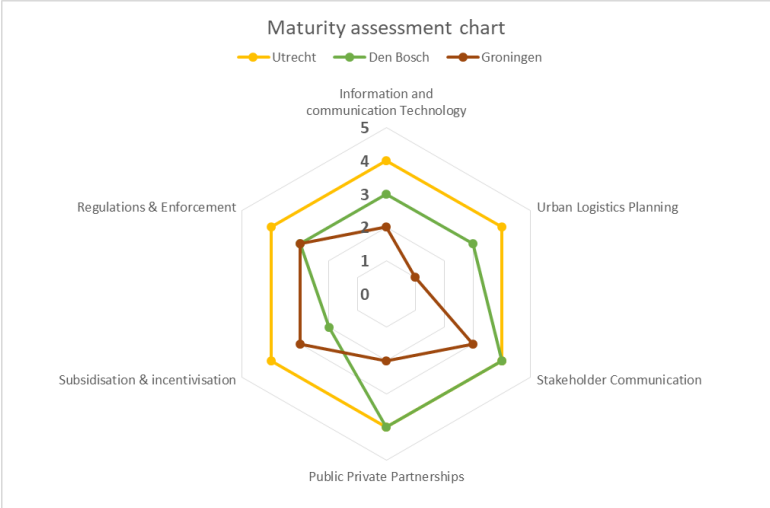

Figure 5: Result of testing CL3M on three municipalities

During the testing of model, most feedback given was related to specificity. During the maturity assessment it became evident that cases can vary, and needs in terms of city logistics measurements can differ between municipalities. A report from Topsector logistiek also states that requirements differ widely between segments of city logistics, and that also solutions to the same problem can be handled differently (Logistiek, 2017). Bruin, Freeze, Kulkarn and Rosemann (2005) state that to meet audience needs, a balance must be created between a complex reality and model simplicity. As such, integrating all feedback into the model would create an overly complex model, creating confusion and a lack of interest. To tackle the issue of creating a balance between a generalized and overly complex model, a SWOT analysis can assist. Combining the output of a maturity model with creating a SWOT analysis helps to build an effective roadmap for implementation with actionable insights (Lecinski, 2021). For the City logistics Maturity Model for Municipality established in this research this means the output of the assessment would be both the score (0-5) and a SWOT per each area of development, and thus create a tool that is both generalized and tailored to individual cases.

4. Conclusion

The landscape of city logistics is changing at a fast pace, with a need of a more sustainable approach to city logistics being unavoidable as logistical traffic in cities keeps increasing, resulting in unsafe,

congested, and environamentally polluted city centers. Municipalities play a great role in tackling this matter, having many instruments at hand. However, it is not self-evident that all municipalities use these instruments to their full potential. A method to measure to measure city logistics performance of municipalities can help in creating awareness and guidance, to ultimately lead to a more sustainable environment for inhabitants and businesses. Subsequently, this research is focused on developing Maturity model as a tool to assess the maturity level of a municipality for its performance related city logistics process management.

To measure performance within city logistics the most used criteria are based on technical, economic, environmental, social, and service aspects. After conducting a literature study, the first step was to scope and design the maturity model. The City logistics Maturity Model for Municipality (CL3M) requires a domain specific, multidimensional model to assess city logistics from a municipal point of view. The model includes six levels (0-5) and a PCDA cycle is embedded throughout the levels.

The model is populated through three focus fields (Technical, Social and Corporate, and Policy), branching out into six areas of development: Information and communication technology, urban logistics planning, Stakeholder communication, Public Private Partnerships, Subsidisation and incentivisation, and Regulations. Furthermore, a strong correlation between the six areas of development and the five municipal roles was found, adding to the validity of the model. To furthermore validate the model, expert interviews were conducted to ensure completeness of the model in regards to the scope.

The CL3M model was tested for three municipalities, namely, municipality of Utrecht, Den Bosch and Groningen. Through these maturity assessments it became evident the model required specificity complementary to the existing assessment interview, and thus a SWOT analysis should be added as a conclusion during the maturity assessment.

The CL3M is yet in its juvenile stage and by further development, the model can reach its full potential in usefulness, reliability and adaptation. Noted during the research was the importance of public procurement for city logistics. Currently this topic is not embedded into the CL3M as no way was found to integrate it. Another first point of improvement would be the assessment method. Currently an expert in required to conduct the interview as interpretation on the question has to be further clarified. A more general and quantitative method, perhaps in the form of self-assessment could increase ease of using the model.

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