TOWARDS A ZERO EMISSION CITY LOGISTICS MATURITY MODEL

Thato Motloung, Buas, Breda University of Applied Science

Hans Quak, BUas, Breda University of Applied Science

Abstract

With the approach of the zero emission zone implementation in 30-40 cities mandated by the Dutch Klimaatakkord, comes the need to determine whether the SMEs located within these zones are aware of the coming changes and if they are, how far they have come in their preparation. This paper delves into the development of the zero emission city logistics maturity model tool which is used to indicate the progress of these small to medium enterprises in light of reaching fully zero emission city logistics operations. The paper starts off with a review of existing maturity models which forms the baseline for the zero emission city logistics maturity model in rubric form. A QuickScan analysis is developed in order to facilitate data collection by students who then approach businesses and use the QuickScan results to benchmark the businesses progress against other businesses. This paper then concludes with the preliminary results from the initial QuickScans performed by HBO level students.

1.   Introduction

1.1.   Zero-emission zones for city logistic in the Netherlands

Following the United Nations Paris Climate Agreement in 2015 the Dutch 'Klimaatakkoord' was established, citing five areas in which greenhouse gas emissions could be reduced by 49% compared to 1990 levels; these sectors are: built environment, mobility, industry, agriculture and electricity (Rijksoverheid, 2019). Under the topic of mobility, the Klimaatakkord states that 30-40 Dutch cities are required to define medium sized zero-emission zones by 2020, with the regulation beginning in 2025; these zones are expected to lead to a yearly 1 Mton reduction in CO_2 emissions (Rijksoverheid, 2019, p. 69). In addition to the zones being implemented, the agreement encourages the use of electric vehicles for the commercial logistic movements further citing the private-public partnerships they have created to provide the required infrastructure (Netherlands Enterprise Agency, 2019) (Rijksoverheid, 2019, p. 61). In 2020, the goal of creating zero-emission zones was furthered by the drafting of the Implementation Agenda, signed on the 9th February 2021 by transport companies, municipalities and the Dutch minister of environmental affairs which outlines the details behind how the mid-sized zero-emission zones will be rolled out on the 1st January 2025 including the exceptions of new Euro 6 trucks and vans which will be phased out before 1st January 2030 (Rijksoverheid, 2020, p. 7). To date (October 2021) almost 30 Dutch municipalities have signed the agreement which states that cities need to declare the size and area of their zero-emission zones.

1.2. Organizing city logitics without emissions: industry perspective

With the 1st of January 2025 drawing closer, the lack of knowledge about the forthcoming ZE regulations as well as insufficient insight into the zero-emission options SME's could adopt is an issue. Currently there is no clear idea on the progress of (SME) companies operating vans or trucks in the future zero-emission city logistics zones. Numerous studies have been done on the barriers to the adoption of zero-emission vehicles (Burke & Miller, 2020) however, in light of the time pressures due to the implementation phases of the zero-emission zones, this adoption needs to be sped up and the barriers addressed. This also provides an opportunity to explore other ways in which SME's could to comply to the ZE zone requirements (e.g. using ZE service providers at hubs, or bike couriers services to name a few).

Some larger logistics companies have already started working on a zero-emission logistics strategy to meet the future zero-emission zone (ZEZ) requirements, but many companies active in city logistics are not yet familiar with the coming zero-emission (ZE) requirements or have not started working on a zero-emission city logistics strategy. To assess how far companies are in their zero-emission city logistics preparation, and what issues they face, in order to develop tools and information to make the transition to a more sustainable city logistics system possible, it is necessary to assess the current level and the needs companies (in different city logistics segments and sizes) have. This will be done by means of a maturity model which will enable a high-level view of how far companies are in preparing towards zero-emission logistics operations in the signatory city-centres. These insights are a first requirement to further develop support for companies that are preparing towards zero-emission zones, as there needs to be a voice for the barriers to achieving zero emission operations by companies to municipalities so that adequate infrastructural support can be given to these companies.

1.3. Set-up of paper: structure, motivation

There is currently a lack of uniform tools that companies can use to measure and benchmark their ZE emission progress, in addition to this, outside of the larger corporations that have signed the implementation agenda, it is unclear whether small to medium enterprises (SME) are aware of the impending zero emission zone implementation and if they are what they are doing to work towards being prepared and in which way these companies can be supported in their (future) efforts to achieve ZE city logistics operations. This research reported in this paper aims at answering several questions (for which different ways of data collection or used, see

Table 9.

Table 9 Research questions and data collection

	Research Question	Data Collection
Theoretical	What is meant by process/project maturity	Review of maturity models
Empirical	How mature are the preparations that companies are making towards zero-emission city logistics?	
	What are the indicators for zero-emission maturity for companies operating in the city centres?	Maturity model development supported by maturity model review and validation by interviews
	On what basis can companies be benchmarked with each other pertaining to their zero emission city logistics maturity.	QuickScan development (Thato Motloung) QuickScan application (HBO students)

This paper is structured as follows: it begins with a review of maturity models which will then be viewed in the scope of zero emission city logistics in chapter 2. This review will then be synthesized to develop a model which is suited to establishing zero emission city logistics maturity, this is done by conducting desk research as well as interviews with early adopters, the results of which can be viewed in chapter 3. This maturity model will then be validated by conducting interviews, once established a QuickScan is developed which will provide a guideline to filling the maturity model. The QuickScan will be used to fill in the maturity model, thus providing a high level view of company maturity. These scans will be conducted on company premises in the city centres to establish the general understanding that SME's hold towards zero emission city logistics, the results of which will be discussed in chapter 4. The preliminary conclusion will follow this, being the final chapter of this article.

2.   Developing a maturity model for zero-emission city logistics

2.1.   Different maturity models

In order to develop a maturity model for ZE city logistics, a review of the existing literature towards building and understanding of how maturity models are designed is conducted. From this three types of models were distinguished.

1. The Capability Maturity Model (CMM) and Capability Maturity Model Integration (CMMI),

2. The Project Management Maturity Model (PMMM)

3. The Business Process Maturity Models as 'roadmaps with best practices from which organizations gradually benefit' (BPMM).

Ad1. Capability Maturity Model Integration (CMMI, 2002): The CMM can be seen as the foundation of hundreds of maturity models in existence today. The CMM has 5 step-wise levels which range from the initial phase to the optimizing phase and each level has certain characteristics which must be fulfilled before you move onto the next level, which is more organised than the previous; the five levels are mentioned in Table 10. Each level of this model has three critical dimensions to explore: people, tools

and equipment (resources) and processes (Constantinescu, 2007, pg.32), within which key process areas exist. The key process area is defined by key practices that lead to institutionalization, which are the policies, procedures and activities (Paulk et al., 1991, pg.29) as well as the effective training of staff to practice in these key process areas.

The purpose of the CMM and CMMI are to institutionalise knowledge and company practices so as to reach company goals and achieve a state of continuous improvement and possible automation (Kerrigan, 2013; Mccormack, 2004). The CMMI does not provide steadfast rules as to how progression is made between the levels (Kim & Grant, 2010, pg.231), this creates the opportunity for users to define what key practices are important for the organization in that level. The CMMI provides a guideline for these key areas, however, their assessment can be made to fit the particular organization. This creates an opportunity for organizations to create their own zero-emission goals and standardize assessments to gauge whether the process is heading towards maturity and are the goals being met timeously. This lies within the scope of zero-emission logistics goals since the concept of maturity can be defined as the readiness to engage in zero-emission readiness and how entrained into the organization the process of preparing for zero-emission zones is and whether the organization has capacity for continuous improvement.

The CMM and CMMI models offer a very high level way to assess project maturity and the room for organizations to determine their own key practices, however, since this model was designed for software projects, there is a gap in understanding the various assessment areas. In addition to this, it is also importance to note that zero-emission logistics is a concept that has not yet been institutionalised, the aim of assessing how far a company (or the government) is in achieving maturity requires that the party already has a vision and roadmap, and in that way one can determine how far the party is in achieving that goal.

Ad2. Project Management Maturity Model (PMMM, 2001). This maturity model, developed by Harold Kerzner (2001) zones into using project management tools successfully to achieve a state of continuous improvement and project maturity (see also Table 10). Each level of the PMMM has well defined characteristics, a roadmap to achieving that level, possible roadblocks, advancement criteria to get to the next level and well defined assessment instruments which make the PMMM easy to implement.

Since project management is well defined and has years of research behind it, there is an ease of adapting it to zero-emission projects as most of the tools are in common use and are well understood. Project management maturity models also use multiple choice surveys and the Likert scale to determine the level of maturity which greatly improves the ease of use within companies as the questions are closed and thus provide streamlined and straightforward answers. There is a high measure of adaptability for zero-emission project maturity as the tools are already structured in a way that is understandable. The PMMM, however, is based on the willingness of other companies to be benchmarked which may be a major shortfall in companies that do not trust that their information will be protected and wish to maintain their competitive edge.

Ad3. Business Process Maturity Model (BPMM): Business process management "is the art and science of overseeing how work is performed in an organization to ensure consistent outcomes and to take advantage of improvement opportunities" (Dumas et al., 2013), and much like Project Management, it is a methodology used by companies in order to achieve continuous improvement and can be seen as a language in which business is done within a company. Similarly, it is also stratified into 5 levels which vary from immature (ad hoc) whereby processes are executed heuristically (Adriansyah et al., 2011) to extended, where there are tried and trusted business processes outlining co-operation and collaboration among competitive networks (see Table 10). According to Looy et al, BPMM's are "evolutionary models for measuring (as is) and improving (to be) maturity" (Van Looy et al., 2010); this is based on continuously assessing business capabilities and identifying bottlenecks. The BPMM also delves into collaborative networks, which goes further than the benchmarking efforts mentioned in PMMM. These collaborations heavily rely on integration and linking of strategy as well as common methodologies and to a certain extent software. The most powerful aspect of BPMM is the road mapping ability. BPMM moves the strategic goals into a more tactical and operational level as the focus is not on the overarching strategy but how to create and run individual processes efficiently, once this has been established, the same process among different companies can be compared and benchmarked to achieve joint process optimization and/or collaboration and streamlining of processes.

The maturity models mentioned above can be used in unison as there is no mutual exclusivity and there are complementary elements. An example of this is that the project management maturity model appeals to a higher level of organization than the process focused models (CMM and BPMM) and these can be used as subsets of the project management maturity model as indicated below.

Table 10 Levels and purpose of different maturity models

Model	CMMM (1987)	PMMM (2001)	BPMM (2004)
Level 1	Initial	Common Language	Ad Hoc
Level 2	Repeatable	Common Processes	Defined
Level 3	Defined	Singular Method	Linked
Level 4	Managed	Benchmarking	Integrated
Level 5	Optimizing	Continuous Improvement	Extended
Purpose	Project management, Process management, organizational support, product integration, verification and validation.	Project management, process management	Business process engineering, functional business process management,

2.2.   Outline principles for a maturity model for zero-emission city logistics

The Zero-Emission Maturity Model, which will be developed to indicate the level and eventually the progress of companies towards achieving zero-emission city logistics operations is based on the traditional structure of the reviewed models, however, there are some differences which prevail between the use of the traditional maturity models and their application to the ZECL case, mainly being:

1) The process of gaining maturity also speaks to topics such as innovation adoption theory (Rogers, 1983) which states that there are 5 stages to the adoption of new innovations (i.e. knowledge, persuasion, decision, implementation, and confirmation). Since the implementation of zero-emission technologies is fairly new, companies are still to gain trust in the innovations that come with these technologies.

2) The innovation adoption theory is further bolstered by the AIDA model used in marketing, which outlines the four stages that consumers go through in making a buying decision (i.e. awareness, interest, desire, and action). With the first two stages engaging the customer and gaining their confidence in the product. These four levels take the consumer from not having knowledge of the technology to creating an awareness and highlighting the benefits which the technology could bring.

The resulting ZECL maturity model which is synthesised from the maturity models reviewed as well as the innovation adoption and AIDA model point towards a 6-level model. The innovation adoption models cover the initial two stages (levels 1 and 2) and the existing maturity models then cater to the mature stages (levels 3, 4, and 5). Because of the uncertainty pertaining to the awareness of zero-emission city logistics regulations especially among small to medium businesses whose core operations may not be centred around logistics, there was a need to create a level 0, which is directed towards businesses with no prior knowledge of zero-emission zone implementation. The levels are expanded upon as follows:

- <u>Level 0 Oblivious</u>: an organization in the oblivious stage is unaware of its macro environment and the sustainability issues affecting it, this organization is often blind-sided by developments and plans for the future with an internal orientation. As such, this organization falls under level 0 as they are oblivious to the zero-emission efforts championed by the local municipality in which they operate in.

- <u>Level 1 Awareness</u>: an aware organization is one which knows about the changes in the industry relating to sustainability and how it relates to their operations, however, they are not making efforts that are aligned to the zero-emission policies. There may be individuals or departments who think that perhaps zero-emission logistics does not fall within their scope of work and thus do not look any further, some may even feel that since the government policies are always changing, they will wait until the last minute to implement operational changes.

- <u>Level 2 Interest</u>: organizations who are well informed may decide to explore their options by encouraging individuals within the company to compile plans on how they can implement zero-emission logistics changes within the company. The interest level is where the company decides to make concrete first steps in the direction of adapting their city logistics operations to become zero-emission. Research

is an important aspect of the interest stage as the company will be making comparisons between products that may be beneficial in their quest for minimizing their carbon footprint. Some organizations may even decide to host trial implementations to test options and see whether they can roll out the solution on a wider scale. Managers will also be taking account of what skills are required, budgets, the need for external partnerships and alternatives that will enable them to transition seamlessly.

- Level 3 Managed: once the solutions have been tested, the results need to be noted and the roll out process starts. In the managed stage, what started out as research is being implemented into the day to day operations and the organization is in a state of change and transformation. At this level, it is critical to drill the goals down into key performance indices which are relevant and measured often to ensure the company is progressing towards the logistics and ZECL goals. The managed stage exposes whether the assumptions made in the trials hold up in large scale operations. At this point, the infrastructure becomes central to planning and operations, zero-emission solutions are still being implemented in real life and the extent to which the company can maintain regular operations becomes clear.

- Level 4 Established: the established level is where the changes have become a norm, the organization is wholly aware of zero-emission goals and are working towards achieving their targets daily, this includes the automation of the KPI's that can be automated, freely available trainings for employees, well documented processes such as standard operational procedures.

- Level 5 Optimized: the optimized level speaks to a culture of continuous improvement within an organization. The hiccups have been ironed out and since the organization has well documented processes, they are able to automate as well as provide transparency to those within their supply chain. Optimization also pertains to the uptake of innovation and encouraging the development of complementary systems, for example, off the grid electricity solutions to complement the on grid charging ports for electric vehicles.

In addition to the maturity levels, the model expands into key areas of transformation within the companies. These areas are related to the adoption of technology within a company based on Porter's Value Chain (Porter, 1983). Logistics activities, including city logistics are supported by a number of functions. The maturity model deals with city logistics movements and as such the area of infrastructure as per Porter's model includes the elements of physical infrastructure as well as finance, planning and fleet management. Human resources is then renamed 'personnel' and procurement is explored under the unmbrella of partnership which covers the procurement of goods and services as well as collaboration between companies. due to the technology development not being the core focus of the maturity model, this falls away and the focus of the entire model is then redirected to the adoption of technology as opposed to it's development. The resulting maturity model with it's six areas of transformation and 6 maturity levels.

3. Quick scan for zero-emission city logistics

In order to assess the maturity level of a company, a corresponding quick scan has been developed, that allows (among others) students to examine relevant companies and enables the right amount of information to assess the ZECL maturity level a company is in. A QuickScan is a "participatory modelling tool that links stakeholder and decision-maker knowledge to assessments for policy-making purposes" (Verweij, et al., 2016). In this instance the main stakeholders in consideration are the SMEs conducting business within the designated city centres where zero-emission zones are to be implemented. The QuickScan is used to determine the current ZECL level by conducting on site viewings, taking photographic evidence and hosting interviews with the QuickScan questionnaire, the answers to the questionnaire will determine the levels of each area of transformation which will be indicated on the matrix. The matrices from different companies can then be used for benchmarking in order to have a high level view of how far companies in a certain cities or sector are in their progress towards (as well as their knowledge about) zero-emission city logistics. By determining the maturity level of individual companies, it becomes possible to provide relevant information and advice on how to develop to the next level. Since the purpose of the QuickScan is to provide a high level view of the status quo of zero-emission city logistics efforts by way of providing content to fill in the maturity matrix (see section 3.), it is important to identify what the goals of the QuickScan are for the different stakeholders:

Table 11 Zero-emission City Logistics Maturity Model

Area of Transformation	Level	Personnel	Fleet Management	Operations	Finance	Purchasing	Infrastructure
0	Oblivious	No knowledge of ZECL or any external environmental changes due to ZE regulations	No knowledge of ZECL or any external environmental changes due to ZE regulations	No knowledge of ZECL or any external environmental changes due to ZE regulations	No knowledge of ZECL or any external environmental changes due to ZE regulations	No knowledge of ZECL or any external environmental changes due to ZE regulations	No knowledge of ZECL or any external environmental changes due to ZE regulations
1	Awareness	HR is aware of ZECL however has not explored the impacts of ZE on employees and their skills	Fleet manager has awareness of ZECL, however they have may have reservations. Fleet may comprise of Euro 5-6 trucks (infrastructure)	Operations manager has awareness of ZECL, however they have may have reservations	Finance manager has awareness of ZECL, however they have may have reservations	Purchasing manager has awareness of ZECL, however they may have reservations	There is an awareness of the types of alternative fuels and ZE vehicle fuelling solutions
2	Interest	HR has conducted research on ZECL and identified skills gaps, training needs and capacity requirement.	Fleet manager undertakes research on the types of ZE vehicles and may have purchased a few (<10%) zero-emission vehicles to supplement of the fleet. Fleet may also comprise of new Euro 6 trucks	The operations manager has commissioned a research (by intern, employees or consultancy) on the feasibility of ZECL. There is also possibly a trial implementation, capacity gaps are identified.	The financial need for ZE has been forecasted and a TCO calculation has been completed. Funds are availed for purchasing ZEV	Purchasing manager has conducted research on ZE vehicle types and capabilities. There is also an overview of capacity gaps and subcontractors which can be used to fill those gaps.	The company has researched zero-emission energy providers, the ZE vehicles may already be utilizing public fuelling/charging stations. The fuelling hub applications are lodged
3	Managed	The training needs of the ZECL employees are catered to and employees are open to discuss their progress and issues with the training with HR	Fleet is composed of a couple of ZE vehicles for city logistics use. In addition to mainly Euro 6 trucks.	The outcomes of the research have resulted in a trial implementation which is integrated into the normal operations. There are defined KPI's	Actual ROI becomes clearer vs forecasts. Investments are made in accordance to TCO figures	Vehicle suppliers, mechanics and subcontractors have been found, partnership agreements are signed, operations are running however they may not be fully integrated	There are ZE fuelling points on the company location, continued use of public solutions
4	Established	There are a set series of trainings on ZECL. Staff is knowledgeable about ZE operations.	Fleet is composed of mostly ZE vehicles for city logistics use. The Euro 6 vehicles are being phased out	There are SOP's on the support systems for ZECL (Loading docks, charging stations, planning) ZE trucks are responsible for 60-80% of city logistics. ZECL is integrated into normal operations.	Funds are availed for upscaling ZECL. The ROI on the initial vehicles is monitored	Subcontractors and suppliers are privy to company data in order to improve their operations, there is a level of integration and transparency. Green logistics policies are enforced on subcontractors.	Company utilizes on grid energy solutions, however, is looking towards more sustainable use of this energy.
5	Optimized	ZES is fully integrated into the corporate culture, the ZES vision is fully part of trainings and corporate culture	The City Logistics fleet is completely Zero-emission	KPI monitoring is automated, there is a focus on continuous improvement. 100% of inner city movements are zero-emission. There is a focus on network thinking, therefore shared loads and city hubs become a norm.	Inner city fleet is completely turned over to zero-emission, the project budget is reviewed and the need for further funding for research is assessed	Suppliers and subcontractors are integrated into the companies ERP system and there is a high level of transparency. The subcontractors work in a network	Company utilises a private smart energy solution which optimises lertical energy use.

- Research: Establish the ZEZ readiness of companies and their needs in terms of support from companies and cities. Inform policy-makers of the progress.

- Businesses: Create an awareness and therefore a sense of urgency in preparing for ZEZ in order to avoid supply chain disruptions when changes are implemented. In addition to this, the feedback from the QuickScan will enable companies to establish the next steps they could take in order to level up their organizational readiness

- Municipalities: Obtain a clearer view of the readiness of businesses to comply with policy changes as well as establish the need for support from the private sector in terms of infrastructure and general accommodations.

The QuickScan questionnaire comprises of seven sections which cover the various elements required for a company to reach zero-emission, each section below covers the explanation of the section as well as guidelines for assessing the answers given for some of the questions:

Section 1: General – The general section covers basic information about the company such as the interviewee, company location, the cities they are operational in as well as the company size in FTE.

Section 2: Strategy – Often, a lot can be established about a company's inclination towards innovation and change from their vision, mission and strategy and goals; hence why this is included in the QuickScan.

Section 3: Infrastructure – If the company opts for the use of electric vehicles, hydrogen vehicles, cargo bikes or barges, they need to consider the infrastructure that is required in order to operate these vehicles. This could be: electrical charging poles or loading and unloading docks etc.

Section 4: Personnel – Staffing is important in every organization, their expertise, skills and openness to change and development dictates the direction of the company. Ofttimes going ZE requires training on how to operate the assets, project management, upskilling of staff and possibly the hiring of people who will carry out the new operations. This requires the organization to be ready for change and have a culture of continuous improvement and learning. This section seeks to determine whether the company has educated their staff and championed zero-emission city logistics.

Section 5: Fleet Management and Operations – The best indication of a company's receptiveness of innovation and change is investment and where the investments are being made. This section explores the operational changes undergone by the company to embrace zero-emission operations.

Section 6: Partnerships – It may be necessary for businesses to develop relationships with service providers for the running of their operations, these partnerships may take the form of suppliers, distribution agreements with logistics service providers, load sharing, or outsourcing of parts of the supply chain. In order to establish these partnerships, agreements have to be made between both parties laying out their duties to each other. This section deals with suppliers (electric vehicle OEMs, power companies etc.) and companies who carry out zero-emission transportation.

Section 7: Finance – Capital is required for the purchase and operation of new assets such as those used in zero-emission projects. Funds, subsidies and incentives enable companies to accelerate their progress towards zero-emission, this section seeks to verify whether the company has budgeted for or is willing to pay a premium for zero-emission solutions.

Having developed the ZECL Maturity Model and QuickScan and validated it using interviews with subject matter experts, it was necessary to create a link between business, research and academia, this was done by collaborating with universities of applied science (HBO) for the data collection portion of conducting QuickScans. The students, tasked with conducting QuickScans go into the ZE zoned business districts and identify small to medium sized businesses for interviews and then fill the maturity matrices independently. The results of the first group are discussed in section 4.

4. First results and discussion

The first group to carry out the QuickScan consisted of 12 HBO level students in Rotterdam, the students collectively interviewed 22 small to medium businesses in the Rotterdam ZEZ. During the QuickScan period, these students were questioned about their sentiments regarding the scan using a slide scale ranging from strongly disagree to strongly agree. The students indicated that they agree that the maturity model and QuickScan are relevant and urgent; they also responded that the small to medium enterprises agree to the relevance and urgency of the topic however, the SME scored slightly lower than the students sentiments. The students found the QuickScan easy to understand, however, the execution proved to be a little difficult due to factors such as time, the willingness of business owners to participate and the scope of the interview questions.

When questioned further on how the QuickScan could be adapted, they mentioned that the questions are more suited to larger organizations and the small to medium businesses they interviewed had a lower maturity meaning that some of the questions were on a higher level than what they had attained, feedback was given that the QuickScan could comprise of 6-7 main questions which encapsulate the gist of the research topic and could be drilled down to more specific questions if the enterprise had progressed further to a higher maturity level.

The preliminary results of the QuickScan conducted within the Rotterdam ZEZ has mostly receivers who are working in retail (therefore mostly business to customer) as respondents, the companies were small to medium businesses with an outlier who is a global franchise. In terms of company strategy and goals, very few respondents indicated that sustainability in city logistics is a goal and thus do not have performance indicators tied to ZECL. In terms of vehicle ownership, the majority noted that they own between 1-3 vans using internal combustion engines and those who do not own their own transport

make use of the services of the larger logistics companies in the Netherlands which may or may not use zero-emission vehicles according to their discretion, the small to medium businesses do not expect them to comply to any zero-emission agreements or regulations as long as the goods are delivered timeously. At the moment, the majority of companies in the designated Rotterdam ZEZ are aware about ZECL however, they are not making any changes towards becoming zero emission, in addition to this over half the respondents indicated that they do not know of any subsidy schemes for zero emission vehicles and close to all the respondents said they do not have a budget for zero-emission city logistics operations and they are not prepared to pay a premium for zero-emission city logistics service providers. Overall, the high level average maturity of the small to medium companies seems to be in level 1: Awareness and there is a great need for information to filter down to grass roots level in order for the businesses to better prepare for the ZEZ implementation.

5. Conclusions

A maturity model is a tool used to gauge the progress of business units towards a specific goal, in the case of zero-emission city logistics for companies, this beacon is that small to medium companies manage to transform their city logistics operations to zero-emission by using the available solutions at their disposal before the ZEZ implementation date of the 1st January 2025. In attempting to understand the current state of ZECL adoption, a ZECL maturity model has been created which describes the level by level approach outlining the stages of developing ZECL maturity for businesses in the areas of: personnel, fleet and operations management, finance and partnership. In order to fill this model the ZECL QuickScan interviews are conducted within the areas that have been designated as ZE zones. The useability of the QuickScan as the tool for filling the maturity matrix has been hailed by the students conducting the interviews as useful, allowing them to interact with the real life implications of zero emission logistics regulations and how they are received by the enterprises, however, they have indicated that perhaps the questions are better suited to more mature companies and the respondents find it quite tedious to answer questions on considerations they have not made, especially in light of the time constraints. The results of the QuickScan have indicated a low maturity level (level 0-1) demonstrating a great need for information dissemination among the grassroots businesses not only in the logistics field but SMEs located in the proposed zones which are mostly retailers who have few vehicles and make use of logistics service providers.

Acknowledgements

References

Adriansyah, A., Van Dongen, B. F., & Van Der Aalst, W. M. P. (2011). Conformance checking using cost-based fitness analysis. In Proceedings - IEEE International Enterprise Distributed Object Computing Workshop, EDOC. https://doi.org/10.1109/EDOC.2011.12

Albliwi, S. A., Antony, J., & Arshed, N. (2014). Critical literature review on maturity models for business process excellence. IEEE International Conference on Industrial Engineering and Engineering Management, 2015-Janua, 79–83. https://doi.org/10.1109/IEEM.2014.7058604

Awasthi, A., Adetiloye, T., & Crainic, T. G. (2016). Collaboration partner selection for city logistics planning under municipal freight regulations. Applied Mathematical Modelling, 40(1), 510–525. https://doi.org/10.1016/j.apm.2015.04.058

Burke, A., & Miller, M. (2020). Developing Zero-Emission Bus and Truck Markets Will Require a Mix of Financial Incentives, Sale Mandates, and Demonstration Projects. Davis, California: Institute of Transportation Studies.

Constantinescu, R. (2007). Reliability and Quality Control-Practice and Experience CAPABILITY MATURITY MODEL INTEGRATION. https://www.jaqm.ro/issues/volume-2,issue-1/pdfs/constantinescu_iacob.pdf

Crainic, T. G., & Montreuil, B. (2016). Physical internet enabled Hyperconnected City Logistics. Transportation Research Procedia, 12, 17–19. https://doi.org/10.1016/j.trpro.2016.02.074

Dumas, M., La Rosa, M., Mendling, J., & Reijers, H. A. (2013). Fundamentals of Business Process Management. Fundamentals of Business Process Management. https://doi.org/10.1007/978-3-642-33143-5

Fowler, M. (2014). MaturityModel. https://martinfowler.com/bliki/MaturityModel.html

Hacken, H. (2017). Research Framework - an overview _ ScienceDirect Topics. https://www.sciencedirect.com/topics/computer-science/research-framework#:~:text=Research Methodology&text=Research framework will be for,be followed in this study.

Kerrigan, M. (2013). A capability maturity model for digital investigations. Digital Investigation, 10(1), 19–33. https://doi.org/10.1016/j.diin.2013.02.005

Kim, D.-Y., & Grant, G. (2010). E-government maturity model using the capability maturity model integration. JSIT, 12(3), 1328–7265. https://doi.org/10.1108/13287261011070858

Mccormack, K. (2004). The development of a supply chain management process maturity model using the concepts of business process orientation. Supply Chain Management: An International Journal, 9(4), 272–278. https://doi.org/10.1108/13598540410550019

Netherlands Enterprise Agency. (2019). The National Charging Infrastructure Agenda. Den Haag: Rijkswaterstaat.

opwegnaarzes.nl. (2021). Municipalities take a formal decision to introduce a zero-emission zone: On the way to ZES. https://opwegnaarzes.nl/actueel/nieuws/gemeenten-nemen-formeel-besluit-voor-het-invoeren-van-een-zero-emissiezone

Paulk, M. C., Curtis, B., Chrissis, M. B., Bamberger, J., Kasse, T. C., Konrad, M., Perdue, J. R., Weber, C. V, Withey, J. V, & Averill, E. L. (1991). AD-A240 603 Capability Maturity Model for Software.

Porter, M. E. (1983). Competitive Advantage: Creating and sustaining Superior Performance. Macmillian.

Rijksoverheid. (2019). Nederlandse Klimaatakkord. Den Haag: Rijksoverheid.

Rijksoverheid. (2020). Uitvoeringsagenda Stadslogistiek. Rijksoverheid.

Rogelj, J., Den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K., & Meinshausen, M. (2016). Paris Agreement climate proposals need a boost to keep warming well below 2 °c. Nature, 534(7609), 631–639. https://doi.org/10.1038/nature18307

Rogers, E. (1983). Diffusion of Innovations,.

Schwalbe, K. (2013). An introduction to project management. In Nursing Management (Vol. 50, Issue 10). https://doi.org/10.1097/01.NUMA.0000580584.07510.9b

United Nations. (2015). Paris Climate Agreement. Paris: United Nations.

Van Looy, A., De Backer, M., & Poels, G. (2010). Which maturity is being measured? a classification of business process maturity models. CEUR Workshop Proceedings. https://www.researchgate.net/publication/266409817_Which_Maturity_Is_Being_Measured_A_Classification_of_Business_Process_Maturity_Models

Van Looy, A., De Backer, M., Poels, G., & Snoeck, M. (2013). Choosing the right business process maturity model. Information and Management, 50(7), 466–488. https://doi.org/10.1016/j.im.2013.06.002