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Risk-aware roadmapping for city logistics in 2025

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Abstract. This paper proposes a scenario based, multi-stakeholder, adaptive pathway approach, with an application for city logistics policies in 2025. The context of our application is the problem of limited sustainability of current freight transport practices in cities towards the long term future. We develop a multi-stakeholder roadmapping approach for this problem, that can deal with contextual uncertainties, framed in scenarios of the future. With this approach, problems identified by stakeholders can be translated into effective policies. The different perspectives of stakeholders and the time sensitivity and interdependence of their actions are accounted for explicitly in this approach. The roadmap includes a graphical representation that can be used for communication and policy design purposes.

Keywords: Roadmapping, Pathway, Scenarios, City Logistics

1 Introduction

In the Netherlands, city logistics is a domain that is on a turning point of change. Slowly the awareness is increasing that urban freight distribution does not meet the targets in terms of liveability [1]. It has become common knowledge that urban freight transport is of great importance in maintaining the economic vitality of the city. However, the negative impacts seem to outclass the benefits of urban freight transport [2]. In November 2014 the Dutch government, the local government and various logistics parties signed a covenant: the Green Deal Zero Emission Stadslogistiek (=City Logistics), Green Deal ZES [3]. The cooperating parties aim to develop and to intensify their activities towards zero emission city logistics in 2025. Despite this covenant and good intentions of the parties, there is absence of significant changes [4]. Various studies show city logistic concepts that can contribute to the liveability in the inner city [5]. However, due to a lack of coordination, it is not clear which stakeholder is responsible for what action and when to act in time. Uncertainty about the future is a major concern of all parties involved.

The focus of this paper is on the development of a city logistics roadmap under conditions of uncertainty. Strategic roadmapping for city logistics may help to coordinate the possible actions. Various techniques are available for supporting policy planning under deep uncertainty, for example robust decision making, decision trees, roadmaps, and several policy planning approaches [6]. Here, we aim to demonstrate

how to cope with uncertainty in the development of a strategic roadmap. According to Ilevbare et al. [7] there is a general lack of attention to uncertainty across the majority of published roadmaps, although uncertainty and risks are fundamental aspects of strategic planning [8]. By including uncertainty in the roadmap, we expect that the likelihood will increase that the roadmap will be respected by all stakeholders. In the Dutch case, we hope that the use of scenarios in roadmapping will level the intentions for urban freight transport with the GreenDealZES covenant's propositions.

The structure of the paper is as follows. Chapter 2 describes the literature review about the lack of inclusion of risks and uncertainty in roadmapping and elaborates on the theory used. Chapter 3 explains the scenarios for city logistics and shows the developed roadmap for City Logistics 2025 in the Netherlands. Chapter 4 provides our conclusions.

2 Uncertainty in roadmapping

Roadmapping is a powerful and flexible technique for supporting strategic planning. The roadmap template is used to capture, structure and share knowledge about the area of interest. A roadmap provides a tool for identifying and assessing strategic issues, leading to agreement among decision makers on appropriate actions [9]. Roadmapping (and its many derivatives) is one of the most used management tools for supporting innovation and strategy. Roadmaps are used at companies, sectors and national levels [10]. Roadmaps are mostly represented in a layered structure of solution strategies together with a dimension of time or used for illustrating the sequence of actions in time [11].

Embedding uncertainty and risk in roadmaps is called 'risk-aware roadmapping'. A striking observation therefore is that strategic planners do not take uncertainty into account. Ilevbare et al. [7] examine 650 roadmaps in the public domain. Only 10% of those roadmaps contain uncertainty or risk. Eleven of these roadmaps apply scenario techniques to deal with uncertainty or risk. Nevertheless, there are growing efforts to develop methods and processes to support and to inform adaptive decision making [12]. These efforts have focused on developing techniques and tools for dealing with uncertainty, risk and time horizons. Ranger et al. [13] developed decision centred approaches that provide guidance on scoping problems in complex settings. The decision centred approaches identify relevant information for selecting decision making methods that are appropriate to the level of uncertainty. They also provide approaches for incorporating adaptation principles and heuristics. An example of adaptation principles and heuristics is developed by Hallegate [14].

In order to overcome the lack of including uncertainty in roadmaps, this paper seeks for a framework that can improve the use of the roadmap. The approach based on the Dynamic Adaptive Policy Pathway framework [6]. Uncertainty is dealt with by including scenarios for the future. To deal with roadmapping in deeply uncertain sectors, one can design dynamic adaptive plans [6, 13, 14]. To create a dynamic plan, a strategic vision of the future is required, and short-term actions will guide future actions. The roadmap is designed according the framework (Fig. 1).

Fig. 1. Framework for the development of Dynamic Roadmaps (adapted from [6])

The Dynamic Roadmap framework contains the following steps:

1. *Current situation*: understand the current issues and define objectives of stakeholders.
2. *Scenarios*: Identify the vulnerabilities and the opportunities that should be mapped, this can be done by using scenarios.
3. *Identify actions*: brainstorm about actions that are needed to achieve the targets.
4. *Develop Pathways*: describe the sell-by date of the actions and tests the impact of the actions.
5. *Select Pathways*: determine the sequence of actions (a pathway) and put the measures in a preliminary order to prevent lock-ins.
6. *Monitor*: a monitoring system with related contingency actions to keep the plan on the track of a preferred pathway.

In the next section we describe the elaboration of these steps that was done to define pathways in the roadmap for city logistics in the Netherlands in 2025.

3 Case: The Future of city logistics in the Netherlands

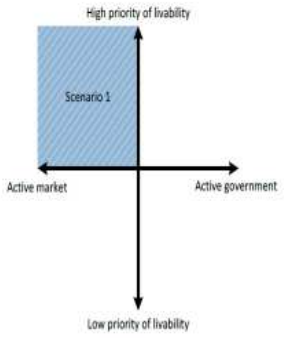
This section shows the results of applying the framework for the development of dynamic roadmaps for the future of city logistics in the Netherlands. Each step of the framework is briefly explained and the roadmap is presented.

Current situation

It is well known that the domain of city logistics has many stakeholders. Stakeholders include shippers, carriers, shop owners/retailers, municipalities, and consumers. The city logistics system faces a complex challenge due to multiple objectives, including broadly: low impact on city liveability (environment, noise, vibrations, congestion, safety and city scape), an efficient logistic process (fully loaded vehicles and the concept of 'sending customers'), and an appropriate service level for the receiving customer (delivery on-demand, flexible same-day-delivery).

Building scenarios

For generating accepted future scenarios, several steps need to be taken, in order to explore potential problems for the stakeholders in the future. Schwartz's [15] view on scenarios is that the future is uncertain, but that the use of scenarios can help to prepare for it. Scenarios assemble possible futures in story form to help you make better decisions. This statement is aligned with the proposition that scenarios can be used for 'risk-aware roadmapping'. The scenarios are used to secure risk-aware roadmapping, since the scenarios cope with (different) uncertainties. From interviews it is perceived that the role of the government seems the most dominant uncertainty factor for the stakeholders in the field. They are not sure how important the attention for liveability will be and how actively the government will interfere in the market Therefore these two factors are used as a starting point to describe a number of plausible futures. To cover the uncertainty of these factors a maximum and minimum scenario are defined to ensure the boundaries of potential outcomes. Additionally the scenarios can contain some other future state uncertainties related to technology adaptation, the economic situation, and some social parameters to provide a clear distinctive picture of the future for each scenario. Each scenario is located in a different quadrant of the matrix and gives insight for the stakeholders of city logistics in the pitfalls they have to overcome, the vulnerabilities of the system and the potential opportunities there are. They are able to test whether the robustness of their operations is sufficient to deal with these futures. The objective of the scenarios is that stakeholders use it in their design to consider how they can make robust logistic systems. In the case of city logistics the scenarios were reviewed by experts of the sector to check whether the main uncertainties are covered in the scenarios. They provided feedback on preliminary scenarios to improve the validation of the scenarios. The matrix in Figure 2 provides the position of the four orthogonal scenarios in the urban logistics roadmap *(Fig. 2)*:



Objectives local governments
Market force is leading
Facilitate start-up incubators
Accessible city

Criteria	Change
Number of vehicle movements	+ 20 %
Emission op PM10 and NOx	+ 5 %
Emission of CO_2	+ 10 %
Number of residents in city	+ 20 %
Number of retailers	- %
Insecurity (# accidents)	+ 10 %

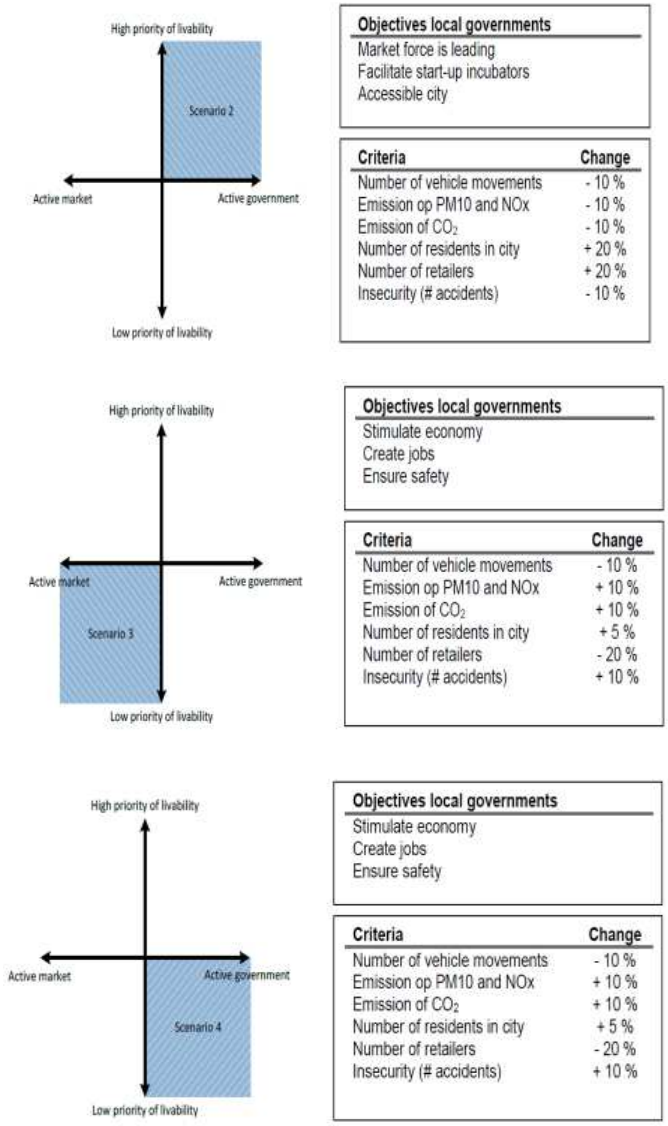


Fig. 2. Four Scenarios based on the uncertainty factors: the role of the government and the attention for liveability

The resulting scenarios are briefly described (A more detailed description of the scenarios can be found in [16]):

- *Conscious Entrepreneurship* is dealing with city logistics in an environment with high priority for liveability and acts mainly as a market that should meet the expectations of high standards in the city.

- *Pragmatic Governance* where the difference compared to scenario 1 is that the government is interfering actively by means of adoption of measurements and facilitating platforms.
- *Shop Vacancy* deals with a society that is not mainly concerned with the liveability in the city. There are other problems to focus on than improving the standards, but if there is an improvement, it is initiated by market forces.
- *Resilient Logistics* deals with an environment where standards of living are not the main concern. External events force the government to focus on other issues in society. The scenarios were provided as a case to design roadmaps taken the developments described in the scenarios into account to deal with uncertainties over time.

Identify Actions, Develop Pathways and Select Preferred Pathways

The steps Identify Actions, Develop Pathways and Select Preferred Pathways are bundled here in one research activity because the results of these steps are obtained in one intensive workshop. The workshop participants all were actor representatives from the city logistics domain: 2 carriers, 2 municipalities, 2 shippers, 2 retailers, 1 city hub and 2 consumers/inhabitants.

The workshop is subdivided in four rounds. These rounds help to make clear what the deliverables are and provided a step-by-step approach for the intended results. In the first round the participants have to mention the vulnerabilities and problems for the logistic system in their scenario case. The problems and vulnerabilities are drawn on sticky notes, clustered per problem owner in city logistics. The second round covers the solutions and action strategies to deal with the vulnerabilities. Again, these actions are clustered per stakeholder. In the third round the participants design a precursor of the dynamic roadmap. The participants are asked to think about the sequence of the action strategies and stick them to a timeline. The final and fourth round, people from different cases could reflect on the timeline with actions of other cases. During the reflection the reviewers have the opportunity to add extra intervention strategies to the preliminary roadmaps. The roadmaps can now be drawn.

Explanation of the map with pathways (Fig. 3): The coloured lines represent the identified strategies of the stakeholders. The colour of the line reflects the contribution of the strategy to the liveability in the city. A green colour corresponds to a sustainable development of city logistics, ranked with number 1. Yellow corresponds to rank 2 strategies, orange to rank 3 and the red lines correspond to non-improving strategies, ranked with a 4. The transparent lines in the figure are plausible moments a strategy can start. However, it is not recommended to start yet, since it may exclude other strategies. Another element in the map is the length of the lines. The length of the line corresponds to the sell-by date of the strategy. It shows how long the strategy is effective to meet the liveability targets of the Green Deal ZES. The lines end with vertical black stripes. These stripes indicate the point that strategy does not meet the targets anymore. This is called the 'Tipping Point' of the strategy. The strategies contain white dots, which represents a 'Transfer Station' to another strategy. Connecting the strategies via transfer stations results in a metro looking map of pathways. The last element in the map is the grey arrow. The arrow indicates a logical subsequent strategy after a chosen strategy.

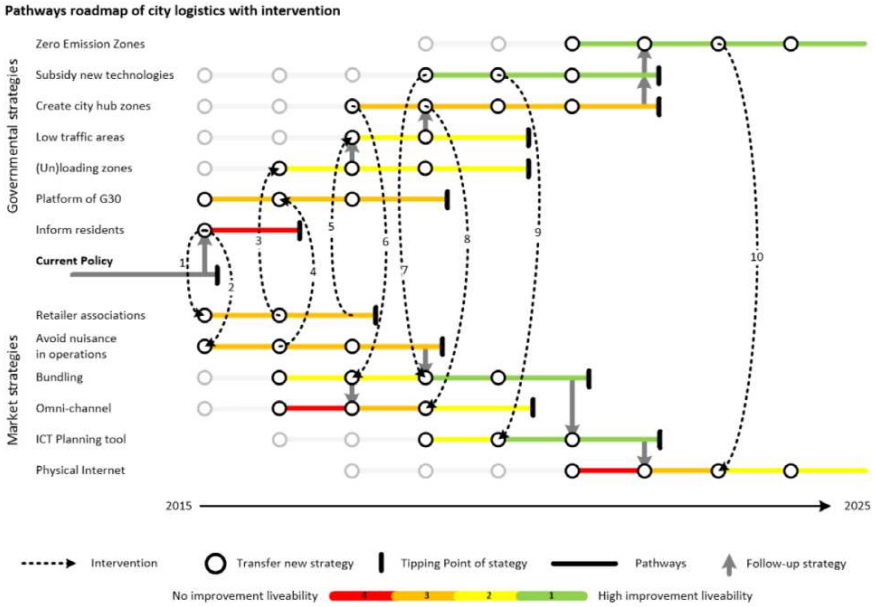


Fig. 3. Strategic Pathways Map of City Logistics [16]

First the market strategies are elaborated. Retailers can start cooperation directly, without any interference of other parties. The retailers start to cooperate, some improvements of the urban environment can be realized via agreements between retailers concerning waste, loading times, and so on. Also avoiding nuisance in operations can take place without many interferences. Carriers and retailers can agree upon delivery moments, avoiding shopping hours for example. Both strategies are orange coloured. Market parties can also start autonomously with bundling and omni-channel shopping. Both actions need alignment between market parties. Bundling of freight reduces the vehicle movements in the city, so it is a substantial improvement of the liveability. Bundling of freight does not imply that the goods are distributed with (for example) electric vehicles. The bundling strategy turns green at the point where commercial parties collectively start to bundle freight in order to avoid nuisance. This increases the impact on the urban environment significantly. Omni-channel shopping might impact the liveability in a negative way, possible more vehicle movements are needed to provide goods to the consumers. The omni-channel line is therefore red. It is also more likely to happen that first goods are bundled before retailers start with omni-channel shopping concepts. In combination with bundling it will slightly improve the urban environment and the colour is now orange.

The final two strategies concern planning alignment. A general ICT planning tool can be developed by transporting parties. The planning tool can help to increase the load factor of trucks, which results in less vehicle movements. The colour of the planning tool strategy is yellow. When the planning tool is combined with the bundling strategy, it turns green. The Physical Internet strategy is named at the bottom of the map, implying that it costs the most effort to realize. The risk of Physical Internet is that is hard to monitor and control the transporting parties of the freight.

There is even a higher risk that Physical Internet leads to an increase of vehicle movements and a decrease of the load factor. The colour of the line is therefore red. If it is combined with a general planning tool, it may result in a little improvement of the vehicle movements and the strategy turns orange after a while.

The upper part of Figure 3 contains the governmental strategies. The first step of the map is informing residents by the local authorities, aiming to make residents aware of the urgency of a liveable city. This strategy is coloured red, since informing people does not affect the liveability in the city directly. Local authorities can also start with a dedicated platform for transport to align policy with other municipalities. The G30 (the 30 biggest municipalities in the Netherlands) can support the city logistics with the development of a uniform transport policy in different municipalities, which is beneficial for carriers. The platform strategy is ranked 3 and has therefore the orange colour. Governments can also opt for concentrating activities by setting loading and unloading zones. Following that measure the government can appoint low traffic zones in the centre. Shopping people experience reduced annoyance levels due both strategies, so the lines are yellow. The government can also set up zones for realising city hubs. Only one hub does not influence the liveability in the city, but it lowers the market threshold to start using city hubs. Creating zones for city hubs is therefore coloured orange.

Subsidy is an expensive measure, but may result in more sustainable resources for city distribution. Providing subsidy for innovative technologies does improve the liveability in urban area, so it is a green line. After a couple of years of subsidy, the government can start locking the city centre for conventional vehicles. Zones that only allow zero emission vehicles will push the market to invest in green vehicles. No emission in the centre is good for the urban environmental pollution and does contribute to the liveability of the city centre. Therefore the measure of Zero Emission Zones is also coloured green.

Monitor

The local government is able to influence the process of change of the distribution of urban freight. The municipality has mitigating, hedging and seizing actions (represented by the numbered, dotted arrow lines) to shape the logistics system in urban areas. These actions of the government can help to improve the basic map and to make it more robust [6, 17].

4 Conclusions

Using scenarios in a workshop environment is extremely important for ‘risk-aware roadmapping’. The capital gain of risk-aware roadmapping using context scenarios strongly depends on the workshop configuration.. The degree in which the context scenarios are used in developing pathways determines the risk-awareness and thus the robustness of the roadmap. Additional the right selection (diversity) of participating stakeholders is a critical factor for the quality of the pathways. Meanwhile it is observed that the dynamic roadmaps will not only support the strategical planners in their goalsetting/reaching but also the roadmapping process brings people together of different responsibilities, sharing information and perspectives. Our approach allowed

us to develop a first pathway roadmap of city logistics to improve the liveability in 2025 in the Netherlands covering the uncertainties about the participative role of the government and the attention for liveability. The pathway roadmap clearly visualises how the government and market actors can strategically interact to reach different levels of liveability. For the policy practice The green line pathways could be used as leading policy paths to support the goals of the Green Deal covenant..

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