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Trends and Potentials of City Logistics Concepts in the Age of E-Commerce from a Sustainability Perspective

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Abstract:
The ever-growing populations of cities cause the need of solution finding when it comes to urban logistics or city logistics. Customers demand convenient delivery that meets their needs and rising expectations. Especially in case of the steady growth and development of e-commerce, the fragmentation or "atomization" of deliveries is an increasing burden for urban infrastructure. As a result, the traffic in cities suffers from rising parcel deliveries which in turn impairs the sustainability of city logistics in general. Currently, a range of concepts, that targets the solving of city logistics problems, does exist or is developed. This paper aims to display the variety of city logistics concepts.

1 Introduction

Along with the steady-growing world population, the share of citizens living in cities increases continuously. For instance, in the year 2050 the share of urbanites will rise up to approximately 84% in Germany.[1] For that reason, existing city infrastructures will face enormous loads. More serious saying, it is allegeable that current infrastructures cannot cover the increasing level of transport in cities in the future. Urbanization therefore causes several challenges due to the rising population density. People become more and more aware of the effects of urbanization in their daily lives.

Next to freight traffic, private and public transport compete for space on the roads of cities which leads to a higher traffic volume and finally to traffic congestions (cf. Crainic et al. 2009: 1). Furthermore, a decrease of quality of life in the cities is remarkable due to noise and air pollution caused by urban traffic (cf. Crainic et al. 2009: 1). One of the most important challenges is the enhancement of efficient transportation of persons and freight with a simultaneous reduction of its negative outcomes like congestion or pollution (cf. Benjelloun et al. 2009: 1).

Despite the rising urban population and its impact due to individual and public transport itself, consumption patterns as well as consumer behavior play a decisive role in terms of urban freight transportation. Nowadays, e-commerce has become a common way of consuming. From the year 2009 to 2013, the share of e-commerce from the whole retail turnover in Germany has climbed from 7.3% to 11.3%[2]. The consequence is the rising frequency of deliveries in logistics which accompanies an increasing atomization of order sizes. Weltevreden (2008) ascertains that the "[…] increasing popularity of online shopping leads to a growing amount of delivery vehicles in residential areas to deliver the packages to consumers' homes." (Weltevreden 2008: 639). Likewise, we claim that there will be a co-existence of stationary trade and e-commerce in the future which leads to even reinforced burdens for urban freight transportation.

2 Theoretical background

2.1 City logistics and urban logistics

Consulting the different literature about city logistics it is ascertainable that the term city logistics is not defined consistently. Moreover, the term urban logistics is used synonymously. Krampe (2012) defines the object of city logistics as the dimensioning of supply and disposal channels, and their legal, organizational and technical design (cf. Krampe 2012: 424). Thoma (1995) distinguishes between city logistics in the narrower sense as the supply and disposal of goods in inhabited and busy areas, and the term regio logistics that describes city logistics in the broader sense, that means the supply and disposal of goods in agglomerations (cf. Thoma 1995: 56). "The City Logistics concept has emerged as a new, comprehensive way to address this issue and mitigate the negative effects of increasing freight volumes moving in cities, while not penalizing the city's many activities: economic, social, administrative, cultural, touristic, and so on." (Benjelloun et al. 2009: 1). Crainic et al. (2009) state that "City Logistics aims to reduce the

[1] Cf. http://de.statista.com/statistik/daten/studie/167166/umfrage/prognose-des-bewohneranteils-nach-wohnstandort-seit-1990/

[2] Cf. http://de.statista.com/statistik/daten/studie/201859/umfrage/anteil-des-e-commerce-am-einzelhandelsumsatz/

nuisances associated to freight transportation in urban areas while supporting the economic and social development of the cities." (Crainic et al. 2009: Abstract).

In this paper, the term city logistics subsumes different concepts that aim the reduction of the traffic load in cities caused by urban freight transportation.

2.2 E-commerce and e-business

Lots of contributions defining the term e-commerce have been made in the literature. Gunasekaran (2002) states that e-commerce can be defined as a process area that covers buying, selling and trading of products, services and information with the help of computer-based networks, especially the Internet (cf. Gunasekaran et al. 2002: 186). In this paper, e-business comprises e-commerce. "'E-business' is applied as a broader term encompassing e-commerce but also including all electronic transactions within an organization." (Chaffey 2009: xiv). In addition, Swaminathan and Sridhar (2003) define e-business as a business process for doing business transactions via electronic media (like the Internet), (cf. Swaminathan, Sridhar 2003: 1389). "The e-business landscape contains two major divisions, (1) consumer-oriented activity and (2) business-oriented activity, both supported by (3) the e-business infrastructure. Consumer-oriented activity comprises business-to-consumer, government-to-consumer, and consumer-to-consumer activity. Business-oriented activity comprises business-to-business, business-to-government, and government-to-business activity." (Geoffrion, Krishnan 2001: 9).

2.3 Sustainability

The subject sustainability becomes more and more important in any conceivable case. First mentioned within the UN report in 1987, Brundtland defines sustainable development with seeking to meet the needs and aspirations of the present with parallel ensuring the ability to meet those of the future (cf. Brundtland 1987: 51). One method to classify sustainability is the triple bottom line (TBL) approach which acts as a holistic concept integrating an environmental, an economic and a social perspective within the approach of sustainability (cf. Savitz 2006: viii). The focus of the ecological component lies on the impact of an organization's activities on natural systems, mainly the consumption of all natural resources. The economic component aims for the creation of long-term profitability and tries to evoke alternative financial measures like intellectual capital. Furthermore, the social component represents all influences of the enterprise on the social system and therefore contains all social-related aspects like social justice, preferences of stakeholders or labor rights (cf. Jamali 2006: 811).

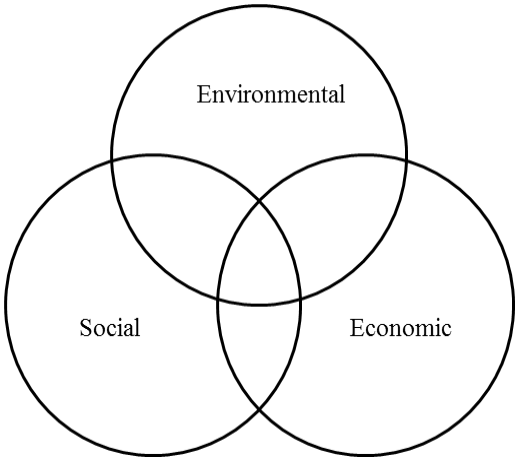

Fig. 1: Classic dimensions of sustainable development (source: own illustration following Tanguay et al. 2010: 408)

3 Chances and challenges of e-commerce from a logistics point of view

Metaphorically spoken, logistics acts as the backbone of e-commerce processes (cf. Delfmann et al. 2002: 203). It is not deniable that one of the most important impacts and reasons for failing e-commerce companies is the lack of efficient logistics. The role of logistics is a key success factor in the field of e-commerce because not only the price influences the customer's purchase decisions but also the speed of delivery. Otherwise buying from online shops is not considered to be a reasonable alternative to the stationary trade (cf. Gunasekaran et al. 2002: 193). Logistics service providers are facing chances and challenges simultaneously. On the one hand, e-commerce means a significant expansion of business activities for logistics service providers but on the other hand the handling of delivery for e-commerce and for stationary trade at the same time challenges them. As an effect, different business concepts with different requirements have to be managed in the same company. Another aspect deals with the increasing number of failed deliveries since customers are often not at home during delivery times of packages. Consequently, the packages need to be redelivered, returned to a post-office or even to the sender which leads to extra delivery cost anyway (cf. Weltevreden 2008: 639).

4 Concepts and trends of city logistics

Currently, an extensive variety of city logistics concepts does exist. They overlap each other in terms of functionality, means of transport and so forth. We attempt to define two categories to differentiate the concepts by means of movement. They are namely "mobile" and "stationary". We put the concepts into two trend-funnels with the dimensions "relevant today" and "relevant in the medium- and long-term", cf. Figures 2 and 3.

The concept e-mobility describes the distribution of urban freight via electric vehicles. The drone, presented mainly by Amazon[3] and DHL[4], is assessed to be relevant in the medium-term time horizon.

[3] Cf. http://www.forbes.com/sites/gregorymcneal/2014/07/11/six-things-you-need-to-know-about-amazons-drones/
[4] Cf. http://www.welt.de/wirtschaft/article122747484/DHL-testet-erstmals-Paketlieferung-per-Drohne.html

Whereas the cargo bike (cf. Kloosterman 2010: 25 f.) and the cargo tram (CarGo Tram Dresden, Germany) (cf. Arvidsson, Browne 2013) are already in operation. The term crowd logistics subsumes "[…] crowdsourcing first-and-last-mile activities, using employee tweets for flexible re-routing, and using social network mining as a trigger for new products, significantly impacting costs, flexibility, and CO2 efficiency."(DHL Customer Solutions & Innovation 2013: 12). Finally, we classify the Dabbawala, a food-providing service from Mumbai, India based on the cooperation of thousands of workers (cf. Agrawal 2009: 81) in the center of the trend-funnel.

Switching to the second trend-funnel, we focus different kinds of city logistics concepts which are stationary that means immobile. The Tower24 was a pick-up terminal in Dortmund, Germany. Customers were able to pick-up their parcels around the clock.[5] DHL's parcel box (Paketkasten)[6] is a simple but highly effective city logistics solution for private properties. In contrast, the Packstation[7] by DHL provides a public service for receiving and sending parcels 24 hours. Another concept represents the shop PUDO (the compound term is invented by the authors of this paper). PUDO stands for pick-up and drop-off point and means a location, that offers a parcel pick-up and drop-off service[8] but has a completely different core business. Examples are small, local shops or petrol stations. An established city logistics concept is the freight village that keeps large truck loads outside the peripheries of the cities. The integrated mall is an architectural innovation and conglomerates the function of shopping malls and logistics centers.[9] We describe the integrated mall as a future concept to combine stationary trade and e-commerce. The customer has the opportunity to pick up his online-ordered goods at the integrated mall.

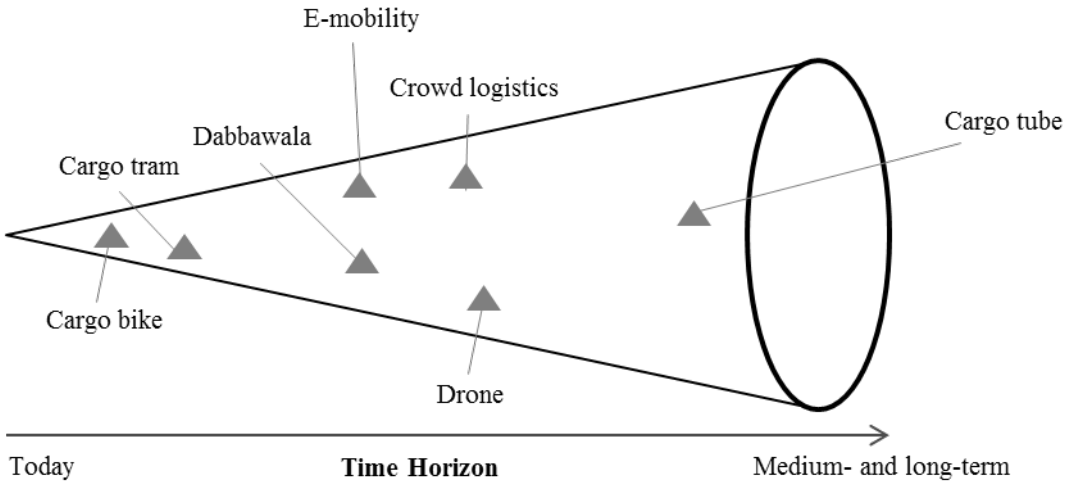

Fig. 2: Trend-funnel with mobile city logistics concepts (source: own illustration)

[5] Cf. http://www.cio.de/news/cionachrichten/805063/
[6] Cf. https://www.paket.de/paketkasten
[7] Cf. http://www.dhl.de/de/paket/pakete-empfangen/packstation.html
[8] Cf. http://www.parcelholders.co.uk/PUDO
[9] Cf. http://www.ris-logis.net/Gruene_Logistik/zukunftskonzept_EEELZ.htm

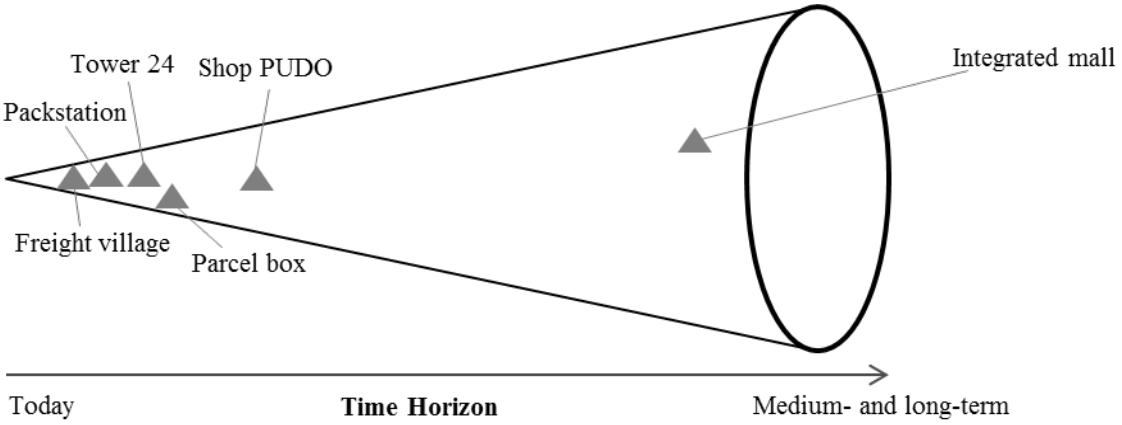

Fig. 3: Trend-funnel with stationary city logistics concepts (source: own illustration)

5 Development of sustainability criteria for city logistics concepts

As mentioned in chapter 2, sustainability is viewed from environmental, economic and social perspectives. To assess city logistics concepts in the context of sustainability, certain criteria need to be identified. Previous works by Hausladen et al. (2013) derived a set of criteria dedicated to the three TBL dimensions serving as an analysis framework to assess the contribution of emerging IT solutions like cloud computing or business intelligence to sustainable logistics processes (cf. Hausladen et al. 2013: 164).

Concerning sustainability assessment in urban areas, several sets of criteria using the TBL approach were proposed and identified (cf. Sahely et al. 2005: 77; Tanguay et al. 2010: 411). To keep a certain balance among the dimensions and for sake of simplicity (cf. Tanguay et al. 2010: 415), three equally weighted criteria are suggested for each dimension of sustainability which may follow a generic character, i.e. acting as an umbrella term for several sub-critera. Furthermore, a connection to logistics solutions needs to be established since city logistics concepts are intended to be assessed.

Following the proposition of Sahely et al. (2005), the most important criterion concerning the environmental pathway is resource use. That includes the usage of construction materials, energy usage and land use for buildings and transportation (cf. Sahely et al. 2005: 77). The emission of greenhouse gas (GHG) marks the second criterion and clearly conveys the message to reduce these substances. If electric energy is used, we assume a production of green electricity where no GHG is emitted. Furthermore, the operation of the city logistics solution is considered and not the production of vehicles used for this solution. Other emissions as the last environmental criterion addresses residual emission types such as noise, light and other pollutive substances which may harm the environmental infrastructure in cities. Coming from an economic perspective, a long-term orientation of profitability must be postulated to maintain economic sustainability (cf. Wu, Pagell 2011: 578). Moreover, cost aspects need to be investigated in detail to ensure the financial sustainability of city logistics concepts as well. That results in investment costs as the second economic criterion for setting up the city logistics concepts and, as a third criterion, operating costs subsuming all costs occurring when distributing items within the system of the

city logistics concept. Healthcare and safety are often suggested as measurement criteria for the social dimension of sustainability (cf. Tanguay et al. 2010: 411; Hutchins, Sutherland 2008: 1688), but are subsumed due to the general approach of city logistics under the criterion quality of life. A second criterion aims at the impact on the city structure and should express potential changes and alterations induced by the implementation of the city logistics concept. To complete all nine criteria, concerns resulting from computer science are enunciated by data security and exploitation. Here, data privacy and unauthorized data usage are focused, albeit only in a B2C context in which private data are of relevance.

6 Sustainability-potential-analysis and classification of city logistics concepts in a portfolio

In the following, the city logistics concepts presented in chapter 4 are assessed in terms of sustainability by using the TBL oriented criteria explained in chapter 5. Here, we use a quasi-quantitative matrix method to assess the degree of sustainability of every city logistics concept in intervals of 25%. Finally, all nine sustainability criteria are weighted equally to obtain a balanced impression of sustainability within the TBL context. Table 1 shows the assessment matrix and the resulting degrees of sustainability.

Table 1: Sustainability-potential-analysis of city logistics concepts (source: own illustration)

	Environmental			**Economic**			**Social**			
	Re-source use	GHG emis-sion	Other emis-sions	Long-term ori-entation	Invest-ment costs	Opera-ting costs	Quality of life	Impact on city structure	Data security	Ø [%]
Cargo bike	●	●	●	◔	◔	◔	●	●	●	92
Cargo tram	◐	●	◔	◐	◕	◐	◔	●	●	69
E-mobility	◔	●	◔	◔	◐	◔	◔	◔	◔	75
Dabba-wala	●	●	●	●	◔	◔	●	●	◔	92
Drone	●	●	◐	◐	◐	◔	◕	●	◐	67
Crowd logistics	●	●	◔	●	◔	◔	◔	●	◐	83
Cargo tube	◕	●	●	◐	○	◐	●	◔	●	67
Pack-station	◔	●	●	●	◔	◔	●	◔	◔	86
Parcel box	●	●	●	●	●	●	●	◔	●	97
Tower24	◐	●	●	◐	◕	◐	◔	◐	◔	64
Shop PUDO	●	●	●	◔	◔	◔	●	●	◔	89
Freight village	○	◔	◐	◔	◕	◐	◕	◐	●	50
Integrated mall	○	◔	◔	◔	○	◐	◔	○	◔	47

The last step of the analysis combines the trend-funnels for city logistics concepts and the sustainability-potential-analysis within two portfolios. Figure 4 shows the portfolio for mobile city logistics concepts and figure 5 for stationary approaches.

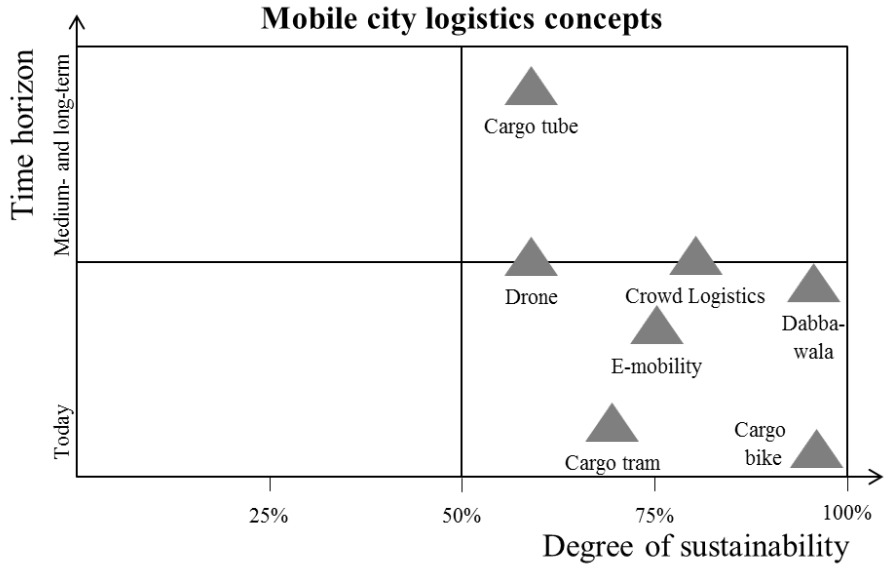

Fig. 4: Combined portfolio for mobile city logistics concepts (source: own illustration)

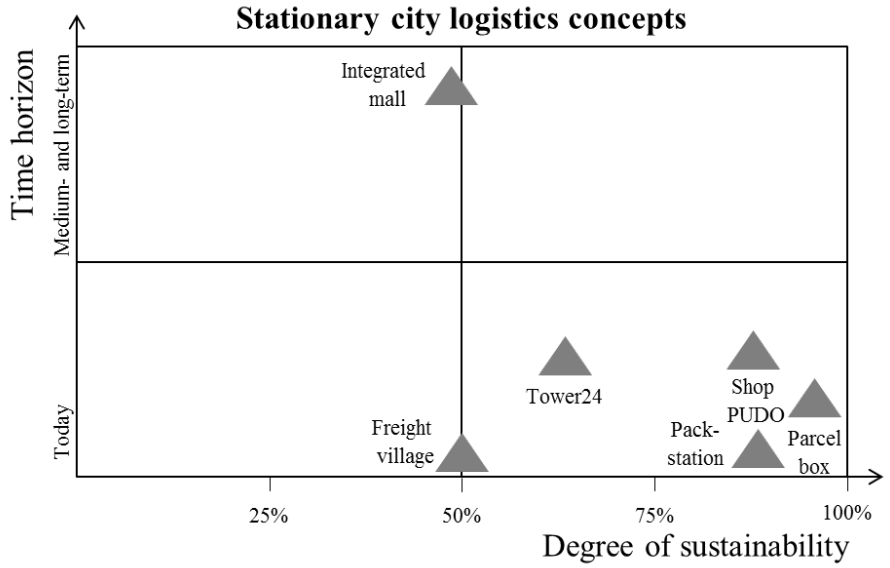

Fig. 5: Combined portfolio for stationary city logistics concepts (source: own illustration)

The combined portfolios enable to draw conclusions about the potentials of different mobile and stationary city logistics concepts.

For the application and implementation ideas for the city of Leipzig the city logistics concepts out of the lower right quadrant of the combined portfolios, which are up to now not realized in Leipzig, are taken into consideration.

7 Application ideas for the city of Leipzig

The following reflections represent application ideas of the paper's authors. Two solutions each out of mobile and stationary city logistics concepts are selected for the city of Leipzig. Therefore, the fact that those concepts are not implemented yet serves as a basis of decision-making.

The first mobile city logistics concept which is applicable for the city of Leipzig in the author's opinion is the cargo tram. It represents an efficient way of transport to shops and supermarkets within city centers. Moreover, it contributes to efficient intermodal transport from inner cities to production and distribution centers as well as freight villages or other transshipment points. Arguments for the implementation in Leipzig are the given rail net of trams in public transport and the reduction of road congestion because a cargo tram replaces load trucks. Arguments against the application are high investment costs[10] and the increasing traffic volume on the tram rails. As an idea, the nightly operation could be taken into consideration.

In terms of stationary city logistics concepts the shop PUDO is declared as a realizable idea in the city of Leipzig. The authors suggest it as a standardized and aligned solution for all parcel services and thus related to all customers initiated by the city government. As a consequence, the current single, fragmented company-specific solutions are obsolete and Leipzig's citizens do know where to go to get and send their parcels independently from the different parcel services. Barriers against the implementation in Leipzig are the complexity of installation and the fact that these solutions are mostly industry-driven. For that reason, governmental interventions are not requested.

8 Conclusion, limitations and outlook

The actual intent of the paper was to show trends and potentials of different city logistics concepts and to connect these ideas with a sustainability assessment. Here, we have classified the city logistics concepts into mobile and stationary solutions and have executed a short trend-funnel analysis. Furthermore, a balanced set of sustainability criteria suitable for city logistics solutions has been derived from the literature to serve as a basis for the sustainability-potential-analysis. The trend-funnels and the results from the sustainability-potential-analysis have been put together into two portfolios. Finally, implementation aspects for two specific city logistics solutions have been discussed.

Occurring limitations of the investigations can be found in the quasi-quantitative style of the sustainability-potential-analysis and the assessment by a small expert circle. Furthermore, not all city logistics solutions on the market or still in research were captured. The presented city logistics solutions themselves are not fully comparable since some are complete concepts, e.g. the integrated mall, and others

[10] Cf. http://www.berliner-zeitung.de/archiv/sachsen-will-die-grossen-innenstaedte-ueber-das-strassenbahnnetz-versorgen -per-schiene-bis-zur-ladentuer,10810590,8896124.html

are specific solutions, e.g. the parcel box. Moreover, we assumed a green energy usage which is by now not completely applied in practice.

By anticipating the limitations, an expert analysis with a sufficient basic population to generate an objective assessment of sustainability can be suggested as a further research avenue. A comprehensive subsumption of city logistics concepts to make them better comparable is suggested as well. Finally, possible applications for the city of Leipzig need to be more conceptionalized through feasibility studies, procedure models and cost/ benefit analyses.

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