

Congestion Charging

Tested Methodologies

and **Results** from Europe



PRESS4**TRANSPORT**

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EXECUTIVE SUMMARY

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This document is intended to present a mobility demand management tool – **congestion charging** – as implemented in the European Union. It introduces the concept by first analyzing the background and investigating the regulatory framework in place, then presents two outstanding cases from Europe where congestion charging was introduced with success, finishing up with recommendations and possible implications in research. The structure of this paper is the following:

Section 1, **CONGESTION CHARGING**, presents the brief introduction of congestion charging and the scope of the topic addressed, providing some background information on the transport sector and why congestion charging makes sense in an environment where congestion, traffic levels and

pollution can no longer be ignored and are increasingly present in business decisions and optimization. This section basically shows the background and justification behind congestion charging.

Section 2, **POLICY BACKGROUND**, shows the ways that the European Union is tackling the problem from a policy point of view. It basically gives a general overview on the current actions and measures already in place to address the problems described in Section 1.

It also introduces the reader to **mobility management**, why it is necessary and what tools are available.

Section 3, defines the **RESEARCH CONTEXT AND PROGRAMMES** on both EU and national levels to show the efforts and frameworks that are currently in place to tackle the problem. It tackles the different views, implementations and approaches that give rise to



different systems of mobility management and specifically congestion charging. These differences are then further analyzed in Section 4.

Section 4, **RESEARCH RESULTS**, demonstrates how congestion charging schemes are implemented in practice in two countries that are early adopters of this measure: **England** and **Sweden** through the analysis of case studies. The case studies go through the systems in place in London and Stockholm and also contain a comparison of the two schemes based on various aspects, showing how contrasting circumstances and approaches in different countries result in varying yet at the same time convergent systems pursuing the same goals.

Section 5, **EUROPEAN POLICY IMPLICATIONS**, and 6, **OUTLOOK ON RESEARCH**, investigate implications for European policy and the possible and desirable future avenues of

further research that could serve to pave the way for a more widespread implementation of congestion charging across the **European Union**. These sections aim to present the reader with a view on possible future trends and insight into the desirable improvements and directions that could enable research to improve the situation over time.

Overall, this document aims to give a comprehensive and concise overview on congestion charging in theory and practice in the hopes that this topic becomes more popular and well-known as well as increasingly implemented across Europe to foster more livable cities and a more sustainable transport systems.

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CONGESTION CHARGING

The scope of the Topic

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Congestion charging, simply put, is an effort to make drivers pay for the delays, costs and congestion they impose upon each other. It enables the **internalization** of these costs; thereby introducing them to the optimization process of individuals every day (“should I use my car to go to work, or should I walk?”), while it also has economic and environmental advantages.

The importance of the role transport plays in our everyday life as well as the economy and society is not to be contested. Transport produces more than 10% of the GDP within the EU, and provides employment to more than 10 million workers. Transport is one of the major fields where economy, society and the environment intersect each other. As a major source of

pollution, it is also a key area where harmful emissions (greenhouse gases, acidifying substances, ozone precursors, particulate matter, etc.) can effectively be reduced.

During the 1990's, European cities have begun suffering from congestion due to swiftly increasing traffic volumes. The conditions have continued to worsen to a level that it now threatens competitiveness and has very serious environmental implications. Congestion in the city centers across Europe also results in the isolation of outlying regions (“**The EU is threatened with apoplexy at the centre and paralysis at the extremities**”), since the low traffic volumes do not make new infrastructure elements viable, thereby making these regions stranded, without transport links to regional centers. The lack of efficient and effective organization is apparent in Europe's transport system from these missing links,



bottlenecks and a general lack of interoperability. A few ambitious projects have been completed (such as the **Øresund bridge-tunnel** between Denmark and Sweden), but further improvement can only be foreseen in the medium term. One of the reasons behind these issues is the fact that users rarely cover the full costs of their transportation. The costs of infrastructure, congestion, environmental damages and accidents are not covered, or are considered “external”.

In order to deal with transport problems, three issues must be tackled:

1. **Economic growth** generates transport demand
2. **Enlargement of the EU creates huge transport flows**, especially at the borders
3. **Improving the accessibility** of remote regions and

upgrading candidate countries requires enormous amounts of investment capital.

Because of the sheer magnitude of the costs to society associated with transport, there is no room for errors in judgment. Different transport policy measures have been developed throughout the years to cope with the problems transport is facing. These issues require a **MULTILATERAL APPROACH** careful planning and execution, and sometimes need considerable time to take effect. Countries in the European Union address this issue differently, using different measures.

This Fiche aims to give a general overview on the concept and idea behind congestion charging, including policy background, research and practical implementation through a brief analysis of the systems in place in London and Stockholm. It is also intended to give an outlook



to possible ***future trends***
and research avenues.



offending vehicle actually matches the number plate.

The effect of congestion charging on businesses within the zone is controversial. Some businesses may report a *loss in sales*, while increased delivery costs are also an issue. The former may drive a extension of opening hours to include weekends or holidays (when the charge does not apply). Since the charge affects different social strata to a different extent, the overall effect on business is likely neutral with large variations between shops. This may result in some **businesses relocating outside** the zone after the introduction of the scheme.

Even though the primary goal of the charge is to **reduce congestion** (environmental aspects, concerns or targets were not listed among the reasons for introducing congestion charging in London, for example), environmental benefits are also realized through

the net reduction in traffic volumes and the changes in modal split. Greenhouse gases, nitrous oxide and particulates can all be expected to decrease upon introducing charging, although whether sustained benefits can be achieved (as opposed to a one-off result at the time of introduction) is still a matter of debate, and studies are currently being undertaken to investigate this matter.

Initial public resistance is likely to diminish after the first few months of introduction as positive effects are starting to materialize. This can be observed in both the London and Stockholm cases, where public acceptance increased rapidly after introduction.

The Common Transport Policy

The European Community has long been unable to implement the Common Transport Policy as defined by the **Treaty of Rome**. The foundations of the Common Transport Policy have been



Demand for transport is continuously increasing all over the world, which raises many problems to be solved such as: overload of traffic interchanges, increase in the number of congestion's occurrence, lack of parking places, stranded areas with underdeveloped infrastructure, insufficient access of outlying regions, changes in quality and safety level of transport services as well as traffic accidents and environmental pollution. Simply constructing further infrastructure obviously does not solve these complicated questions. For these numerous reasons European Commission aims to strike a **balance** between economic development and the quality and safety demands made by society in order to create a modern, sustainable transport system.

Transport is one of the European Community's foremost common policies. As the *Treaty of Rome* came into force in 1958,

this policy has been directed towards making boundaries between Member States irrelevant by facilitating the free movement of individuals and of goods. Later, the Treaty of Maastricht confirmed the foundations of the Common Transport Policy, inter alia by introducing the concept of the **Trans-European Network (TEN)** which represents an integrated and comprehensive approach at European level with the help of Community funding. The main purposes of this transport policy are to complete the internal market, support sustainable development, extend transport networks throughout Europe, make use of space as efficiently as possible, reinforce safety and facilitate international cooperation. The Single Market indicated a considerable turning point in the common policy concerning the area of transport. Since the 2001 release of the White Paper published by the European Commission, this policy has been oriented towards



harmful effects such as delays, traffic safety issues or environmental pollution requiring surplus expenditures from society, which are not covered at all in many cases. If road space is unpriced, traffic volumes will increase until congestion limits further growth (a case of “Tragedy of the Commons”). For decades, economists have recommended road congestion pricing as a way to encourage a more efficient use of the transport system, and address congestion and pollution problems, providing net benefits to society. Considering these reasons the European Commission has proposed several measures in order to cope with imbalance of transport, increasing congestion, high number of accidents as well as with poor quality of air and environment.

The main guidelines of the policy:

1. Revitalizing railway network, the Commission has

already adopted a second “railway package”,

2. Improving interoperability between networks and systems,

3. A framework directive to establish the principles of infrastructure charging and a pricing structure, including a common methodology to incorporate internal and external costs and aiming to create the conditions for fair competition between modes,

4. Supporting the development of new technologies such as electronic driving licenses, speed limits for cars and intelligent transport systems.

Inter-modality: relieving roads

This directive aims to reduce road transport by developing **combined transport** bringing together rail, inland waterway and sea transport. Intermodal or combined transport means the transport of



appropriate pricing and infrastructure policies were to be pursued, these inefficiencies would largely disappear over time.”

For solving this matter the European Commission has developed the following guidelines:

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- 1. Harmonizing and separating fuel taxation for private and commercial users,*
- 2. Elaborating the appropriate charging system for infrastructure use,*
- 3. Achieving full internalization of external costs.*

The integration of external costs must also encourage the use of modes of lesser environmental impact and using the revenues raised in the process, allow investments in new infrastructure, as proposed by the European Parliament in the **Costa report**.

In certain sensitive areas it should be made possible for constructing new infrastructure to make an “income” available even before it can collect its first operating revenue. In other words tolls or fees would be levied in order to finance future investments. As the level of funding from national budgets is quite low and the possibilities of private partnerships are limited, innovative solutions based on a pooling of the income from infrastructure charges are needed. The policy of the European Union tends to open up the opportunity of allocating part of the revenue from user charges to the construction of environmentally friendly infrastructure. Regarding the financing of infrastructure, the Commission plans to propose a change in funding rules and establish a Community framework to channel revenue from charges on infrastructure use towards implementing new investments.



RESEARCH CONTEXT AND PROGRAMMES

Key research areas and actions at EU and National levels

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Key actions at the EU level

Congestion charging belongs with other transport policy measures to manage demand and to make the transport system of the EU more sustainable.

DG MOVE is in charge of the transport policy and alternative fuel policy of the EU. The **decarbonisation of transport** is a very important issue in the EU 2020 strategy and is coordinated by DG MOVE. It is also expected to launch a Clean Transport Initiative in 2011, and is co-funding research projects focused on alternative fuels and propulsion systems. Through the Green Car Initiative, it also

supports the electrification of transport.

**Strategic Energy
Technology Plan** (SET-Plan) aims to foster the development and deployment of cost-effective low carbon technologies through a variety of means.



SET-Plan is operating on two timelines, for 2020 it plans to develop and deploy a framework for low carbon technologies. By 2050, they intend to limit global temperature rise to 2 °C by reducing EU GHG emissions by 85-90%.

CiViTAS aims to give participating cities tools to achieve a cleaner, more



manage demand on their roads by congestion charging. We are also continuing to monitor work around the world, looking at new technologies that might make road pricing a practicable option for the future, and to draw on international experience of options such as car-share and toll lanes to consider how better to manage motorways.”

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This programme is very important in the sense that it provides an example of how to implement a complex demand management and sustainable transport strategy through tools such as congestion charging, thereby laying the groundwork for a wider application across Europe.

For Sweden, the **MISTRA** Foundation aims to support initiatives focusing on sustainability and solving long-term environmental problems.

MISTRA

THE FOUNDATION FOR STRATEGIC ENVIRONMENTAL RESEARCH

MISTRA invests in strong research groups in collaboration with the users contribute to solving major environmental problems. The aid amounts to approximately SEK 200 million (€ 23 million) per year. It invests in about twenty major research programs, each of which runs for six to eight years and in some cases even longer.

Mistra funds run alongside the Foundation for Strategic Research, SSF, research **ProEnviro**. The program focuses on small and medium-sized enterprises in cooperation with universities or research institutions focusing on environmentally friendly products and increasing competitiveness.

Mistra's overall goal is to ensure that the best research is put to practical use at companies, public and voluntary



organizations. In this way, Mistra investments contribute to solving environmental problems. The most recent program they have launched in the field of sustainable mobility, named **TransportMistra**, set out to implement a sustainable transport system by utilizing strategies and models to foster the practical implementation of sustainable mobility solutions, such as congestion charging.



Figure 1: *The London congestion charging zone (Source: US Department of Transportation [11])*

By paying the congestion charge, the purchaser effectively buys the right to enter and leave the central (charging) area as many times as desired for one day. The cost is the same for all vehicles entering the zone, but exemptions apply. For example, residents of the zone are automatically eligible for 90% discount, public transport vehicles are automatically exempt (buses with at least 10 seats as well as taxis), motorbikes and bicycles also. The exemption of motorcycles goes to show that congestion charging is not a tax imposed on motorists for the generation of profit; it is enforced in order to reduce congestion. The net proceeds of the scheme are to be used for “relevant transport purposes” by TfL, the Greater London Authority (GLA), or a London borough council for 10 years.

Enforcement and payment

Enforcement is done by cameras that read the number plates of vehicles entering the zone (ANPR – Automatic Number Plate Recognition). The vehicle registration number is then automatically stored in a database and compared against the database of vehicles that have paid the charge, are exempt or are eligible for a 100% discount each midnight. If the charge has been paid, images are automatically deleted from the core system by midnight of the following charging day. Upon finding a vehicle that entered the zone without paying, the images are retained as **Evidential Record (ER)**, the details are forwarded to the DVLA (Driver and Vehicle Licensing Agency), which in turn supplies TfL with the data of the registered owner. TfL then issues a Penalty Charge Notice (PCN),



the vehicles of persistent offenders may be seized.

There are a wide variety of options available for arranging payment. Daily, weekly, monthly or annual passes can be bought over the phone, the Internet, certain retail outlets, by post or text messages. There is no discount for prepayment. As of the writing of this paper, the daily charge is £8 (~€10). Non-payment results in a fine between £ 60 and 180 (~€75-€220).

Results achieved

On the first day the congestion charge was in force, 190 000 vehicles entered the zone, which was a 25% decrease from normal traffic levels (it should be noted, though, that it was a school holiday). While traffic rose by 5% after the school holidays, a permanent drop of 15-20% remained. Journey times were reduced by 14%, also becoming more reliable (variation in travel times for the same route decreased significantly). The

decrease in traffic (around 4 000 less vehicles each day) was responsible for only a small fraction of the drop in retail sales (7%). Most of the motorists complied with the charge, 100 000 fines were issued monthly (2 000 were contested). The modal split also changed in a favorable direction, as the images below clearly show. The first image contains car use, the second shows bicycle use (red dots are decreases, blue dots are increases).

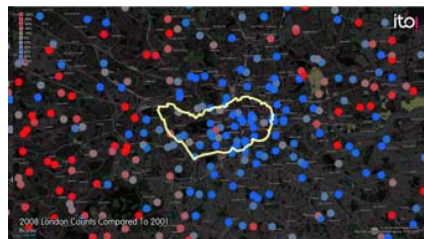
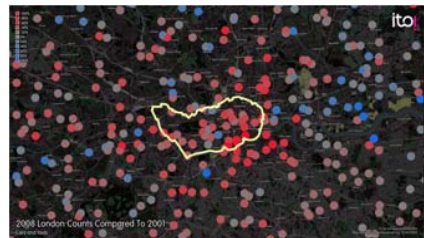


Figure 2: *Changes in travel mode* (Source: Wikipedia)



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Bus patronage is up by 16% within the zone, cycling is up 66%, **CO2-emissions are down 19%**. Public acceptance of the scheme has also improved since its introduction (55% for and 30% against, up from 40-40). As a negative side-effect, traffic on the *Inner Ring Road* increased by about 5%, but this change had little effect on speeds.

Congestion charging had a minor effect on traffic safety as well, although much less than anticipated. It is also difficult to differentiate the effects of the charge from the general trend in London and the UK toward fewer accidents. Estimations concur that around **40-70 accidents have been prevented** annually since the introduction of the scheme. Accidents involving cyclists have actually seen a slight increase, likely due to their increased numbers.

Have a look to the **Congestion Charging** webpage on the *Transport for London* website:

<http://www.tfl.gov.uk/roadusers/congestioncharging/>



The Stockholm congestion tax

Public consultations were an integral part of the London congestion charging scheme, but the Stockholm Trial has taken it one step further. Congestion charging was first introduced for a trial period of six months between January 3, 2006 and July 31, 2006. After extensive consultation and the evaluation of results, a public referendum was called to decide whether congestion charging should be permanent. As a result of the referendum, the scheme was introduced on a permanent basis on August 1, 2007.

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How it works

Unlike the London scheme, the Stockholm congestion charging system is not a uniform entrance fee. Instead, it is differentiated by time and follows peak demand periods (Figure 3).

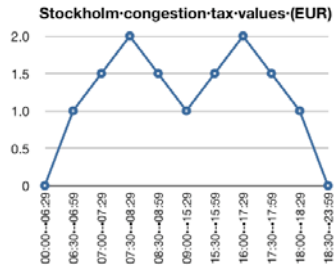


Figure 3: *Stockholm congestion charge prices (Source: own compilation)*

Also, the congestion charge must be paid every time upon entering the zone, to a maximum of 60 SEK (~€6). No congestion charge has to be paid on weekends, public holidays, the day before public holidays, or in the month of July. The amount paid is deductible from the taxes of both businesses and individuals. Businesses may deduct all charges paid, while restrictions apply to individuals. There are geographic and vehicle-based exemptions. Geographic exemptions apply when there is no viable alternative route (such as the island of Lidingö, which has its only connection to the mainland



through the congestion charging zone).

Emergency vehicles, buses (weight min. 14 t), diplomatic corps and military vehicles, motorcycles, vehicles registered in a foreign country, cars running on alternative fuels are automatically exempt (this applies until July 31, 2012).

Enforcement and payment

Control points are placed throughout the charge zone for the purposes of registering passing vehicles. The same ANPR technology is used as in the London scheme (sensors are mounted on gantries). For a more accurate recognition of vehicles that are either exempt or traveling through the charging zone often, there is an option to install a **DSRC (Dedicated Short-Range Communications)** transponder. The control points are laid out around the charging area (see Figure 4).



Figure 4: Control points around Stockholm (Source: Swedish Transport Agency [12])

Contrary to the London scheme, the charges are summarized in a bill (“tax decision”) which is sent to the vehicle’s owner on a monthly basis and can also be viewed on the web page of the Swedish Road Administration by logging in). The bill must be paid by the end of the next month, and the onus is placed on the vehicle’s owner, even if the bill never arrived. The bill is sent either by traditional mail, to the recipient’s internet banking account, or the money is deducted automatically via a direct debit arrangement



(Autogiro) for maximum convenience of the end user.

If the bill is not paid in due time, a reminder is issued along with a 50 EUR penalty fine. If the bill and the penalty fine remain unpaid for a further 30 days, the case will be transferred to the jurisdiction of the Swedish Enforcement Administration. They will issue an additional penalty fine of at least 60 EUR, also noting the vehicle in the Enforcement Register unless the bill is paid.

Results achieved

According to the data collected and published by the Swedish Road Administration, traffic volumes decreased by 20-25% within the charging zone during the trial period. As congestion charging was discontinued on July 31, 2006, traffic volumes increased to their original levels.

Air quality changed in much the same way. The great majority of drivers (~96%) complied with

regulations and paid the charge in due time.

The congestion charge creates about **€80 million per year in revenues**. Running and maintaining the system requires circa €25 million per year, the rest of the funds can be used for other purposes, they are allocated to new road constructions around Stockholm.

For further information on the Stockholm
Congestion TAX:

<http://www.transportstyrelsen.se/en/road/Congestion-tax/>



CONCLUSIONS: key outcomes from the two projects

Economical and environmental effectiveness of the schemes

Apart from its role in **reducing congestion** in downtown London, congestion charging is also a tool for internalizing other external costs resulting from transport (such as pollution). In this regard, flat-rate schemes are not efficient. In an ideal situation, the charge that must be paid would be differentiated by the time of day and the route taken. It should be noted, however, that such an approach would require greater effort in monitoring the movement of vehicles. It would also result in greater complexity regarding the calculation of the charge.

These effects would require substantially increased administration costs.

Congestion tends to be less heterogeneous in peak hours, so the flat-rate charging, while not perfect, is not a bad approximation.

The amount to be paid is also debatable and should be periodically reviewed to perpetually **adapt the system**. As prices and incomes rise, the amount to be paid, regardless of its initial value, will become less significant, and therefore the effects of the charge will diminish. If public transport demand or congestion just outside the charging zone increase dramatically, then the charge may be too high. If congestion is not substantially affected, then the charge is too low.

It is also a subject of debate whether it is appropriate to only introduce charging in **city centers** as traffic speeds have been falling in other areas as well. It would probably make sense to introduce congestion charging outer areas as well, especially during peak hours.



Comparative analysis based on the **Smeed Criteria**.

The 1964 Smeed Report set out the **design criteria** for road pricing schemes which are still valid today and are applicable here. Before continuing with the comparison of the London and Stockholm schemes, it is useful to review these criteria:

- 1. Charges should be closely related to the **amount of use** made of the roads,*
- 2. It should be possible to **vary prices** for different **areas**, times of day, week or year and classes of vehicle,*
- 3. Prices should be **stable and readily ascertainable** by road users before they embark upon a journey,*
- 4. **Payment in advance** should be possible although **credit facilities** may also be permissible,*

*5. The **incidence of the system** upon individual road users should be accepted as fair,*

*6. The **method should be simple** for road users to understand,*

*7. Any **equipment** should possess a **high degree of reliability**,*

*8. It should be reasonably **free from the possibility of fraud and evasion**, both deliberate and unintentional,*

*9. It should be capable of being **applied**, if necessary, to the **whole country** and to a vehicle population expected to rise to over 30 million.*

It should be noted that these criteria are meant to apply for those eligible for payment (exemptions should not be considered here). The original Smeed criteria have since been expanded to contain 12 aspects (See Table 2).



The following table compares the two charging schemes detailed so far against the extended **Smeed Criteria**:

Smeed Criteria	London scheme	Stockholm scheme
Usage	No	Yes
Price Variation	No	Yes
Perfect Information	Yes	Yes
Payment	Yes	Yes
Fair	No	No
Simple	Yes	Yes
Reliable	Yes	Yes
Enforceable	Yes	Yes
Expandable	Yes	Yes
Foreigners	Yes	No
Privacy	Yes	Yes
Technology Integration	No	No

Table 2: Comparison based on the extended Smeed Criteria (Source: own compilation)

Usage

Charges should be a function of road usage. Neither scheme complies with these criteria, although it should be noted that the Stockholm system has differentiated prices based on the time of day.

Prices should be varied by area, vehicle type and time of day to better reflect social costs. As discussed above, the Stockholm scheme partly complies with this requirement by being time-sensitive.

Price variation

Perfect information

All road users should have the necessary information about pricing and how to pay before embarking on a journey. Both systems are in compliance with this requirement as information about the charging schemes is readily available through a variety of channels.



EUROPEAN POLICY IMPLICATIONS

What next?

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Both systems have been very effective and are considered to be successful both by their respective administrators and the general public. Initially low public acceptance has improved much in both cases after introduction, and solid results have been achieved. Therefore, both solutions should be considered as leading examples to other European cities that are contemplating the introduction of a congestion charging scheme.

As we have seen, most of the extended **Smeed criteria** are met by the London and Stockholm schemes (London fails 4, Stockholm fails 3). Future developments should aim at increasing compliance with these criteria. Perhaps the greatest

challenge is the necessity of perpetual **adaptation** in order for the charge to remain fair and financially relevant. Data on how congestion charging impacts local businesses is debated and controversial, more research is definitely needed in this area.



The London and Stockholm systems are among the few **pioneers** of congestion charging; hopefully more and more governments and municipalities will begin to consider adapting these systems so that the effects of ever-increasing mobility demands, congestion, and pollution may be increasingly addressed in Europe and around the world. These goals require that **European policy remain focused on and committed to sustainability** in



general and sustainable mobility in particular, and continue onwards on the path of integration in the area of transport systems and legislations in its Member States.

While there have been a few examples of voluntary and proactive implementation across Europe, it is likely that widespread implementation (required to achieve environmental, economic and social benefits) cannot be expected in the absence of a

comprehensive and persevering incentive and policy background. Naturally, such a system requires a strong **research background** as its foundation (see next section).



OUTLOOK ON RESEARCH

What next?

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There are a number of initiatives, calls and research opportunities in the European Union that provide an excellent ecosystem for research. A common policy on congestion charging would require more focused research to solve problems and answer questions about congestion charging such as:

1. *Public **acceptance**,*
2. *Effect on **businesses**,*
3. ***Evasion, abuse and enforcement**,*
4. *Social **inequalities**,*
5. *Different **legislative frameworks**.*

The answers to these questions and the feasible solutions are expected to be extremely varied across the Member States due to different social, economic and legal backgrounds. One of the main challenges future research on this topic needs to face is the consolidation of these **differences across the EU**, all the while developing the system that still remains usable, effective and fair.

Research should focus on new and state of the art tools to gain public acceptance within a reasonable time frame (in the cases of London and Stockholm, it took long years to get public acceptance to higher levels, and the situation has since deteriorated with the financial crisis dragging on).

Another avenue to focus research on is a more comprehensive idea on the overall effect such a measure has on local businesses inside and outside the charging area and develop strategies to avert adverse effects on the local



economy and quality of life by preserving economic activity in city centers as much as possible.

As with charges and taxes that are not proportional to income, it is very important **to assess the impact with regards to social inequalities** and taking this information into account when determining charge levels in order to avoid privileging middle-class and prosperous road users.

Finally, research into harmonized legal frameworks could serve both enforcement and a more widespread implementation of congestion charging. A common and harmonized framework for regulations, enforcement and incentives has **the potential to ease introduction and mitigate problems** usually associated with the implementation of such a measure.



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