WPT1: D.T1.2.8
STUTTGART

TRANSNATIONAL REPORT ON UNDERSTANDING FREIGHT BEHAVIOURS AND IMPACTS IN SULPITER FUAS

Version 3
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Status (F: final; D: draft; RD: revised draft):	**RD**

1. Introduction

This document arises from the FUA reports of each involved city and will provide the inputs for the deliverable T1.2.11 “understanding Freight behaviour and impact on FUA”. It is essential to arrive to a harmonized description of each FUA and to provide a suitable comparison among them.

Each FUA is required to fill in the following form starting from the surveys and tool implementation.

Please note that this template includes the minimum requirements for the SULPiTER project. The information included in this template will be used for the transnational report (D.T1.2.11) and for the final output of the work package O.T1.7.

Please, do not answer as a questionnaire (i.e.: yes, no, maybe…) but use the template for elaborating the results of your interviews. As an example, we expect a deep and exhaustive qualitative report. Each component of the survey should be analysed and reported here with comments and interpretation of the results.

Once you completed the report, please format the document removing the tables for a better readability.

2. The territorial context

FUA name
Stuttgart Region

Km² involved in the study-area

As is typical for agglomerations, the Stuttgart agglomeration can be defined in several ways.

The widest possible definition would be the **German federal state of Baden-Württemberg,** with a population of 10.5 million and a surface area of 35,000 km2. However, for large parts of the state Stuttgart is just the political capital, while some main cities (Mannheim/Heidelberg, Karlsruhe, Freiburg, Ulm, Konstanz, Villingen-Schwenningen) by all means have their own catchment areas.

The next level below the state on a geographical scale (as opposed to searching for the EU's statistical "NUTS" regions) would be **"Stuttgart Metropolitan Region".** That includes all the area which somehow has Stuttgart as its highest level center, defined on county level. Within Germany, 11 such regions are defined (see fig. 1):

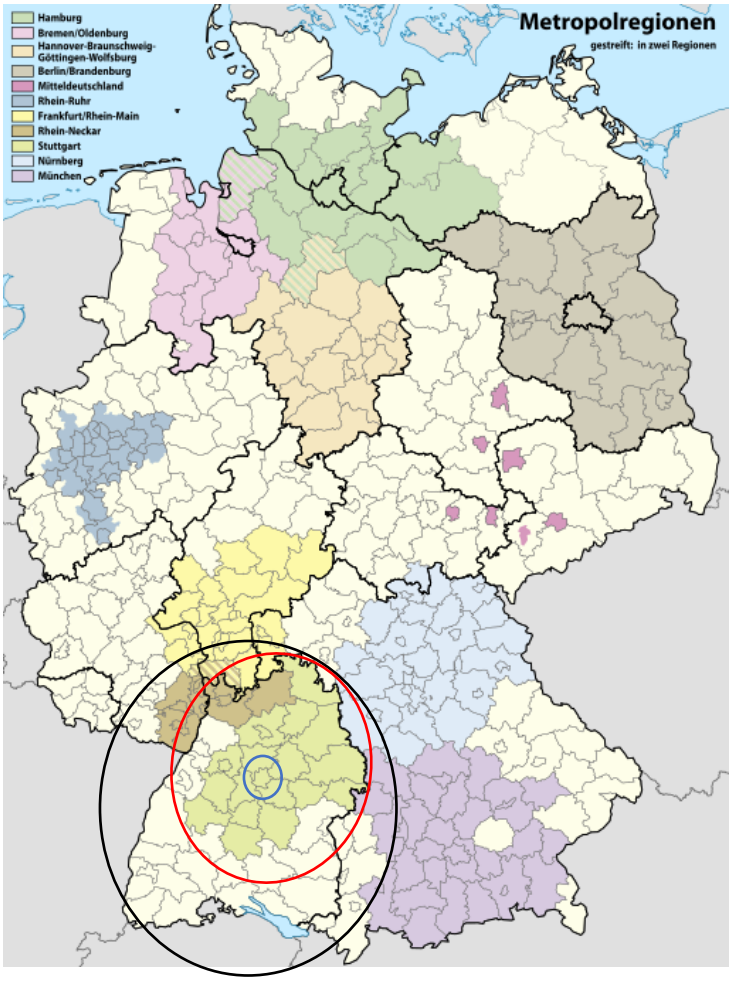


***Fig. 1: Administrative map of Germany** (federal states, counties within federal states), with **metropolitan regions** indicated in colour.*

*Encircled in **black:***
Federal state of Baden-Württemberg.

*Encircled in **red:***
Stuttgart Metropolitan Region.

*Encircled in **blue:***
Stuttgart municipality.

Source: Wikimedia commons; circles added by authors.

This widest reasonable definition includes five of the 12 Baden-Württemberg regions (Stuttgart, Heilbronn-Franken, Nordschwarzwald, Ostwürttemberg, Neckar-Alb), with a size of 15,400 km2 and a population of about 5.2 million. However, while it cannot be denied that Stuttgart is not only by far the largest town of the metropolitan area, and to a certain degree also its center, there are a number of mid-size towns and smaller cities that serve as centers of highest centrality: Heilbronn, Pforzheim, Reutlingen/Tübingen and partly Aalen), so that the functional interdependence of the metropolitan region's outer area is neglectible in our context of goods transport, compared to the traffic to and from these other cities.

Therefore, the metropolitan region also is too large an area to be considered as a "functional urban area".

The next level below the metropolitan region level would be the area of **"Stuttgart Region",** an area that is an administrative region of Stuttgart city plus five adjoining counties. It includes most of the area of intense commuting to Stuttgart and its surrounding towns. While it can be argued that the technical commuting area is somewhat larger and includes the towns of Reutlingen, Tübingen and Schwäbisch Gmünd outside Stuttgart Region, it is clear that on county level the area of Stuttgart Region nevertheless is the best approximation. It has a surface area of 3654 km2 and a total population of about 2.7 million.

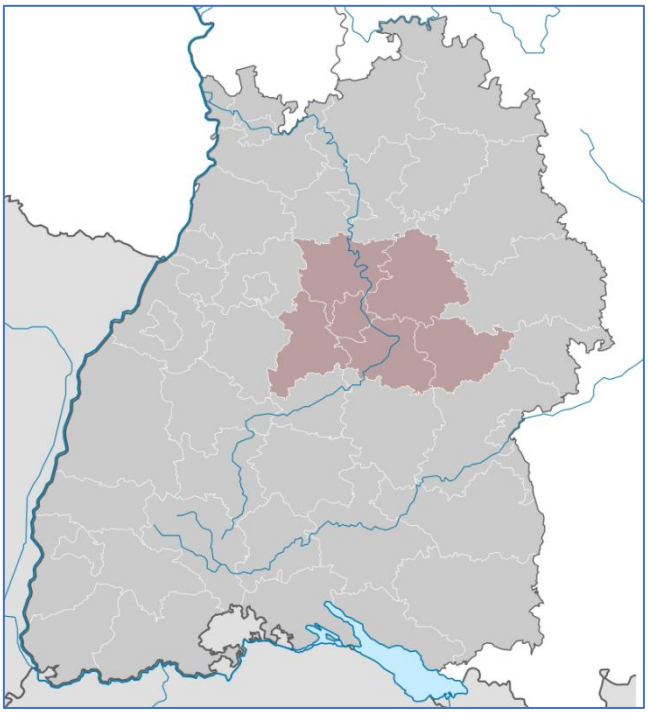
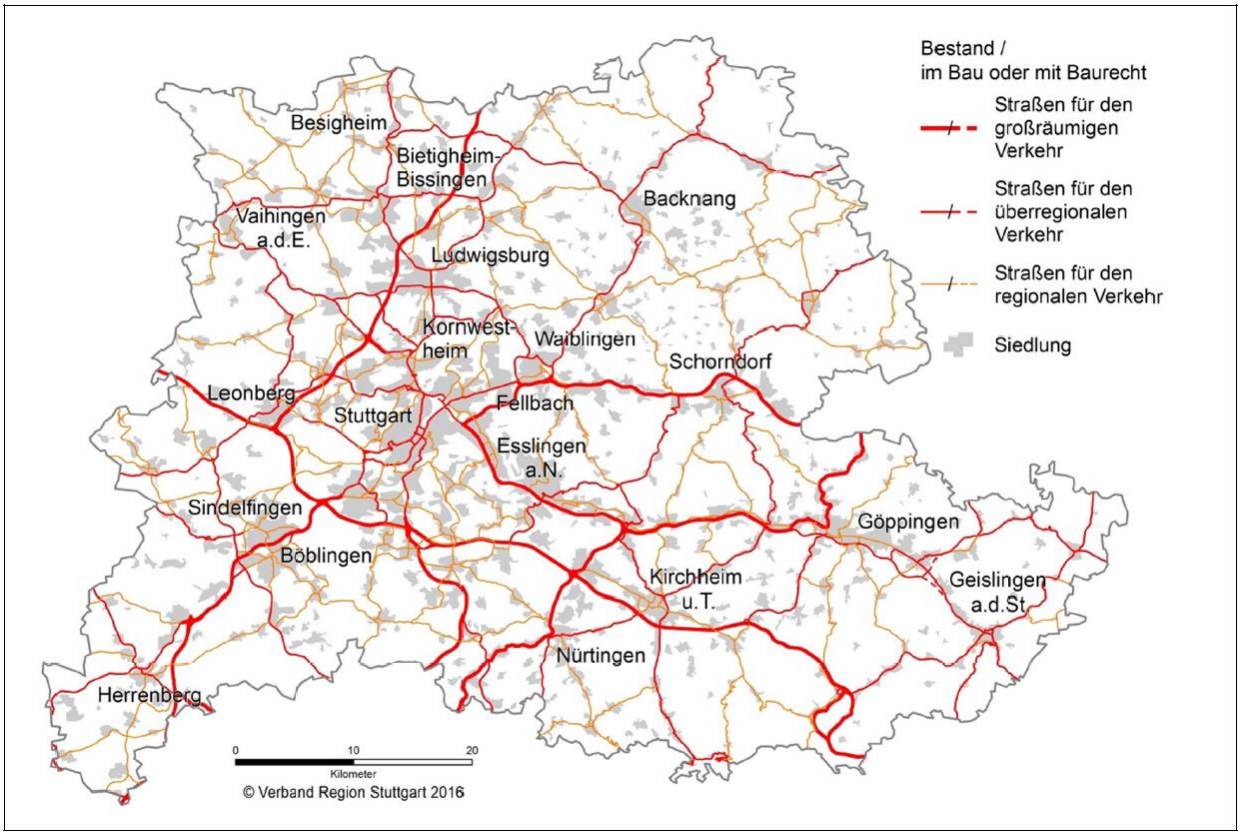


Fig. 2: Area of Stuttgart Region *within the state of Baden-Württemberg.*

Source: TUBS, Wikimedia commons.

Fig. 3: Settlement areas and interurban road system of Stuttgart Region



The above map indicates the road system for
- long distance traffic,
- interregional traffic,
- regional traffic.

*The **indicated towns** are **places of middle level centrality**, with Stuttgart also being the higher level central place for the region as a whole. Bad Cannstatt, east of Stuttgart downtown, also functions as a central place of middle level. It is not indicated on this official map as it is not an independent municipality.*

Source: Verband Region Stuttgart.

In Germany, there is a long-standing political and administrative practice to categorize settlements according to their centrality. This not only includes the "functional urban area" as a whole, but also applies to places on a lower hierarchical level, with lower centrality. Most important for our purposes is the "middle level" centrality, which is defined as a place that offers goods and services not only for day-to-day needs, but also for regular occasional needs: Specialized shops etc. These towns with their "middle level" catchment area typically also have their own labour markets: While it is generally possible within a functional urban area to commute from anywhere into the center and also into quite a number of other places in a broad segment of the functional urban area, definitely a significant portion of commuting, shopping and other trips is within the catchment areas of middle level. In this way, they function as their own urban area, overlapped by the total functional urban area which is defined by its relationship with the central city.

The towns named in the above map do have their own distinct catchment areas on middle level,

occasionally shared with a neighbouring town. These places are:

- Backnang
- Bietigheim-Bissingen / Besigheim
- Böblingen / Sindelfingen
- Esslingen
- Geislingen
- Göppingen
- Herrenberg
- Kirchheim
- Leonberg
- Ludwigsburg / Kornwestheim
- Nürtingen
- Schorndorf
- Stuttgart (as middle level center, with Stuttgart – Bad Cannstatt)
- Vaihingen
- Waiblingen / Fellbach

The map shows the multipolar structure of Stuttgart Region. The areas of middle level centrality each have a catchment area (including the population of their respective central town) of 50,000 to 200,000 inhabitants. Far from just being suburbs, these towns each also have a strong industrial base.

The case of Stuttgart sticks out for a number of reasons:

- Stuttgart is the centre of higher centrality for at least the whole of Stuttgart Region. Beyond that role, for a much smaller area it also serves as a centre of middle level, just as the other towns named above do for their own catchment areas.
- Even as a central place on middle level, is much larger than the others. Together with the few smaller surrounding towns that make up the catchment area on middle level, its total population is 700,000 or about five times the average population of the other 14 catchment areas on middle level, which is just about 140,000.
- Stuttgart in reality is not a homogenous centre of middle level. Its downtown for sure acts as such a centre (besides its main function as the centre of the whole functional urban area and thus of the catchment area on higher level). But the historical centre of Bad Cannstatt, politically a part of Stuttgart municipality, in practice also functions as a centre of middle level. It is just not described as such a centre in the regional system of spatial planning, because it is not an independent political entity.
- However, Bad Cannstatt as a local labour market as well as a shopping centre has its own catchment area. Because of the lack of spatial planning data, it is a bit difficult to judge the extent of that catchment area, but we can assume that in total it is well above 100,000 people and thus a rather typical entity on middle level.

N. of inhabitants

The population of Stuttgart Region (the total functional urban area) is 2.7 million.

For a more detailed explanation see “Zoning criteria”, below.

N. of municipalities involved

Stuttgart Region covers the area of **179 municipalities.** However, for the purpose of the study, most of them are not relevant as individual study objects. The majority are former villages that developed into residential suburbs, and the larger municipalities also have some industry.

That results in a rather disperse pattern which cannot be analysed by sampling. Any meaningful analysis of the area as a whole thus needs modelling, including the transfer of results from one part of the area to another part.

N. of working units (employers)

The total number of working units is much higher than the number of companies / employers, because an employer can have activities spread out over a multitude of locations. However, for Stuttgart Region we can state a number of rather specific issues:

The number of companies with registered employees in Stuttgart Region was 128,533 in 2014. These companies had a total of 1,260,205 employees. The number of business locations in Stuttgart Region was 137,228 in the same year, with a total number of registered employees of 1,088,224. Apparently, a number of businesses have more than one location, and companies based in Stuttgart Region employ about 180,000 people in locations outside the region. The economically active population is quite a bit higher, since these figures include neither public service nor self-employed people like doctors, consultants and lawyers.

Industry (“Verarbeitendes Gewerbe”) plays a rather big role in Stuttgart Region. In 2016, there were 1,660 industrial plants with more than 20 employees, totalling 331,118 employees. If we assume that producers with more than 20 employees really work on an industrial scale (while smaller producers work more or less as craftsmen), this means that more than 30% of all employees in Stuttgart Region work in industrial enterprises, even when “industry” is defined in the most narrow sense. The average size of these industrial plants is about 200 employees. Of course, with several mayor Daimler, Bosch and Porsche plants, each with many thousand and even tens of thousands of employees, most of the 1,660 plants are relatively small, while most employees work in a few really large plants.

Source: Regionaldatenbank of Statistisches Landesamt Baden-Württemberg for the basic figures, own calculations.

This is a huge deviation from the average sectorial labour distribution in European regions or urban areas, and even far exceeds the figures of the typical industrial regions. However, the deviation is caused by only very few large industrial plants. If we imagine the region without perhaps the dozen largest plants (almost all in the automotive sector, as a rule exploiting technologies around the combustion engine, plus a few electric tool and equipment producers such as Trumpf, Kärcher and Stiehl), the figures would look much more average. And just those largest plants do command their own logistics supply chains, which to a large part are separated from general delivery services.

As a result, the figures and findings for Stuttgart Region can be used for other functional urban regions of similar size. It should just be remembered that Stuttgart Region has an additional layer of logistics related to those large plants. However, that layer is not included in this report. It would mean to deal with

individual supply chains, which are company secrets.

N. of zones used in the tool and in the o/d matrix

We used **seven** zones:

1 – Historical center of Bad Cannstatt, including the downtown shopping area.

2 – Area of Bad Cannstatt railway station and new shopping center.

3 – Remaining area of Bad Cannstatt.

4 – Remaining area of Stuttgart.

5 – Adjoining county "Rems-Murr-Kreis".

6 – Remaining area of Stuttgart Region.

7 – All else.

Zoning criteria

(nuts level, all of same nuts dimension or not, all similar dimension or different in dimension, ...)

The zoning was done in order to use Bad Cannstatt as a test field for the Stuttgart agglomeration. This meant that first of all the central district had to be clearly identified. We did not go for any administrative or historical boundary, but went to the spot and checked where the relevant businesses were. As a result, we got **two central zones**:

One includes the historical (medieval) downtown plus some adjoining streets, which form a functional unit. It is like the historical centers of the mid-size towns in Stuttgart Region (and beyond), and is typical of its type for Germany.

The other central zone was designed around a recently built mall and the Bad Cannstatt railway station. It also includes the shopping street that connects the railway station with the historical town. This also is typical for mid-size centres in Germany.

We wanted to learn about these two zones separately for the following reasons:

- Historical downtowns have a different settlement and business pattern than more recent central areas. We did not know whether that means different delivery patterns.
- A main road runs through central Bad Cannstatt, basically separating the two areas. It would result in meaningless data, if entry and exit of each vehicle on that road would be included in traffic counts.

The other zones were defined in relation to these inner city zones:

Zone 3, the historical and political Bad Cannstatt without its inner city, is the main catchment area for Bad Cannstatt downtown. It has intense links to the inner city.

Zones 4 to 7 are defined in relation to NUTS levels: Zone 4 is the remainder of Stuttgart (defined as a NUTS 4 as well as a NUTS 5 area, but without Bad Cannstatt). Zone 5 is another NUTS 4 area, Zone 6 is comprised of four NUTS 4 areas. Zone 7 is the residual zone "rest of the world").

This zoning allowed for detailed full analysis in Bad Cannstatt and for sufficient detail regarding the

regional matrix.

With Stuttgart centre plus another 14 centres on middle level, even if we thought of the 14 smaller centres as representing the functional urban area better than the overall high level centre, why did we not use one of them as a model, but the centre of Bad Cannstatt, which is not even officially named as a centre?

The answer is: Just because of that! We were looking for an apparent contradiction: A centre (plus catchment area) both as generic as possible and at the same time ready for detailed study on the ground.

Going to a town around Stuttgart and inquiring there about transportation and logistics, would need consent with the local political authorities. It is unthinkable that a regional authority (or a project on behalf of it) would just go for the town that fits best and then do something there that is visible in public and will have political implications. The centres around Stuttgart all have their old political traditions and maintain a strong standing. They would not accept to be just on the receiving end of a measure. It is of course possible to work with those administrations on a friendly base, but most likely not within a pre-defined project for pre-defined aims.

For Bad Cannstatt, the things were the other way round: Also a historical town as well as an industrial town of quite some size, it was merged into Stuttgart in 1902. Since that time, it feels a certain lack of attention. That is quite understandable: One just has to imagine a historical downtown with many stores, plus an adjoining shopping centre, due to its political integration into another city not being on the map of spatial planning. Therefore, any attention by a project was welcome.

Please insert a map of the study area (if available please attach also the shape file with area and road graph layer)

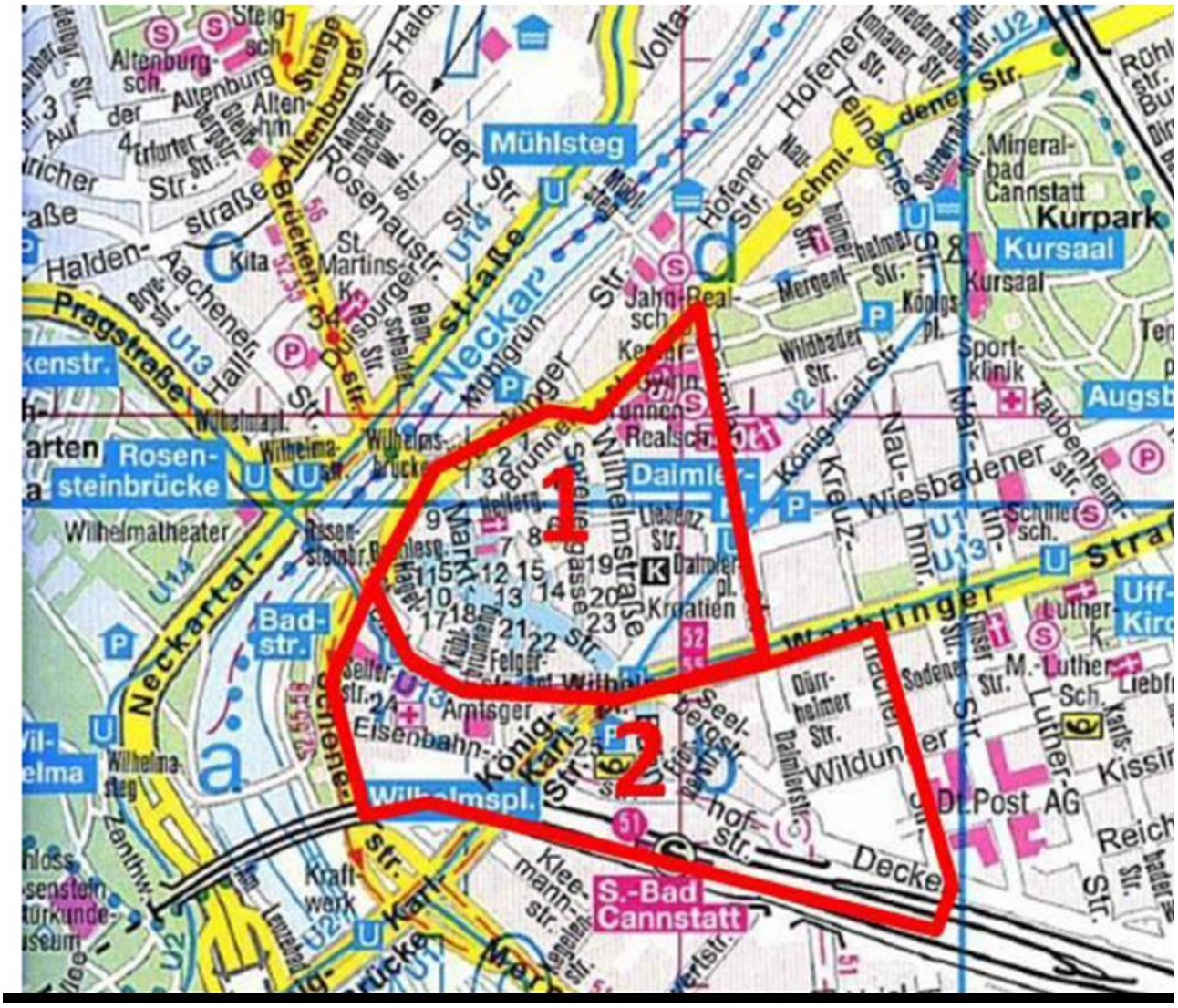


Fig. 4: Study area, inner Bad Cannstatt. Through traffic on König-Karl-Straße and Waiblinger Straße was not counted.

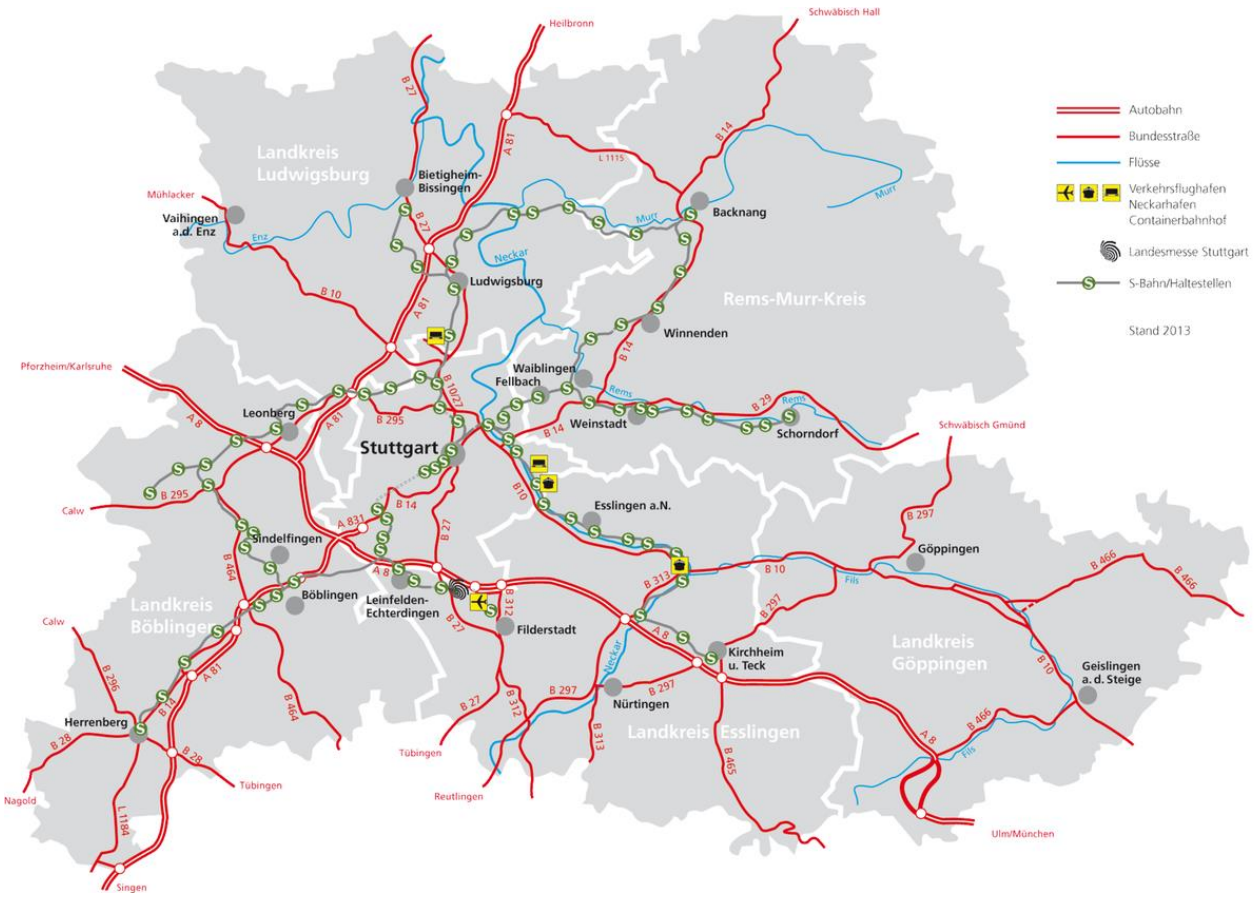


Fig. 5: Total study area
Zones 1-4: "Stuttgart"
Zone 5: „Rems-Muss-Kreis" (upper right)
Zone 6: Landkreis Ludwigsburg, Landkreis Böblingen, Landkreis Esslingen, Landkreis Göppingen
Zone 7: Residual area (outside zones 1-6)
Source: Wirtschaftsförderung Region Stuttgart GmbH

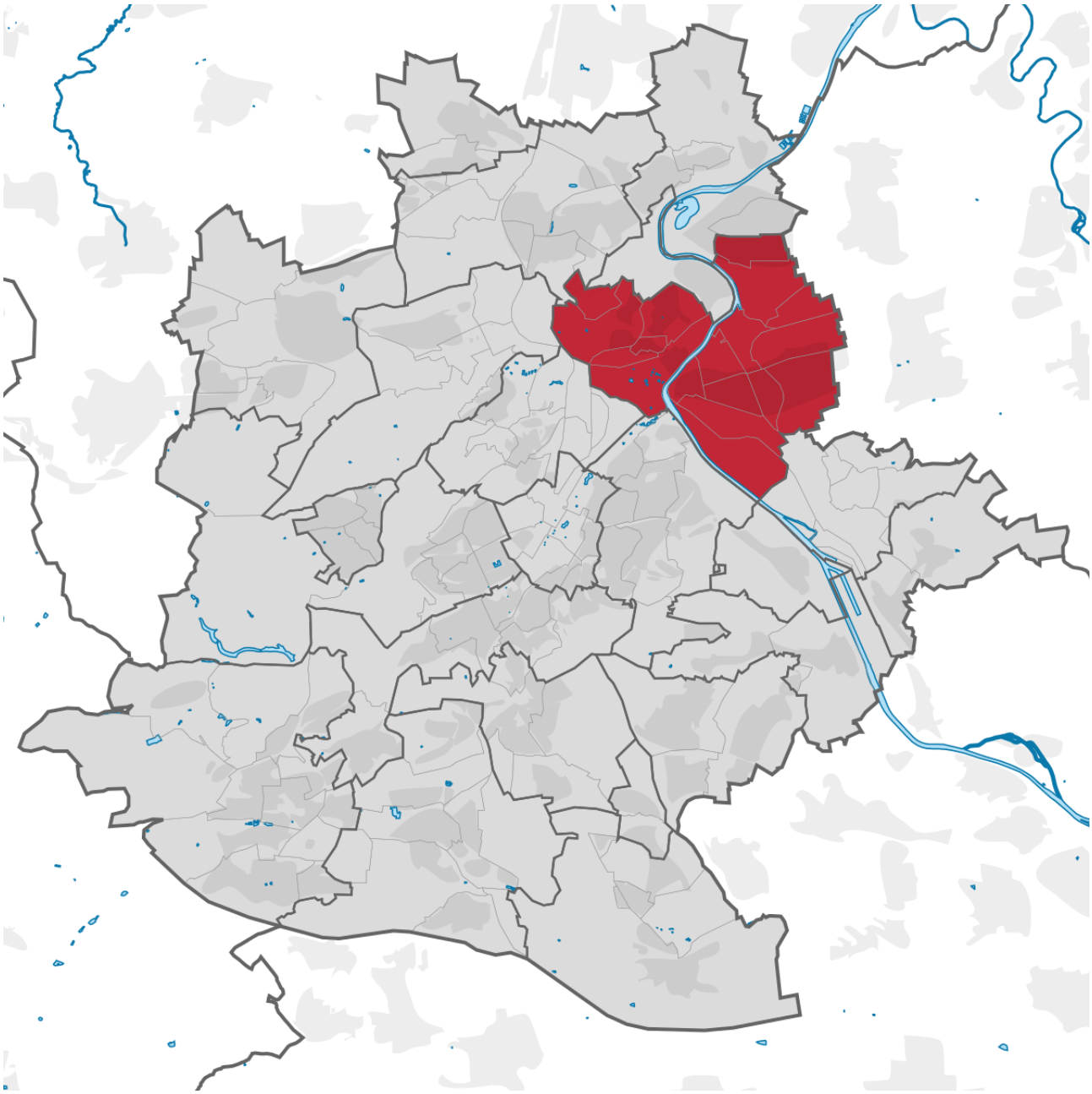


Fig. 6: Stuttgart and Bad Cannstatt
Zones 1-3 (red): Bad Cannstatt
Zone 4 (grey): Remaining Stuttgart
Source: Wikipedia

Current freight mobility impact

Analysis of survey on distribution flows. It may include the following aspects:

- *Total number of interviews (per supply chain)*
- *Number of suppliers (average per category …)*
- *Share of DDP, EX-WORK and OFF TRUCK delivery modes*
- *Frequency of deliveries and type of load units*
- *Number of load units per delivery (minimum, maximum, average)*
- *Usual hours of delivery (distribution)*
- *Share of OWN ACCOUNT COLLECTION*
- *Share of DELIVERIES TO END CUSTOMERS*
- *Problems and suggestions (short analysis and description)*

Please do not include just the figures, but also detail and comment the results.

- Total number of interviews (per supply chain)

A good 200 interviews were made, of which the great majority was done on the spot and in person. The interviewer was a former automotive manager who has served in different executive positions in van marketing. Both his personal appearance and his knowledge of transport logistics resulted in a very low denial rate and in rather qualified answers.

- Number of suppliers (average per category …)

The typical business had a number of suppliers. The total number was not systematically asked for in the interviews, since occasional suppliers are of little relevance. However, the interviewer took care to ask for at least three suppliers where applicable. This way we could be sure to get the relevant suppliers, even if not their total numbers.

- Share of DDP, EX-WORK and OFF TRUCK delivery modes

Most delivery (in fact, almost all of it) was scheduled either by the shipper (larger loads) or by the parcel service.

- Usual hours of delivery (distribution)

Mostly during the late morning.

- Share of OWN ACCOUNT COLLECTION

This was very low. Only a few examples were found, and even these few cases were just a part of the delivery for the business entities which did such collection. So, it may be one or two percent of the trips. The main cause is that retailers as well as restaurants go for the fresh food market in the morning.

- Share of DELIVERIES TO END CUSTOMERS

The business entities in the zones 1 and 2 do not regularly deliver to end consumers. Also, the number of households in this area is limited. Thus, a number of deliveries likely was made to end consumers by the commercial vehicles that entered and left the zones, but these vehicles will also have made stops to serve business entities.

- **Problems and suggestions (short analysis and description)**

The first problem was to define the survey in a way that it could get reasonable results. A sample is likely to misrepresent the logistics flows completely, since the different segments vary a lot in their answering behaviour. We therefore decided to focus on a rather small area but to do a full survey.

We now have data regarding a rather large number of businesses which are typical for an urban centre on middle level. This can be used for other centres in the following way:

- For the downtowns, as a first approximation we can assume that the traffic caused by retail trade is proportional to the size of the catchment area, in comparison with Bad Cannstatt. A closer relation might take into account the "centrality factor" of the respective downtown, which varies throughout Stuttgart Region. However, this factor itself is a statistical number based upon indicators which again may not be precise enough to really improve the results.
- We can also derive typical patterns for typical businesses (groceries, textile, fast food etc.). We do have the data now. The data base may be a bit small to get precise results for each segment. But if we look at e.g. a pedestrian zone with 50 stores of 20 different branches, and if we use typical numbers for each of the 50 stores regarding to their branch, we can assume that the imprecisenesses will equal out and we will get very reasonable results regarding the delivery patterns along this street.

Analysis of survey on transport operators flows. It may include the following aspects:

- *total number of interviews*
- *type of vehicles*
- *sequence of movements (number of movements, number of stops per trip)*
- *typical quantity*
- *frequency of movements*
- *parking during deliveries*
- *main issues*

Please do not include just the figures, but also detail and comment the results.

This already started with a main issue: The transport operators had much different strongholds within the logistics sector, as well as different market shares (throughout and within their segments). And they were not really willing to talk about hard facts of their business in quantitative terms. The big ones were just regional outlets of national / world-wide chains. Their data thus made no sense at all added up.

The parcel services explained that they send a van into inner Bad Cannstatt in the morning mainly for deliveries and in the afternoon mainly for pickups. This goes with our observations (see below), except that it must be at least two vans for DHL.

From the traffic count we then could conclude that the parcel services make for only about 2% of the commercial goods vehicle trips (which is less than expected), but definitely for a higher share of all delivery stops.

Analysis on traffic counts. It may include the following aspects:

- *AADT (average annual daily traffic)*
- *Total and for different categories of vehicles*

Please do not include just the figures, but also detail and comment the results.

We did a very detailed traffic count in Bad Cannstatt to learn about the traffic getting in and out of the zones 1 and 2. For this purpose, all entries of each zone were supervised and traffic was counted by type of vehicle.

On the other hand, we did not count the number of vehicles on the through roads. So, we checked neither the number of vehicles on the road that separates the zones 1 and 2, nor the traffic on the through road next to Bad Cannstatt. This has several reasons:

- For traffic on the main roads, there is a Stuttgart traffic count by type of vehicle (weight class), that can be utilized if needed.
- The fact that a main road runs right through downtown Bad Cannstatt (and not around it) is not coincidental, since towns develop at main roads resp. crossroads. But most of the traffic is through traffic without any relation to inner Bad Cannstatt (much to the regret of locals as well as local businesses). Focusing on this traffic would just diminish the relevance of the traffic that is caused by the zones 1 and 2, if not outright overwrite that data by its sheer magnitude.
- This is true the more regarding the main road bypassing Bad Cannstatt, which is a main Stuttgart traffic artery that leads into a major overland route.

Instead, with the focus on traffic to and from zones 1 and 2, we got results that not only speak for themselves regarding Bad Cannstatt, but can be used for modelling the traffic in and out the inner area.

Matrix quantities, e.g.: are some relations predominant among the others? Do you see an homogeneous distribution or a concentration in some zones? Do you see some unexpected phenomena?

Table: Origin/Destination Matrix

Zones	1	2	3	4	5	6	7
1 – Historical Bad Cannstatt	0	1	5	12	20	25	150
2 – Remaining inner Bad Cannstatt	1	0	5	12	20	25	150
3 – Remaining Bad Cannstatt*	5	5	Due to the size of the cells 3 to 7 and due to the methodology, any calculated distances between these cells would be meaningless. Also, they are not needed for the purpose of the report.				
4 – Remaining Stuttgart*	12	12					
5 – Adjoining Rems-Murr-District*	20	20					
6 – Remaining Stuttgart Region*	25	25					
7 – Rest of the world*	150	150					

Unit: Kilometers

*Distance calculated as described below

Zones 1 and 2 are close to each other and rather small. Therefore, it was assumed that the average

transport between these cells would cover a distance of approximately 1 km.

The warehousing and logistics area of remaining Bad Cannstatt (zone 3) is a bit further off. 5 km is the distance to the wholesale food market at the Bad Cannstatt limit, where in the harbour area also the other main warehousing and logistics activities of this quarter of Stuttgart are located. Therefore, it is plausible to assume this distance also to serve as the weighted average for all transport between zone 3 and cell 1 and 2.

For remaining Stuttgart (zone 4), there is a multitude of possibilities, including several large logistics areas. One of the largest such areas, at the Stuttgart-Feuerbach Autobahn exit, is 12 km away. Again, this is a plausible weighted average.

For the adjoining Rems-Murr-Kreis (zone 5), it was not possible to find a single location that at the same time would serve as a weighted average. Some logistics activities actually are in Fellbach and Waiblingen, which are close to Bad Cannstatt. Others are in Backnang and, to a lesser extent, in Schorndorf, which is roughly as far as Backnang. Therefore, the 20 km in the above table is the distance to a midpoint between Fellbach and Backnang.

For remaining Stuttgart Region (zone 6), there again are a number of logistics centers all across the region. Chosing Köngen in the south-east was plausible, since there among others is the region's DHL depot. It makes the average distance 25 km, surprisingly little above the 20 km for the adjoining district.

As for the rest of the world (zone 7), it was not meaningful to fix a specific point as a representation of the weighted average distance. Quite some traffic is to and from the large depots along A 81 motorway northeast of Heilbronn. Since those depots are transfer points, the non-transferred goods must at the average cover a longer trip. This is why an average of well over 100 km was assumed.

Last of all and as a technical remark, we understand that any transport within a zone covers a distance other than zero (or by definition it wouldn't be a transport). However, this internal transport in our model and for the researched supply chains is relevant only for the very small zones 1 and 2, and they have very little such internal transport. Since a better estimate would not add any significant amount of traffic to the total amount, this question was laid at rest.

The distances therefore are a qualified estimate. Actually, the project team members did offhand estimations, purposely done before any calculations to reflect the level of pre-scientific prejudice. It turned out that all figures were at least 50% larger than these first estimations. The handwritten offhand table that got closest to the results stated "0 – 1 (resp. 1 – 0) – 3 – 8 – 12 – 20 – 100" for the distances. As a result we can state that this table already by itself proves that delivery trips are much longer than assumed, no matter which way they are organized.

Traffic count

A specific traffic count was made in Bad Cannstatt for the purpose of SULPiTER.

Traffic was counted at all entry points to the zones 1 and 2 on two days, a Tuesday and a Thursday, from 6:00 to 12:00 and from 16:00 to 22:00.

The following notes must be made:

- The time from 12:00 to 16:00 was not covered; neither was the time from 22:00 to 6:00. While the latter due to low night traffic is not important, the former means that the figures underestimate the traffic. This was a compromise in order to allocate two shifts to the times when most commercial traffic would be expected.
- Traffic was counted for all entries and exits. It is well possible that commercial vehicles run out

of one zone and into the other, and get counted again.

- We have generated corresponding outbound tables. For all entry points we also have figures for passenger cars, bikes and buses. All data is available in hourly time segments. The table below is an excerpt, showing only the commercial inbound traffic per entry point and summed up for morning and afternoon of both days.

It was not easy even for professionals to distinguish between commercial and private vehicles, when it comes to vans or commercialized private cars. Therefore, all figures for the light vehicles may give an order of magnitude rather than an exact count. In a few cases, the results of the count were implausible. Where this was the case, new counts were made on the same weekday, one or two weeks later.

Table: Inbound commercial goods vehicles

Tuesday	Morning (6:00 - 12:00)				Afternoon (16:00 - 22:00)			
Zone 1	Van	Light Truck	Truck	Heavy Truck	Van	Light Truck	Truck	Heavy Truck
C1B	13	34	12	0	14	13	0	0
C1W	102	224	89	3	61	81	1	3
C2L	54	45	3	0	30	22	1	0
C2K	15	52	11	3	15	16	2	0
C3W	58	194	49	6	52	225	17	1
C3K	12	42	18	0	12	35	0	0
C4B	58	42	21	2	41	10	2	2
C4M	3	8	5	0	2	0	1	0
C5B	3	11	4	1	2	2	0	0
C5K	4	4	2	0	1	3	0	0
C6Z	2	9	0	0	1	2	0	0
C6B	0	0	0	0	0	2	0	0
C7M	8	23	5	0	5	0	0	0
C7Z	0	0	0	0	0	0	0	0
C8K	0	0	0	0	0	0	0	0
C8P	0	1	0	0	0	0	0	0
Sum	332	689	219	15	236	411	24	6
Zone 2	Van	Light Truck	Truck	Heavy Truck	Van	Light Truck	Truck	Heavy Truck
C1D	91	152	26	5	41	59	4	2
C2W	19	43	5	0	15	22	1	1
C3D	105	184	57	3	42	53	6	1
C3K	0	2	1	1	0	3	0	1
C4D	69	101	25	5	21	98	9	3
C4E (out only)								
C5E	69	42	11	0	32	58	16	0
C5W (out only)								
C6S	5	5	0	0	5	3	0	0
C6E	10	26	0	0	15	9	2	2
C7B	1	0	0	0	0	0	0	0
C7S	6	14	1	0	6	3	0	0
Sum	375	569	126	14	177	308	38	10

Thursday	Morning (6:00 - 12:00)				Afternoon (16:00 - 22:00)			
Zone 1	Van	Light Truck	Truck	Heavy Truck	Van	Light Truck	Truck	Heavy Truck
C1B	17	32	6	2	3	3	1	0
C1W	58	179	36	2	23	40	2	0
C2L	20	80	6	0	13	35	3	0
C2K	16	64	12	0	0	17	7	0
C3W	69	253	60	1	60	135	12	1
C3K	12	42	18	0	12	15	1	0
C4B	59	35	21	5	35	18	0	1
C4M	1	7	8	0	1	0	1	0
C5B	0	2	1	0	0	1	0	0
C5K	0	4	0	0	0	0	0	0
C6Z	3	4	2	0	0	3	0	0
C6B	4	1	0	0	0	1	0	0
C7M	11	30	6	0	0	0	0	0
C7Z	0	0	0	0	0	0	1	0
C8K	1	0	0	0	0	0	0	0
C8P	0	0	0	0	0	0	0	0
Sum	271	733	176	10	147	268	28	2
Zone 2	Van	Light Truck	Truck	Heavy Truck	Van	Light Truck	Truck	Heavy Truck
C1D	44	181	50	5	42	39	6	0
C2W	23	38	4	0	9	19	1	0
C3D	74	184	62	8	29	93	6	2
C3K	0	2	1	1	0	0	1	1
C4D	75	73	12	5	23	103	2	1
C4E (out only)								
C5E	15	70	15	0	10	54	8	1
C5W (out only)								
C6S	1	5	0	0	1	1	0	0
C6E	6	12	0	0	21	16	1	0
C7B	0	4	0	0	0	0	0	0
C7S	7	2	1	0	12	13	1	0
Sum	245	571	145	19	147	338	26	5

Note: The entry points in this table are each designated by an abbreviation, in each zone first giving the number of the counter. Since in most cases one traffic counter could watch two entry points, these points are distinguished by the first letter of its road name.

Interpretation / Results

All in all, most traffic is through very few entry points. The highest individual number in the above table is 253 light trucks through one entry point between 6:00 and 12:00 o'clock. This relates to an average of

just one light truck per green phase of a traffic light. Traffic lights in Stuttgart operate on a 90 second scheme, repeating 40 times per hour and thus 240 times in 6 hours. The result, although surprisingly high, thus appears plausible.

Commercial traffic is higher on Tuesdays than on Thursdays, which runs counter to the experience with industrial areas. Also, the specialists from parcel service operators would assume the opposite, judging from their own business.

The figures clearly indicate that the majority of commercial goods traffic is not by parcel services. We asked the counters to do an additional count for the fleets of the larger parcel services. Their vans and light trucks indeed entered the zones occasionally, but did not sum up to more of a handful. We assume that their presence is much overestimated, for the following reasons:

- They carry a clear and visible branding.
- They stop multiple times while proceeding down a street, so their presence is indeed more intense than that of other vehicles.
- It is easy to understand what the parcel services are doing, as opposed to a light truck in more or less neutral colours.
- The courier vehicles thus are identified with commercial goods services, and since we see only what we know, we focus upon them.

However, it is clear from the figures that measures targeting parcel services will for sure not have an overall impact on goods traffic, let alone traffic as a whole.

The figures also include vehicles, probably as a significant share, which are not run by logisticians and not even do delivery services at all. They may be related to construction services and utility services. Furthermore, we learned from other sources that a significant number of commercial vehicles is indeed operated partly for setting out or picking up people, be that family members on private trips or working staff.

Nevertheless, the total figures are high enough to justify targeted measures.

Volume, Distance and Frequency

We have tried to derive the volume of the different logistics chains from the interviews. Indeed, quite a number of the interviewed responded to these questions. However, the aggregations did not result in anything plausible. We assume that the shop owners severely underestimate the amount of goods they receive, and they rather see the individual delivery than the big weekly picture.

As a result, we did two different things: We calculated the distances covered by the parcel services, and we made assumptions that allowed doing the same for the total of commercial vehicles. Both were done to establish a feeling for the order of magnitude.

For the total volume of cargo, we did a volume estimate based upon the travel count and a load factor of 0.2, with 80% inbound / 20% outbound traffic. This load factor appears low, but it is measured in tons – in volume, it would be higher. This results in the following average figures:

Van: 56t/day

Light truck: 494t/day

Truck: 407t/day

Heavy truck: 112.5t/day

Table: Origin/Destination Volume Matrix

Zones	1	2	3	4	5	6	7
1 – Historical Bad Cannstatt	0	0	35.7	95.2	47.6	47.6	11.9
2 – Remaining inner Bad Cannstatt	0	0	27.9	74.3	37.1	37.1	9.3
3 – Remaining Bad Cannstatt	142.9	111.4	Due to the size of the cells 3 to 7 and due to the methodology, any traffic between these cells would be meaningless. Also, they are not needed for the purpose of the report.				
4 – Remaining Stuttgart	381.0	297.2					
5 – Adjoining Rems-Murr-District	190.5	148.6					
6 – Remaining Stuttgart Region	190.5	148.6					
7 – Rest of the world*	47.6	37.1					

Unit: Tons

From the traffic count we knew that the parcel services entered the inner Bad Cannstatt each with probably just one vehicle in the morning and one in the afternoon, although their zigzag journey made it appear in several counts. An exception is market leader DHL, for which we assumed two vehicles each for morning and afternoon.

This purposely resulted in the lowest figures imaginably. For each of the parcel services, we know where their depots are. That again allowed calculating the minimum distance travelled by the vehicles of each service. We based the table below upon these assumptions, well knowing that there are some more services on the market and the number of vehicles may be underestimated.

Table: Distance covered by parcel services for "Inner Bad Cannstatt"

Service	Depot location	Distance (single)	No. Vehicles (morning + afternoon)	Total distance (km, out and back)
DHL	Köngen	25	4	200
Hermes	Bad Rappenau	73	2	292
TNT	Korntal	12	2	48
FedEx	Stuttgart Airport	20	2	80
DPD	Ludwigsburg	20	2	80
UPS	Stuttgart	12	2	48
Sum			**10**	**748**

The result for the parcel services was a surprise: Although we claim that the parcel services are an almost neglectable factor in urban goods transport, these few vehicles alone cover a distance of 750

km/day for inner Bad Cannstatt alone. The individual double trip per day for each van is so long that it is risky to run it electrically with today's batteries, although not totally impossible.

We also found that the "last miles" again were a lot longer than expected, varying from 12 to 73 km. The latter is because the Hermes service has many private households as customers, often outside agglomerations, and thus does not bother to locate itself close to Stuttgart.

The location of the depots also make it appear likely that the total kilometres are roughly the same for Bad Cannstatt as for all 15 centers of middle level in Stuttgart Region. By adding an estimate for the much larger Stuttgart downtown, we can assume that parcel services run a daily 15,000 km the very least just to serve the commercial centers of Stuttgart Region!

In a next step, we did the calculation for the total of commercial goods vehicles as counted in Bad Cannstatt. This again needed a number of assumptions: The total count for each day was well above 2,000 commercial goods vehicles, but we do not know how many of them were counted several times, due to their delivery tours. Therefore, for the total calculation we went for the smallest plausible number of just 1,000 vehicles, well aware that any other number up to two times the amount can also be argued for.

We then assumed the origins and destinations. We assumed that only few of the deliveries are within Bad Cannstatt (roughly 15% or about one in seven), but the largest number is from within Stuttgart, significant amounts also from the adjoining district as well as the other districts of the region. We assumed only 5% of the vehicles to have an origin/destination outside the region. That should not be confused with the origin or destination of the goods, of which many come from far away, but get transferred for the last mile. We again wanted to be on the safe side.

The result can be seen in the table below:

Table: CO_2-consumption for a total of 1,000 commercial goods vehicles per day in Bad Cannstatt

Zone of origin	Distance (single)	Percentage	Vehicles (No.)	Total distance (km, out and back)	Co_2* (t/day)
3 – Remaining Bad Cannstatt	5	15	150	1,500	0.5
4 – Remaining Stuttgart	12	40	400	9,600	3
5 – Adjoining Rems-Murr-District	20	20	200	8,000	2.5
6 – Remaining Stuttgart Region	25	20	200	10,000	3
7 – Rest of the world	150	5	100	15,000	5
Sum		**100**	**1000**	**44,100**	**14**

*Assumption: Average consumption of 10l/100km; factor 3.165 for diesel fuel.

We assumed very modest average fuel consumption. In total, one may double all figures and may still be within the range of plausible results. But even with minimum figures, apparently the commercial goods vehicles serving Bad Cannstatt travel a distance equalling a journey around the globe every day, and causing 14t of CO2. The latter figure may not sound very impressive, but it is a daily figure. If we assume the yearly figure to be 300x the daily figure (250 work days plus a smaller amount for weekends), we

reach a total of 4,200 t/year! Again, this is just the figure for one single center of middle level, of which we have many in Stuttgart Region alone.

Alternative assumption

Based upon the above figures, we could now set the target to "make 30% of deliveries emission free", i.e. electric. We would then first assume that we only deal with those deliveries from zones 3 to 6, because the distances to and from zone 7 are too far. That would then be 30% out of 9 t of CO2/day, i. e. a saving of 2.7 t/day or about 800 t/year. Again, this is just the figure for a daily 300 emission free vehicles, serving Bad Cannstatt, and not at all the total for Stuttgart Region.

We would have to keep in mind that almost all of the effect would be along the way between origin and destination, and only a small share would be an actual saving of emission within downtown Bad Cannstatt. This is the result of the surprisingly long "last miles". Nevertheless, we plan to confront the Freight Quality Partnership with these assumptions in order to find out how in their opinion it changes the Logistics Service Indicator (LSI) for Stuttgart.

We could see from our quantitative results that the number of apparent delivery vehicles in inner Bad Cannstatt was much smaller than expected. This of course has to do with the multiple-stop routes. A pedestrian would stumble across the same vehicle several times and in different places during a morning shopping tour and thus get quite a different impression.

We can quantify only the delivery services to and from the inner town. We do know for each larger service where the regional depot is. However, main delivery traffic appears to be much diverse, between the depots and the households. And then there is the layer of the industrial supply chains, resulting in parcel networks of a different pattern as well as in individual flows to and from individual larger industries. While we do know about many such individual flows, we have not yet been able to sum them up and quantify them. However, for the purpose of getting generic and transferable results, these chains are least interesting, because they for sure are specific for each central place of middle level.

We were surprised about a number of findings:

- There hardly is any long-distance delivery into the downtown area. Almost everything is delivered via regional depots.
- The pedestrian zone has much less parking problems than all other areas. As long as the time window is open, the delivery vans can park anywhere. This cannot be said about the side streets.
- Coincidentally, with the new Bad Cannstatt shopping centre we included a centre that has a decent number of delivery ramps, and these ramps are accessible. When we told the logisticians that there apparently are no delivery problems, they were quick to answer that this was exceptional.

Matrix deliveries, e.g.: are some relations predominant among the others? Do you see an homogeneous distribution or a concentration in some zones? Do you see some unexpected phenomena?

Quantity of volume and of delivery services correspond as far as our research went. This would have been vastly different had we included industrial logistics chains.

Matrix vehicles, e.g.: are some relations predominant among the others? Do you see an homogeneous

distribution or a concentration in some zones? Do you see some unexpected phenomena?
The vans basically shuttle between the area they serve and their regional depot, which typically is as close as possible to an Autobahn exit (the optimum interface position for long distance transport). This results in typical flows along the main entrance roads.
Please provide a comment (qualitative description) for your tool's results, e.g.: • *Vehicle-km travelled by each type of vehicle within the study area* • *Traffic pollutant and greenhouse emissions* • *Network assignment* *Other?*
The main result really was from the Bad Cannstatt interviews and of concern to urban planning there. We are not sure that we can conclude from our study to actual vehicle types' travel, because the segment we observed is rather small. The same goes for the emissions. The real result was that, when confronted with the result, the logistics people started talking about the problems they had in practice. We conclude that quite a change will happen in the future, with a larger number of electic vehicles doing delivery, and microhubs combined with electric cargo bicycles doing much of the deliveries in the centers of towns larger than about 100,000 people.