Exploring effects of future ITS concepts in the KAN-region on office locations

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Samenvatting

Een verkenning van de effecten van toekomstige ITS concepten op kantoorlocaties in de KAN-regio

Dit paper laat zien dat toekomstige ITS concepten die zijn gericht op het vervoeren van personen een verschillende invloed zullen hebben op de aantrekkelijkheid van kantoorlocaties in het Knooppunt Arnhem Nijmegen (KAN). Dit gebeurt aan de hand van de specifieke inhoud van toekomstige vervoersconcepten en de kennis over de specifieke wensen die verschillende typen bedrijven hebben ten aanzien van een locatie. Het gewicht van de aantrekkelijkheid in termen van ruimtelijke consequenties is afhankelijk van het aantal bedrijven dat onder een bepaald type valt en het aantal medewerkers dat vervolgens bij een type bedrijf werkt.

Summary

Exploring effects of future ITS concepts on office locations in the KAN-region

This paper shows that future ITS concepts for passengers have different impact on attractiveness of office locations in the KAN-region. Further, it explores the impact on attractiveness of office locations by linking the concepts to company types. Data on employees of different companies is obtained by using the Reach browser, which again uses data from the chamber of commerce. Finally, the scale of impact depends on the total amount of employees working in these zones.

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1. Introduction

The development of Intelligent Transport Systems (ITS) has taken a leap in the past decade. Under strong influence of improved Information and Communication Technology (ICT) industries, automotive suppliers and scientific institutes have put much effort on developing a range of ICT based applications for vehicles to drive safer, more comfortable, to make more efficient use of current and future infrastructure and to manage fleets more accurately. Policymakers show increasing interest in ITS as a tool for solving traffic and transport problems facing society (e.g. congestion, environmental damage and traffic safety). This interest of policymakers is backed by findings of preliminary scientific research which show that promising perspectives seem within reach (Marchau & Van der Heijden, 2003). *'ITS is different from transportation advancements that it promises to increase the system's throughput substantially* […] (Tayyaran & Kahn, 2003: 91). However, with respect to ITS policymaking many uncertainties exist regarding for instance real traffic impacts of ITS (drivers might adapt their behaviour) and conditions for implementation (e.g. acceptance among users, liability in case of malfunctioning devices), legal issues (Van der Heijden & Van Wees, 2001) and safety potentials. Hence, on the short term, the way in which ITS will affect the traffic and transport system performance is still everything but sure. Although throughout the past years more and more knowledge is gained on the validity of intended ITS impacts and conditions for implementation, there is still a lot of work to be done in this area.

In addition, the long-term effect of ITS on spatial dynamics is even more uncertain. Despite this uncertainty, the expectation that ITS concepts will, in the long term, have significant spatial effects on the location pattern of, in particular firms, is plausible. We can conclude from history that innovations in transportation systems have had significant influence on spatial patterns of activities (see e.g. Filarski, 1999). In general, distances between activities like for example residing and working have increased. Although some patterns of development are clear and can be explained easily, the nature of the relation between new transportation services and infrastructure and spatial patterns of locational development remains difficult to make explicit (see e.g. Banister, 1995). Therefore, we have to develop hypotheses on these relationships with regard to the introduction of ITS.

First, we assume that the implementation of ITS will change the preferences of actors regarding office locations of companies. Secondly, we assume that if preferences will change, they follow the pattern of ITS implementation. The theoretical background and the methodological exploration to research these hypotheses are described by Argiolu *et al*. (2004a).

This paper tries to illustrate what this hypothesis could entail by linking the two main elements of the hypotheses: namely, *the future ITS concepts* (1) and *offices that are geographically dispersed* (2). Interesting questions are for example, what locations will become more interesting? What companies will be interested? How many employees could have advantage from new ITS concepts? To explore these questions previous explorations are used on the plausible ITS concepts for the middle size city regions like for example the KAN-region[2] (Knooppunt Arnhem Nijmegen).

Section 2 briefly describes five possible descriptions of plausible ITS concepts that could be developed in the KAN-region. It shows that for example ITS technology has different impact on public transport than for example on car driving.

Section 3 explains the theory behind companies' location preferences. It describes the most important ideas behind location theory and shows locations factors that are regarded as the most important ones. Further, this section distinguishes five relevant company types; each group typified by their specific interest in the set of location factors.

Section 4 shows the differences of impact according to future ITS concepts, the company typology and the related amount of employees.

Section 5 concludes with discussion and further research.

2. Future concepts of ITS for the KAN-region

Hypothetically, ITS can contribute to the *attractiveness* of a location. As a consequence, it gains influence on future settlement-considerations. This influences actors that are involved in the development of firm location, whilst making spatial choices. Since ITS are state of the art in transportation and only few data is available, the methodological approach to test the hypothesis is explorative from nature: in other words 'what if'?

A detailed future of ITS is not predictable. First of all, ITS has a wide field of development, ranging from technologies that relate to information provision (for example Variable Message Signs VMS) to steering control, systems that take of certain driving tasks, for example Adaptive Cruise Control (ACC). Roughly, there are three groups of ITS: systems that support the driver in controlling his/her vehicle in a better way (Advanced Driver

[2] The urban region in our case is the Knooppunt Arnhem Nijmegen (KAN)-region in the far eastern part of Netherlands. The KAN-region has 670.000 inhabitants approximately. The region is mainly build up from two cities (Arnhem and Nijmegen) with 160.000 inhabitants each and at a mutual distance of about 15 km. Another 350.000 people live across dozens of sprawled towns and villages between and directly adjacent to both cities.

Assistance Systems: ADAS), systems that support the traveller in finding an optimal mode and route, (Advance Traveller Information Systems: ATIS) and systems that are concerned with a more efficient organisation of traffic flows throughout the existing road infrastructure network (Advanced Transport and Traffic Management Systems: ATMS). The implementation of ATIS and ATMS is becoming rather common in urban and developed regions. ADAS applications use more advanced technology and are still being developed at small scale. However, it is expected that the ADAS applications will be become wide – spread across the prosperous regions in the world. It is also expected that the future of transport will include new applications or even new concepts that use combinations of ADAS, ATIS and ATMS (Argiolu *et al*., 2004b). We are interested in what this might mean for a region like KAN.

Both the number and the content of plausible future ITS concepts for passengers can be determined by a procedure that uses morphological analysis[3]. The first step in this procedure involves the construction and initial exploration of alternative ITS concepts for the future. These ITS concepts are constructed by adding traffic and travel management services to Advanced Driver Assistant Systems (ADAS). The main purpose of this step is to structure and limit the set of alternative future ITS concepts. The morphology is constructed by the appropriate value ranges of the dimensions. This morphology defines the maximum number of possible concepts (Porter *et al.*, 1991). At first basic dimensions constituting the variety of concepts are identified. Secondly, the values of these dimensions are specified and finally all possible combinations of these values are evaluated. The unique combinations of possible values along the different features produced a variety of alternative concepts. Next, these concepts where evaluated to prune highly unlikely or unfeasible concepts. This involved, for instance, concepts that are unlikely to contribute to general transportation goals and/or concepts that were unfeasible from technical and/or societal point of view. For more detail on this process see Argiolu *et al*. (2004b). The result was a total of five concepts, three that relate to car driving and two concerning intelligent public transport.

Dedicated lanes on motorways

The concept of *dedicated lanes on motorways* concerns the development of a dedicated lane on which cars will be able to drive automatically. The time of scope of this concept is about twenty-five years from now. One of the trends is to automate car driving on a dedicated lane

[3] For a more detailed description on the nature of the morphological analysis see Van Doorn & Van Vught (1978). For an example of the use of the morphological analysis see Marchau (2000)

on motorways, only meant for private vehicles that use the appropriate technology. The vehicle support can be both lateral and longitudinal and management is focussed on the single road. The road and traffic information support is strong, whereas information supply on additional services is limited to static pre-trip information. Considering the trend of co-operation, the lateral and longitudinal assistance are dependent on infrastructure support. An example of a future policy investment strategy of a region that is similar to this car driving concept is described by Shladover *et al.* (2001). That concept consists of a dedicated lane for vehicles equipped with a Co-operative Adaptive Cruise Control (CACC). As the main purpose of such a system is to increase throughput in networks, this dedicated lane would be managed as a single road and would be developed on motorways. This car scenario includes 'common' or a static navigation system using GPS and CD/DVD ROM data. The traffic control centre only regulates the demand for dedicated lane use.

Shladover *et al*. (2001) have conducted research on such a CACC lane. *'If the cooperative ACC and protected lane are augmented with vehicle steering actuation (combined with the lane-tracking function already developed for lane departure warning), there is a possibility for getting close to the first really automated operations on a protected lane. Adding some more intensive vehicle-roadside communication…for condition checking at entry, the means for automatically coordinating entering traffic with the traffic already in the lane, and some enhanced traffic management capabilities for integrating operations with the rest of the traffic system (ATMS+) we have the makings of the first single-lane automated highway system'* (Shladover *et al.*, 2001: v).

It should be mentioned that this system is not designed for safety purposes. The safety of the system is similar to what we experience on 'normal' motorways with manually controlled vehicles. Its main goal is to increase efficiency and to obtain a high level of comfort for the driver. The estimated effects on accessibility are based on a study which was performed by Shladover *et al.* (2001). They estimated that the effect of this concept on the throughput in the transport system could be as high as 200%! This maximum effect was based on a decreased time gap between following cars to 0,5 seconds[4] and a 100% market penetration of CACC.

Car driving concept II: safety rules

The *Safety rules* scenario is based on a transport policy strategy focusing on the performance of the underlying road network. The most common policy problem on this road is the relative

[4] Compared to our normal follow up distance of 1,2 seconds.

(un)safety or the relative large amount of severe accidents. The focus is on car drivers, by using network traffic support. Further, drivers are supported with both road and traffic information & information on additional services. These additional services could for example relate to mode changing opportunities (park and ride), hotel reservation, guiding for car parking, cultural event based information etcetera. Whereas the more ‘common’ information supply is dominated by generic information, the additional services information type might be much more tailor-made for the specific traveller. The ‘common’ travel information concerns dynamic route navigation and real time traffic and traveller information. The road and traffic information system needs co-operation from a regional traffic control centre that monitors traffic and provides real-time information.

Car driving concept II consists of vehicles equipped with both longitudinal and lateral control. As the concepts of *dedicated lanes on motorways* is primarily designed to stimulate throughput and comfort in motorways, *safety rules* aims for more safety and comfort on the underlying network. This difference results in the fact that the mandatory control level of vehicles is minimized to hazardous situations such as bad weather. Longitudinal driver support is provided by an integrated system based on ACC and ISA. Real-time information on speed limits is provided by the traffic control centre. To obtain information on obstacles like vehicles or animals the integrated ACC-ISA system uses advanced sensors. The system is always assisting and only mandatory in situations of bad weather or if a vehicle approaches an intersection that is marked as unsafe. Speed and distance parameters are controlled by the traffic management centre. In all other situations the driver is permitted to switch it off.

Besides longitudinal systems also lateral systems are an important technology in *safety rules*. An important system on the underlying road network is Lane Keeping. It is developed to prevent collisions due to overtaking. The system uses sensors that are installed at infrastructure. In case of hazardous situations (for example by overtaking when a vehicle is approaching on side lane), the system intervenes by warning signals and issues the vehicle to keep lane.

This concept is clearly designed to increase safety of using the underlying road networks. The effect of safety is regarded as very good. Besides the safety level the comfort level increases too. The systems that are used in the concept are not expected to have significant effect on accessibility (see e.g. Golias *et al.*, 2002).

Intelligent car driving in activity areas

Intelligent car driving in activity areas is based on car drivers within activity areas supported by single road traffic management activity areas. The rationale in this concept is that the regional government's investments are particularly focussed on traffic safety within these activity areas. The information technology in *intelligent car driving in activity areas* focuses on dynamic route navigation. It suggests alternative routes in case of traffic jams or accidents. With respect to parking, the occupation of all parking lots and major parking areas is screened real-time and 'translated' into information on parking options. Longitudinal systems are used separately from lateral systems. Longitudinal systems are Stop & Go, and detection systems. The detection system uses sensors to avoid pedestrians in front, side to (lateral system) or end to vehicles.

A second safety system that is part of this policy strategy is Intersection Collision Avoidance. This system monitors dangerous intersections and warns or informs the drivers of vehicles entering or approaching the hazardous zone. These systems are based on obstacle detection sensors used to avoid encounters with other vehicles and vulnerable road users (i.e. pedestrians). The employ detection functions as a roadside-to-vehicle or even as a vehicle-to-vehicle communication system (Ertico, 2002). Support of information on destinations and travel and support on information on vehicles at intersections is facilitated by a traffic control centre.

Finally, the investment strategy contains information on road speeds by introducing Intelligent Speed Adaptation (ISA) within all activity areas. The system is assisting and meant to help (and not to control) the driver.

It is expected that a concept that combines the systems described above, would increase the safety level significantly. Further, it is expected that this concept would also increase the drivers comfort and that the better management of inner city traffic would increase the throughput.

Automated buses

This concept is based on the use of fully-automated buses for the use of collective passenger transport on dedicated lanes. The scale of the concept is similar to what currently is used for light rail and bus systems using dedicated infrastructure. An important reason to invest in a road-based ITS system over a conventional system like light rail, is the relative low costs in infrastructure construction (Miller *et al.*, 2002). Further, the infrastructure can be developed faster and has lower exploitation costs and is more flexible in usage and expansion in network. A second important reason is that automated transportation is more cost-efficient since high costs on personnel are saved. This means that transport services can be provided cheaper and more frequently[5].

Important feature of the buses is the automation technology. The buses are fully automated and controlled through a combination of a board computer system with pre-installed data on maps, GPS, sensor technology for longitudinal control and obstacle detection and an advanced lane keeping system for lateral control. The infrastructure is dedicated and only available for vehicles that use the appropriate technology.

The management of the system is supported by a regional traffic centre. This centre functions as a control room, where information is selected, vehicles are being identified and from which, in case of emergency, technicians are sent. Systems like Automatic Vehicle Location (AVL) and Short Distance Radio (SDR) are used to give priority to the buses that approach traffic lights. SDR saves time and therefore improves reliability of the transport services. Another feature of the management system is that the infrastructure might also be used relatively easy by other transport services. In a well managed slot system, taxi's can buy slots to use the infrastructure. Besides taxis, the dedicated lanes could also be used by emergency services like police, fire fighting and ambulances.

Passengers that travel by this bus system enjoy the benefits of a dynamic information system on travel and additional services (e.g. mode changing). Extensive use is made from an improved version of what is currently developed as a Personal Intelligent Travel Assistant (PITA). This device is personally distributed and serves both as an electronic payment device and keeps track of all information that is relevant to the control centres and the passenger. All scheduled travel information is loaded in the memory of PITA. If a person is for instance travelling from station X to station Y, and a malfunction occurs, this person can power up his PITA, using his chip-card, which will calculate and show the alternative route to Y.

Current case studies on systems similar to public transport concept show that it could have a positive effect on accessibility, environment and the travel comfort level (see e.g. Miller *et al*. 2002).

[5] 80% of a public transport company costs that exploits bus trips are based on personnel (see Argiolu, 2002). One can imagine what savings an automated bus system could have. It could for example lead to cheaper transport or additional investments in travel facilities or a more frequent trip schedule.

People Movers for intra-urban travel

This concept offers automated individual passenger transport services within activity areas. The technology is less controlled due to lower speed and corresponding safety measures.

This second public transport system covers intra-urban dedicated infrastructure that transport small groups of travellers from the cities main train stations or P&R facilities to various activity centres within the city area. It could also be implemented on intra-urban roads that connect densely used activity areas that generate large flows of passengers. Examples of such areas are large office locations, universities, medical centres and shopping malls. The infrastructure is dedicated to support both lateral and longitudinal control. Detection systems are fully integrated sensing all static and moving objects. The provision of information in this concept is similar to that of *automated buses*.

The effect of this system on safety is neutral. Its purpose is not to increase safety, but to offer a more reliable and comfortable means of (connecting) transport. People use dynamic information, and experience a quiet and smooth travel mode.

3. The influence of the five ITS concepts on location preference

In this section we explore the possible influence of the five concepts on office locations. The motives of firms to (re)locate have been a scientific issue since 200 years approximately and can be summarized by so-called (re)location theories. Pellenbarg *et al.* (2002) distinguish three approaches of (re)location theories: the neo-classical, the behavioural, and the institutional approach. These could be extended with a fourth, namely: the ‘classic’ theories. For more information on the three ‘older’ theories I refer to Argiolu *et al.* (2004a).

Other than the three older approaches, institutional approaches do not only look at the firm, but also consider the social and cultural context in which this location behaviour is embedded. This view is based on the idea that firms have to negotiate with deliverers and suppliers, local, regional or national governments, labour unions and other institutions, about prices, wages, taxes, subsidies, infrastructure, and other key factors in the production process of the firm. Locational behaviour is the result of the outcome of these negotiations (Pellenbarg *et al.*, 2002).

Because of a risen complexity and less belief in deductive approaches, more research has focussed on empirical data. Characteristic about these data is the aim to explain location development according to preferences or so-called settlement factors. To predict or explain movement of companies, various stated preference surveys have been conducted. Although some results differ, little change seems to have occurred in the last decades regarding the nature of these location- or so-called settlement factors in the Netherlands. Lukkes *et al*. (1987) described four factors of increasing importance: accessibility, representation, proximity of clients and the quality of the building in comparison with the price. Later, Atzema & Wever (1994) note that lack of accessibility plays an important role as a *push*-motive[6] for companies. Further, accessibility was the most important *pull*-factor[7], which included proximity to clients, suppliers, local unlocking and parking lots. More recently, Pellenbarg *et al.* (2002) emphasise the work of Louw (1996); he found that the most important motive to leave a location is the fact that a firm has not enough space to expand.

In latter stages of the decision making process to relocate, location specific features, like for example accessibility and representation, become increasingly important. The final stages are characterised by negotiations about prices of location and parking space. As described, companies prefer multiple settlement factors. Furthermore, the emphasis on the specific factors is influenced by the differences in the nature of companies.

Table 1, which is based on an overview described by Louw[8] (1996), is a typology based on this distinction. According to table 2 '*stationeries*' are considered to be more interested in public transport facilities than for instance '*modals*' are. Companies that are mainly attracted by representation and aesthetics are regarded as '*visuals*'.

Embassies, account offices and universities can be seen as '*classicists*'. They prefer settlements that are characterised by historical and dignified milieus. It is clear from table 1 that whether the five concepts will make certain office locations more attractive depends, besides the content of the future ITS concept, very much on the specific interest of the companies. Eventually, we need to reckon for the fact that the differences between the ITS concepts might also trigger different subgroups. So, what if we regard table 1 and link this to our five concepts?

Stationeries are organisations with a strong preference for locations near public transport facilities. That would mean that especially concepts like *automated buses* and *People Movers for intra-urban travel* would be interesting for those companies.

Contrary to stationeries, modals will probably not be very interested in future ITS concepts that are developed within public transport. Instead they could be more focussed on locations that are unlocked by motorways or the underlying road network.

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[6] Push-motives are reasons to move from a location. An example is the lack of space to expand.
[7] Pull-factors are reasons that relate to a new location. An example is an ideal accessibility in the new situation.
[8] The table is based on research performed by the Dutch real estate company DTZ Zadelhoff

	General location preferences	*BIK-codes*
Stationeries	Organisations with a strong preference for locations near pubic transport facilities. Other important factors are: working conditions, such as a nice atmosphere, flexibility within the interior design and organization of the building and accessibility of the entrée. Representation is of less importance. This group consists of governmental and non-profit organisations.	70201 and 70202 (e.g. housing organisations) governmental organisations 751/ 752/ 753
Modals	'Modals' need common buildings with standard facilities. Accessibility by car and the presence of parking lots are important. There is no need for a representative building, and the proximity of public transport is even less important, whereas the rent price should be as low as possible. Core activities of this group are mainly non-office companies like industries, trade companies and transport organisations.	743 inspection/assaying and control 747cleaning of buildings and transport services 748 photographic development places
Visuals	'Visuals' consider representation and aesthetics very important. Further, the company name or logo needs a prominent position on the outer wall. The image of the building has to be congruent with its own product. 'Visuals' are willing to pay relatively high rents. Commercial organisations, service businesses, banks and insurance companies are considered as visuals.	651/652/ 660, 671, 672, 701/702/703 (without 70201 en 70202) 72 (computerservices) 73 (reseach and development activities)
Ambulatories	Most important location factor for ambulatories is accessibility by car. This group provides its services predominantly outside the building, with the building as base. Representation is of less importance as most of the clients are spread throughout the country. Ambulatories are mostly smaller businesses (less than 20 employees) in the services sector: banks and insurance businesses.	BIK code same as previous (visuals), but with employees <20
Classicists	These users prefer settlements characterised by historical and dignified milieus. They opt for traditional buildings. They settle in city centres and accept less accessibility by car. This group consists of law firms, accountant offices, notaries, brokerages and some governmental institutes, like embassies, for whom representation is of less importance.	74 other services (e.g. accountants, architects, advertising agencies, designers).

Table 1. Location preference of different companies Source: Louw, 1996 (edited version)

Concepts that could be developed on that level are dedicated lanes on motorways and car driving concept II: safety rules, of which dedicated lanes on motorways will probably have more impact on throughput but will on its turn be developed on the long term, since its technology is currently less advanced than what is used in car driving concept II.

The difference between *visuals* and *ambulatories* is based on the amount of employees they have. According to our table visuals are mainly interested in representation and aesthetics. And they are willing to pay for those features. Their accessibility by car and public transport is important. In contrary, ambulatories only need good accessibility by car as they have the majority of their work time out of office. Both types of company would be interested in concepts like dedicated lanes on motorways and intelligent car driving in activity areas. Perhaps visuals also show interest in public transport improvements, like automated buses and people movers for intra-urban travel.

Classicists have a rather firm interest in the older areas of cities. Their interest in transport improvements is focussed on systems like intelligent car driving in city areas and people mover systems for intra-urban travel.

4. Illustration: 'visuals' and 'ambulatories'

Besides the interest of companies in office locations based on an improvement in the form of accessibility in terms of comfort, time and reliability, for spatial implications it is interesting to look at the impact this interest could have based on a focus on employees working for certain types of companies. Relevant questions would for example be: 1) where are *visuals* settled? (which will probably be they main area of interest (if it comes to location preference)) 2) how many *visuals* companies can be identified? 3) And how many people do they employ? Section 4 illustrates the differences by looking at visuals and ambulatories.

To answer the questions data is needed in the companies' current location, and how many employees they include. Further, that data has to be structured according to the typology of table 2. The Reach Browser is used to obtain this data. This browser is a financial and marketing browser which is linked to a database by ip-adress. The database information is delivered by Elsevier Company information, the Cambers of Commerce and search- and analyse software from Bureau van Dijk. Reach includes the financial information of at least the last six years, branch codes, names, telephone number, addresses, zip-codes etcetera. The branch code that is used is called BIK (*Bedrijfsindeling Kamers van Koophandel*) and can be translated as Company classification Chambers of Commerce. It is comparable with the Dutch so-called *Standaard Bedrijfsindeling* (SBI), translated as Standard Company classification, which is used by the Dutch national Central Bureau of Statistics (CBS). The third column of table 1 is used to cluster the different codes according to the description that is given in the classification. The classification in table 1 mainly includes the so-called service sector extended with organisations that are also considered to operate as demanders on the same office location market. These organisations are for example foundations and semi-private housing corporations (especially stationeries). Note that the only difference between visuals and ambulatories is the amount of employees working at a specific location.

	Sum of organisations	Sum of employees
Stationeries	69	1223
Modals	1621	6376
Visuals	180	12386
Ambulatories	6311	12877
Classicists	7401	30150
Total	*15582*	*50626*

Table 2. Sum op people working in different branches in KAN-region[9]

Table 2 shows the sum of organisations that are settled in the KAN-region and the corresponding sum of employees. Note for example that there are 12000 people working for visuals and ambulatories although the sum of organisations differs significantly. Classicists form the largest group with 7401 organisations and 30150 employees.

The difference in sum and geography is illustrated by figure 1 and figure 2. What is visible from the map is that indeed, the largest concentration of employees that are working for so-called ambulatories are pinpointed in the city centre of Arnhem and the city centre of Nijmegen. For example the sum of employees (SumOfB) for Arnhem city centre is 567 and for the city centre of Nijmegen is 550.

The legend shows that there is one zip-code with 420 to 480 employees, which is zip-code 6814 (central station area) an area that is directly adjacent to the city centre of Arnhem. Figure 2 shows the map including visuals. If we look at this map we see that the main concentration is somewhat comparable with that of ambulatories. However, in accordance with what is argued in table 1, the largest concentration is in zip-code 6826.

[9] A problem while working with the data was that especially larger, mainly companies operating nationally and internationally, included data that concerned all employees working for the business. This was checked by calling all the offices of those companies. This indeed caused a shift in employees working in a branch. Another problem was that especially cleaning companies have many people under contract of which only a small percentage is actually working at the office location. To middle that data a mean was calculated for these companies, which was further used for the remaining cleaning companies. Although some data will not exactly represent the precise amount of people working at a specific location at this moment due to incorrect data and fluctuations, the data file is quite large and gives a reliable illustration of people working in certain branches at certain places in the KAN-region.

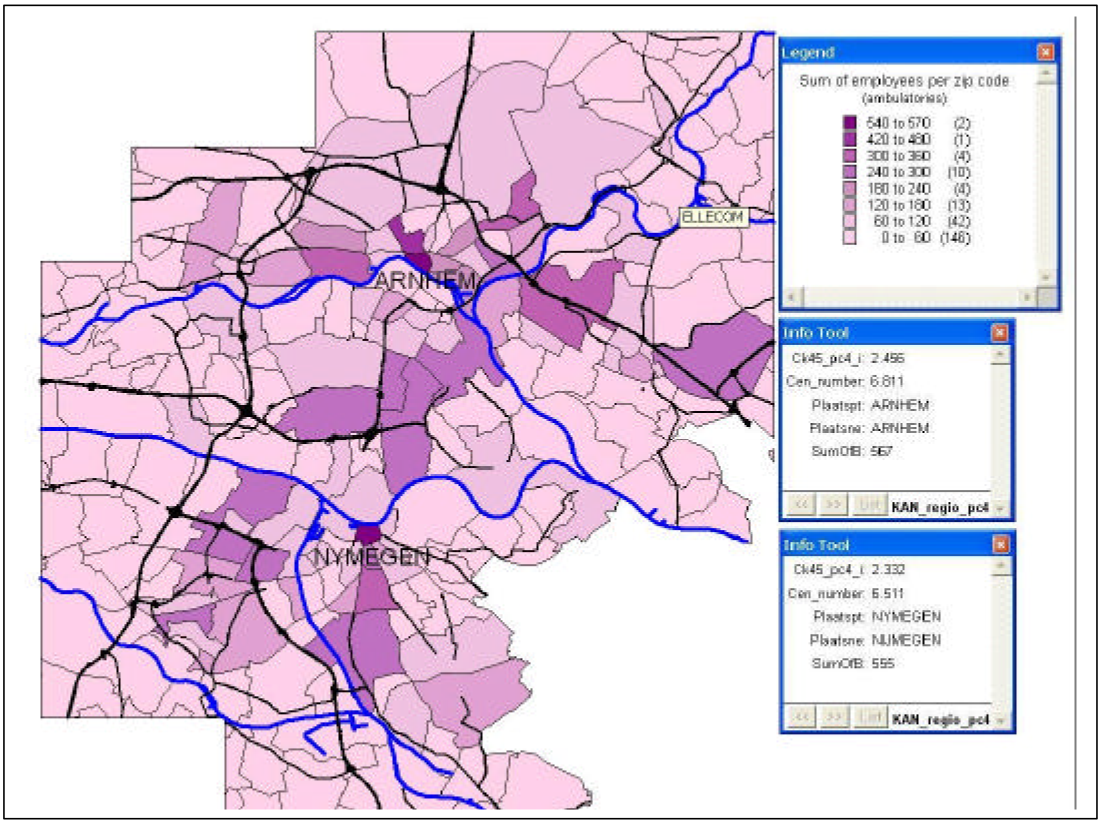

Figure 1. Geographical distribution of 'ambulatories' across KAN-region

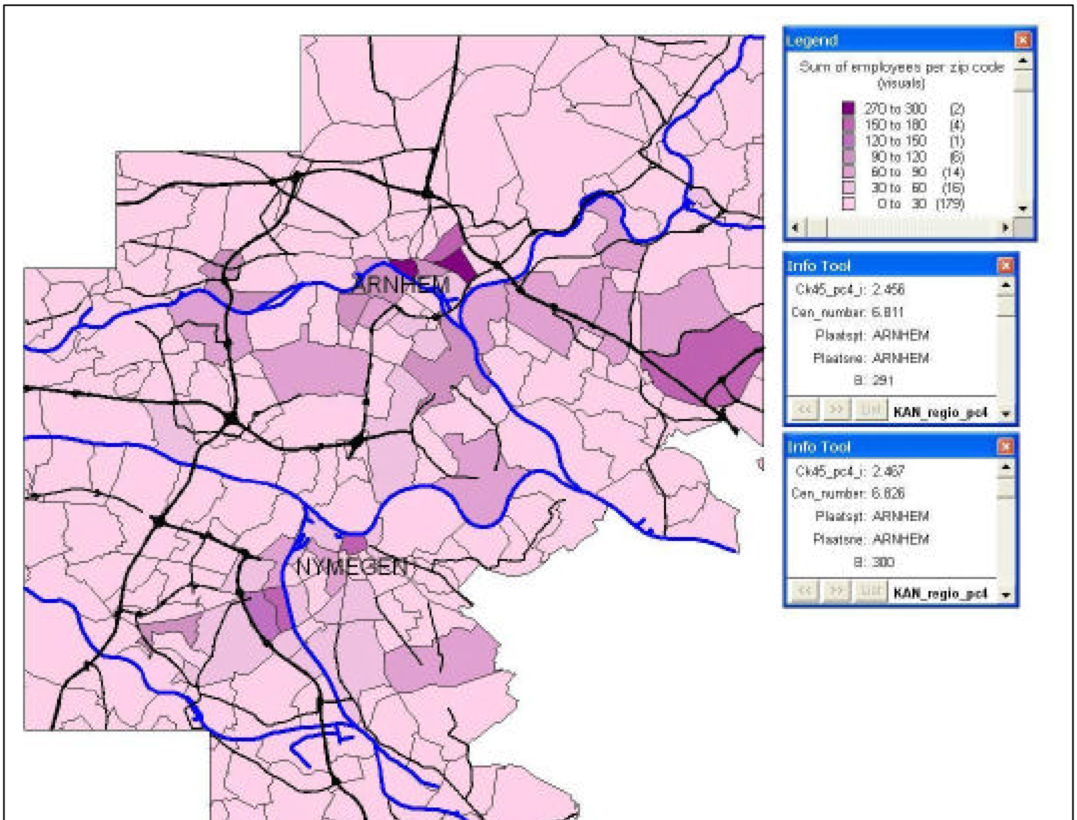

Figure 2 Geographical distribution of 'visuals' across KAN-region

The reason for the concentration of visuals is very likely a result from the business parks called IJsseloord I and II. Another concentration that is different from the ambulatories is that in the south-western part of Nijmegen. The reason for that concentration is comparable with the Arnhem area. In that part of Nijmegen lies business park ‘De Brabantse Poort’.

Although the sum of companies that could be typified as visuals is much lower than those as ambulatories, the amount of people that work at those companies is almost equal. Investments in new intelligent concepts that focus at inner city locations would probably interest a large amount of companies and would benefit many employees (and we did not even look at classicist that have a specific interest in inner city areas according to our table). Investment strategies at motorways and the underlying road network have more influence on locations that inhabit more visuals than ambulatories, but still a considerable amount.

5. Conclusion and discussion

Geographical differences of future ITS-based concepts might result in changes in location patterns. It has been argued that location choices of businesses are to a significant degree sensible for perceived differences in accessibility, either in terms of the travel costs (time, money) or in terms of distance. A next step in reasoning is that these differences in accessibility at a certain moment might lead to gradually changing location choice behaviour of businesses and commuters. These choices will be characterised by a preference for locations that are better accessible by ITS-based transport services as compared to locations that are not. Measured in terms of a long periods (decades), we expect a geographical pattern of (at least certain) business activities that increasingly will match with the geographical pattern of high level ITS applications.

To test the research hypothesis two main studies will be done. The first is a Delphi-expert study to specify the combinations of ITS applications that are plausible to be developed in the future. The second will be a stated preference survey among companies. Comparable studies (see e.g. Tayyaran *et al*., 2003; Tayyaran & Khan, 2003) show that the proposed methodology can be fruitful in answering questions on impact of IT and ITS on location choice. Their results show that for residing ‘[…] *telecommunicating and ITS measures are highly significant factors in the residential choice model’* (Tayyaran *et al.*, 2003: 171).

Clearly many operational decisions have to be taken for performing these sub-studies. A variety of issues has been mentioned already. Important is that by exploring the issue in this paper, and the first attempts to translate them into researchable questions, an important step is made for more systematically studying a challenging issue to link technological innovation and spatial development. Evidently, we will report on the progress in future.

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