Commuting in knowledge intensive organisations: an outline of six different practices

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Introduction

The disadvantages associated with commuting by car are among the most challenging aspects of urban transportation, both in terms of local pollution and global climate effects like CO_2 emission. Norwegian White Paper 26, covering the period of 2018–2029 (National Transport Plan), states that any future growth in private transport in larger cities should be absorbed by public transport, cycling and walking. The Paris Agreement has highlighted the need to implement strategies to curb and reduce emissions in the transport sector globally, and reduction of emissions in urban areas is a priority (FCCC, 2015). Yet, despite the many national and international initiatives in planning, administration and research, commuting is still dominated by car-based transportation in larger European urban regions (Aguiléra & Voisin, 2014; Santos et al., 2013).

To implement efficient and targeted transport policies, it is crucial to have a clear understanding of the commuters' characteristics and travel behaviour, as well as factors that are important for their commuting habits. However, a significant shift in the workforce in most Western countries in recent decades has been the steady growth of knowledge-intensive work. *Knowledge-intensive organisations* (KIOs) hardly depend on traditional localisation factors, such as access to natural resources and infrastructure for freight transport. Some knowledge enterprises depend on good access for customers/clients, but this does not apply to all KIOs. Like most other types of businesses, knowledge businesses depend on the supply of labour. For KIOs, however, employees are the most important production factor, and their performance level will be the principal factor in growth and profitability. Thus, the competition for the best minds will influence both the site selection and choice of personnel policy. There are many aspects of this *competence competition* that directly affect staff travel patterns, including the attractiveness of the local environment (e.g. converted industrial riverside buildings), the design of office buildings (landmark buildings) and special services related to location (e.g. parking spaces, bicycle garages).

The shift outlined above is not radically new, but it has implications for multiple areas related to urban development and transformation, including transportation and commuting, which are rarely addressed in detail. At the heart of these transformations are knowledge workers and KIOs. Although there is no single definition available, knowledge workers are usually described as highly qualified individuals who work with high flexibility and autonomy (Alvesson, 2004; Robertson & Swan, 2003). KIOs are business enterprises that operate in areas believed to be based on knowledge and continuous innovation, typically in industries like information technology, engineering, high-tech manufacturing, consulting or pharmacies. This may also

include parts of public services, such as higher level administration, higher education and institutions based on expertise and competence. For policymakers, there is often a political objective to attracting and stimulating knowledge-intensive work in urban regions, often by initiating the development of business clusters for knowledge-intensive workplaces. At the same time, there is a persistent need to curb car-based commuting around these hubs or sub-regions. The risk is that cities may become rich in human capital but score poorly on environmental sustainability indicators due to unrestrained car-based commuting. To avoid this situation, there is a need for a better understanding of knowledge workers' commuting behaviour and relevant measures to stimulate transitions from cars to public transport, bicycling and walking.

Several studies have suggested that knowledge workers may have different work styles and mobility choices compared with other types of employees, including greater flexibility, less regular commuting patterns and different preferences for residential location (Kunzmann, 2014; Spencer, 2015; van Oort et al., 2009). The way these factors influence commuting, however, has remained unclear, with the focus on residential locations and differences in knowledge bases rather than on commuting trips per se. This paper intends to build on existing research, but it investigates the car-based commuting practices more closely among a sample of highly skilled workers in four enterprises in the greater Oslo region. This region has experienced a growth in KIOs and knowledge workers over the last few decades, and like many other European urban regions, it struggles with high levels of car-based commuting in the outer parts of the city. This paper addresses a question relevant to all cities that have a growing number of knowledge-intensive workplaces: How can measures be designed to support transitions toward more sustainable travel behaviour among knowledge workers? To answer this question, we argue that it is necessary to study socio-demographic characteristics and the material environments, as well as how commuting is performed as social practice. As such, we use a combination of inductive and deductive methods to extract the most central commuting practices, opening for a finer grained understanding of the commutes as they are performed and possible ways to mitigate the use of cars.

In the next section, we give an overview of the literature concerned with knowledge workers' mobility and how this topic has been studied in the context of urban commuting. Here, we provide a brief outline of theoretical approaches on social practice before presenting the methodology applied and the context for our study, which comprises four enterprises situated in the greater Oslo region. Based on this, we present findings that particularly address the various ways that knowledge workers perform their commutes. Our discussion and conclusions in the

last section use the findings to suggest better ways to promote sustainable transportation to and from work for knowledge workers.

Theoretical overview

Knowledge work in urban regions

The growth in knowledge-based work and related social changes have been key topics in economics and sociology over the last three to four decades (Warsh, 2006); Bell 1976) famously forecasted the coming post-industrial society, which he thought would focus on theoretical knowledge and technological innovations. The idea was later taken up by multiple scholars elaborating detailed descriptions of an information society that seemed to transform almost every social sector as new digital technologies evolved (Lyon, 1988; Webster, 1995). Manuel Castells (1996) outlined how digital networks had become the backbone of a new kind of business enterprise with a new knowledge-based workforce, increasingly operating within the 'space of flow'. Richard Florida (2002) took this discussion further, discussing knowledge work in the context of urban development, creativity and growth. He agreed with earlier scholars that information and knowledge are crucial for economic growth and the prosperity of nations but claimed that it is the particular urban environments that facilitate creativity and innovation. More than just knowledge workers and human capital, Florida described a new and broader category—the 'creative class'—that he saw as critical for economic development. Not only has the creative class experienced explosive growth during the last 50 years, but it has also created a new kind of economy where knowledge is at the heart of the new business processes, innovation and global competition. Florida's thesis has influenced much later work and policies to develop knowledge-intensive urban regions. Thus, efforts to ensure competitive regional strategies for *knowledge-based urban development* (KBUD) have been carried out in many urban areas (Yigitcanlar, 2010).

Although Florida's argument on the advent of a new creative class has been much disputed (Lawton et al., 2011; Ratiu, 2013), the understanding that knowledge-based work has become a new and decisive factor for modern urban economies rests on solid ground (Acs, 2002; Drennan, 2002; vanOort et al., 2009; Warsh, 2006). A developed workforce of knowledge workers is critical for urban economic development, and urban planners should pay attention to this large group of workers when implementing transport policies. They are also likely to continue to grow in

numbers, and they have a key role in the development of innovative and economically sustainable urban regions.

Studies of urban commuting

Commuting represents a challenge for urban regions due to the dominance of car-based transport, which causes environmental problems and takes up land and urban space. Thus, studies of commuting in urban regions have been interested in general factors that are important in explaining and influencing modes of travel for commuting. This research has progressed along slightly different pathways. First, there is a large volume of research addressing the influence of residential areas' location for travel behaviour in cities (Ewing & Cervero, 2010; Handy et al., 2005; Lindsay et al., 2011; Stevens, 2017). Most of these studies focus on general urban structure and the locational qualities of the commuters' residential areas. Empirical work has found strong evidence that neighbourhoods with certain qualities—high density, compactness, a mix between residential and work areas and a specific distance to transport facilities—are particularly important for lower car use and shorter commuting distances (Aguiléra & Voisin, 2014; Cirelli & Vineri, 2014; Næss, 2012).

Over the last few years, location-based studies of commuting behaviour have been criticised for having a myopic focus on the dimension of urban density in residential areas as an explanatory factor (Coevering & Schwanen, 2006; Larson & Yezer, 2015; Mindali et al., 2004). Consequently, recent works have increasingly included a wider set of variables, such as transport infrastructure and workplace location and connectivity. Studies that focus on constellations of residential and workplace regions have become more common, and a central theme is whether centrally located workplaces in a city with good transit options is more efficient for curbing car-based commuting compared with polycentric urban structures with dwellings and workplaces close to public transport nodes that are distant from city centre (Næss & Sandberg, 1996, Acker & Witlox, 2011; Aguilera et al., 2009; Manaugh et al., 2010; Vale, 2013). So far, the discussion about this seems to be unsettled, although studies in a Nordic context tend to support the 'centralisation' approach (Engebretsen et al., 2018; Wolday et al., 2019; Newman & Kenworthy 2006).

Recently, urban form studies have also paid more attention to individual decision making as representing factors relevant to explaining urban commuting in the context of the built environment. In a recent qualitative study of commuters in the suburbs of Oslo, which is particularly relevant for the current paper, Næss et al. (2019) found that time saving and flexibility were dominant rationales for commuters' car use when combined with insufficiently developed

infrastructure. Moreover, they found that the employees did not necessarily choose the closest jobs, but instead, would travel a bit farther if they could find better jobs. Clearly, the job applicants also needed to be selected by the employers in competition with other applicants.

A second stream of studies, coming from environmental psychology and economics, addresses *motives and attitudes* as driving forces for commuting behaviour (Abrahamse et al., 2009; Clark et al., 2016; Keye et al., 2018; Ye et al., 2018). In the framework of traditional psychological attitude theory, in particular the theory of planned behaviour (Ajzen, 1991), behavioural intention is considered a crucial psychological factor that determines real behaviour, and in turn, directly influences commuters' choice of travel modes. Studies within this field have suggested that attitudes towards cars and public transport are composed of symbolic, instrumental and affective components (Anable, 2005; Steg, 2005). Drawing on this basic framework, empirical studies of commuters have found some evidence that commuting behaviour, such as mode choice, routing options and public transport services, can be traced back to attitudinal structures (Abrahamse et al., 2009; Heinen, et.al. 2011; Ye & Chen, 2018). In some recent studies, material and behavioural aspects have also been included and combined with attitudinal dimensions (Bösehans & Walker, 2020; Mendiate, 2020; Pengfei, 2020). An example of this is Mendiate et al.'s (2020) study of commuting cyclists in Mozambique, which found that, despite the similarities in attitudes, commuters behaved differently according to the characteristics of the urban fabric in which they live, work, shop and enjoy their leisure.

In addition to the urban form and attitude-based approaches, there is extensive literature on the *influence of demographic variables and lifestyles* for commuting choices, such as gender, age, household composition and income (Anable & Gatersleben, 2005; Guell et al., 2012; Sandow, 2011; Steg, 2005). Related to studies of demographic variations, the complex relationships between location structures and factors related to urban lifestyles have been further explored (Frenkel et al., 2013b; Heinen et al., 2010; Schwanen & Mokhtarian, 2005; Vos et al., 2012). To some extent, this work has been polemical in the established tradition of urban form works, which have dominated the discussions and policies in this field. In a study of selected cities in the Organisation for Economic Co-operation and Development (OECD) countries, it was found that everyday sustainability practice (including commuting) was primarily a function of individuals' socio-economic characteristics and environmental concern, while factors related to urban form were less significant (Lo, 2017). Lately, more attention has been given to the importance of equity and the uneven nature of most metropolitan regions in discussions about sustainable urban commuting. An important, but often neglected, reason for long-distance commuting in larger metropolitan areas is housing affordability, which appears to be highly correlated with population

density (Clark, et.al., 2013; Modarres, 2019). As urban core density increases, housing affordability is diminished, pushing middle- and lower-income populations further away. Thus, sustainable commuting modes become a 'privilege' for those who can afford to live in the right districts.

Knowledge workers commuting

The growth in knowledge workers in urban regions has given rise to some discussions about certain factors that may influence their commuting behaviour. First, it has been argued that this represents a group with distinctively different amenities and lifestyles and that they prefer to live in certain residential areas. A central part of Florida's (2005) thesis is that workers who are part of the creative class prefer to live in places with a vibrant city culture, a diverse set of leisure activities and good opportunities for alternative lifestyles. In his work, tolerant and diverse neighbourhoods are key qualities that attract talented employees to particular regions. Although Florida did not explicitly discuss commuting, he emphasised that knowledge workers prefer mixed-use urban settings for both living and working (Florida, 2002, p. 164). This position has been much disputed, and the thesis that knowledge workers prefer to live in very different residential areas than other workers do has been contested (Frenkel et al., 2013a; Lawton et al., 2011; Niedomysl & Hansen, 2010; Spencer, 2015; Zhao et al., 2017). However, studies have found that much long-distance commuting to and from city areas is done by people with high education (Engebretsen et al., 2012; Viry & Vincent-Geslin, 2015). Although they are not overrepresented among groups of long-distance commuters, findings from a cross-European study suggest that they tend to move in and out of long-distance situations more frequently than other groups do (Viry & Vincent-Geslin, 2015). Studies indicate that high-income workers have increased commuting distance due to reverse commuting when workplaces in city municipalities are relocated to suburban regions (Aguilera et al., 2009).

Another issue is that knowledge workers may take on different commuting patterns due to particular *work styles* related to a larger share of information and communication technology (ICT)-based work tasks. In general, knowledge work has a higher level of flexibility than service or industry-based work does. Typically, the focus is on the production of some forms of information, documents, ideas or concepts, making 'workplace' a more elusive term. For many knowledge workers, the home or leisure home may represent a possible place to conduct parts of their work (Aguiléra et al., 2012; Rietveld, 2011; Wilton et al., 2011). The development is closely related to the implementation of ICT to support almost all communication, work tasks and

production processes. A combination of organisational structures with higher task flexibilities and the advancement of ICT have made possible an alleviation of the traditional time-space constraints and increased the range of locations and times available for conducting these activities (Alexander et al., 2010; Couclelis, 2009). Thus, for knowledge workers, work may be conducted at several locations and follow flexible and highly individualistic temporal rhythms. Norwegian and international studies indicate that increased access to ICT has increased the tendency to work while commuting (Gripsrud & Hjorthol, 2006; Julsrud & Denstadli, 2017; Line et al., 2012). Studies of residential choices have also found that, to some extent, they are influenced by lifestyle issues. The focus on the knowledge workers' culture and lifestyle has been very limited. An important exception is Frenkel et al. (2013b), who used an inductive approach to explore knowledge workers' lifestyles and the implications for residential preferences. Based on a study of knowledge workers in the Tel-Aviv metropolitan area, they found that residential choice is guided by culture-oriented leisure activity patterns, as well as the 'classical' locational factors (Frenkel et al., 2013b).

A long-held argument is that highly skilled workers have less regular work assignments that make physical co-presence less critical and substitution of commuting more relevant (Cairncross, 1997; Nilles, 1991; Toffler, 1980). However, several studies have documented that the interconnections between ICT and commuting are complex, and this may create a higher level of mobility, as well as reduced mobility (Choo & Mokhtarian, 2005; Fiore et al., 2014; Mokhtarian, 2003). Workers that move into highly irregular work forms, supported by mobile technologies, may end up with a higher need for the flexibility offered by a private car. Still, public transportation provides commuters with the opportunity to work on the journey, which (so far) is not an option for drivers.

Knowledge workers' mobility and commuting behaviour has also been seen as constrained by the particular *type of knowledge* they work with. A key point of departure has been the distinction between analytic, synthetic and symbolic types of knowledge (Asheim et al., 2007). Analytic knowledge concerning principles and causalities is typically found in engineering and natural sciences. Synthetic knowledge involves skills and procedures used to solve practical problems, while symbolic knowledge is related to creative and aesthetic types of work, typically found in creative and cultural industries. Empirical studies have found some evidence that the different modes of knowledge production require different social environments and have different needs for face-to-face interactions. In general, studies have confirmed that knowledge workers in creative sectors are more likely to live and work in city centres compared with knowledge workers that have a more synthetic or analytical core (Musterd, 2004; Spencer, 2015). Based on a

study in the Munich region, Zhao et al. (2017) found evidence that advanced synthetic and symbolic employees had a greater revealed preference for living in central areas than analytical high-tech workers did. Thus, at least to some extent, these more job-oriented studies support Florida's (2002) hypothesis that creative-oriented knowledge workers require more extensive forms of communication and a more developed culture than the other types of knowledge workers do.

The general characteristics of the preceding literature have suggested that knowledge workers may have needs and preferences that differ from those of other groups of employees when it comes to urban commuting. The focus of attention has mainly been on a macro-level related to variations in residential areas and the effect of ICT, as well as the particular type of knowledge that they are processing. The issue of knowledge workers' lifestyles and work style has been discussed to a much lesser degree, although evidence shows that this may be significant. This study follows up this line of research, but it analyses it as a particular type of *work-related social practice* rather than a lifestyle. Consequently, our attention is closer to individuals' everyday mobility practices rather than residential and working areas. This work follows up recent calls for a more practice-based approach in studies of travel behavioural change (Schwanen et al., 2011; Sovacool, 2014; Spaargaren, 2011).

Commuting as a social practice

The point of departure for the descriptions and classifications suggested here relies on a practice-based approach, where we focus not only on material and structural aspects but also on meaning and motives involved with commuting. This can be seen as a meso-level approach where the real routines and work-related processes are in focus rather than attitudes, types of knowledge or structural characteristics of a particular business sector alone (Mattioli et al., 2016). Following a *practice-based understanding* of behaviour, the locus of interest comprises the everyday actions of groups of actors rather than intentions or expected functions. Instead of seeing mode choice mainly as a derived demand, it is viewed as a routinised type of behaviour developed over time, linked with certain types of meaning, skills and technologies (Reckwitz, 2002; Shove, 2010; Warde, 2005). A practice approach places attention on the materiality involved, as well as the meaning and competence attached to the particular practices. This implies a shift of attention from the individual towards the travel-related routinised activities per se and their particular constellations of materiality, meaning and competence. Recently, this has been suggested as a promising alternative approach for studies of commuting activities, where the mode of car

driving is discussed (Cass & Faulconbridge, 2016; Guell et al., 2012). The advantage of this approach compared with more common methods, such as time geography, is that it addresses the constellation of routines, technologies and skills that are integrated in the everyday routine commute more holistically. In contrast to the commonly used activity-based modelling of travel activities (Axhausen & Gärling, 1992; Baustert et al., 2019), a social practice approach draws attention to the role of travel routines and how they bear social meaning in people's lives. Thus, while in the former, the individuals and their choices represent the main object of study, in the latter, practices as part of a social environment are the primary unit of analysis.

Methodological approach and the regional context

Methodological approach

This study is based on a case study of four enterprises in the Oslo region in Norway. A benefit related to a case study approach is that findings from one case can be replicated by other cases, much like repeated series of experiments (Ragin, 1987; Yin, 2003). A chain of cases displaying similar results strengthens a particular hypothesis or finding more than a simple case study does. This is of especial interest here since the cases consist of employees doing relatively similar types of work, although located at different places in and around the city. At the same time, there is diversity among the enterprises, opening for a discussion about causality factors. Thus, the cases have been selected to accomplish the following: (i) secure a variety of locations in different types of areas of the region, which also have differences in transport resources, both in terms of public transport and infrastructure for car use; and (ii) find enterprises/organisations that are comparable when it comes to a high level of education/demand for competence among the employees. Our understanding of knowledge-intensive enterprises is based on the general characteristics and activity field of the enterprises, characterised as organisations where qualified employees form a major part of the workforce and engage mainly in 'intellectual work' (Alvesson, 2004; Giuice et al., 2017). The term *knowledge workers* is used here to describe employees working in these companies.

This study analyses knowledge workers' commuting through the lens of social practice theory, addressing the structural, motivational and work style–related aspects. Drawing on a social practice-based approach, our aim is to explain the car-based commuting activities in KIOs and

define dominant types of commuting practices across four case enterprises. As illustrated in the theoretical overview, current work on commuting behaviour focusses on both material and immaterial variables, including urban structures, individual attitudes, social norms and lifestyles. A social practice approach does not separate these dimensions, but instead, sees them as integrated elements in everyday routines. Hence, to some extent the social practice theory bridges the dominant paradigm, presenting an alternative platform for discussing travel activities.

To understand and display variations in social practices, a general typology of car-based commuting activities is elaborated. The typologies that are elucidated here seek to describe how everyday practices of car-based commuting have taken different forms across four types of knowledge-based enterprises. Thus, much in line with some recent works seeking to group commuters based on a mix of attitudinal, behavioural and demographic dimensions (see above), we establish clusters based on a diverse set of variables.

Most studies analysing social practices rely on a qualitative method. Our study contributes to a small body of research by applying quantitative strategies to capture dimensions of social practices (Mattioli et al., 2016; Southerton et al., 2012; Uteng et al., 2019; Yamaguchi, 2019). Although commuting and mobility at work have been studied through the lens of social practice theory (Cass & Faulconbridge, 2016; Kietzmann et al., 2013), to our knowledge, this is the first quantitative social practice study of commuting in knowledge-intensive enterprises.

To obtain information about the journey to work and the relevant issues, an Internet-based survey was carried out among employees in the four enterprises/organisations. The survey was distributed to all employees in collaboration with human resources (HR) departments in the enterprises. The survey contained detailed questions about the journey to work (including travel length, time use, transport mode, etc.), travel experience and motives for the mode choice. In addition, one- to two-hour talks were conducted with the representatives from the boards in all enterprises to obtain additional information about the company profile and policy to curb car-based commuting.

The survey collected information on issues capturing dimensions of commuting as a social practice, based on the framework suggested by Shove et al. (2012). Items addressing components of meaning, materiality and competence were included, although the first two dominated. To locate and define social practice areas, an exploratory factor analysis (Principal component analysis) and a cluster analysis were used. Clusters were constructed using a log-likelihood distance measure and the Bayesian information criterion (BIC) to define the optimum number of clusters.

It is difficult to give full and complete descriptions of social practices using a quantitative approach, partly because the information is necessarily mediated by the informants' interpretations, by which they 'make sense' of their behaviour in particular ways (Weick, 1995). This can overshadow the social practices that would emerge in observations or through deeper reflections. Results from quantitative data sources cannot give complete descriptions of social practices but merely indicative outlines. However, the strength of this approach is that it opens for an overview and outline of established social practices that may be followed up by later in-depth studies.

Analysis

To obtain information about commuting behaviour and related travel at work, a travel diary approach was used. Informants were asked to describe their last travel to and from work. Seasonal variations and the extent to which the last commute deviated from their regular travels to work were also recorded. Dimensions of materiality included parking facilities and access to public transport at home and at the workplace. For those using cars as their main transport mode, follow-up questions addressed motivations and aspects of meaning. Informants were presented a list of 12 predefined items and asked what their main motivations was for using private car to work (See table 5). Replies was given on a 5-point likert scale. The dimension of competence, also highlighted in many social practice studies, was downplayed in the questionnaire as this was considered to be of lesser importance for the drivers, and no new modes were addressed directly.

The analysis of the data follows three main steps: First, a binary regression analysis was conducted to explore various factors that may have influenced the commuters' decision to commute by car, including work style, locational factors, work needs and demographics. Based on this, we sort out key factors influencing modal choice before we address the car-based practices in more depth in the next section. A factor analysis with varimax rotation has been applied to capture dimensions of meanings and motives. Bartlett's test of sphericity indicated that the correlations between the variable were different from 0 (sig = .000). The Kaiser–Meyer–Olkin measure for sampling adequacy was .595, indicating acceptable levels for further analysis. An inspection of the scree plot showed that four factors explained most of the variation, and adding more components improved the variance explanation to limited degrees. The four main components explained 42% of the variation altogether. The motivational dimensions from the factor analysis were included in a two-step cluster analysis with variables describing workstyle and

locational factors that had proven to be important in the preceding analysis. This extracted groups of employees with similar commuting practices, including dimensions of materiality and technological and situated skills. Clusters were constructed using a log-likelihood distance measure, and Schwarz's BIC was used to define the optimum number of clusters. Based on this process, six practice-based groups of commuters were developed, where travel activities and dimensions of meaning and motives were included. These clusters were then used to discuss variation in practices across the enterprises, ultimately allowing policies to be applied that can target the different practices.

The greater Oslo region

The greater Oslo region is the most densely populated area in Norway, with more than 1.3 million people in Oslo and Akershus county. For the last decade, the region has also been a central destination for intra- and international migration, and it is currently one of the fastest growing urban areas in Northern Europe (Askheim 2020). This has made traffic development challenging, and a shift in transport mode for commuters is especially important. However, the challenges in Oslo are similar to what we can see in many large urban regions in Northern Europe: Outside the urban core, the bulk of the commuting trips are made by private cars to workplaces located in the fringe area or in the centre (Vincent-Geslin & Ravalet, 2016; Vågane et al, 2011). In the city centre, in contrast, a well-developed public transport network gives much higher shares of public transport, as well as walking and biking. Increasing housing prices in the city area force many to relocate to more remote regional areas, including highly educated parts of the workforce. The workforce is characterised by a high number of enterprises with highly educated employees. Estimates show that close to every third employee in the municipality of Oslo has a university degree, and 13 per cent have a master's or PhD degree, making it the urban region with the highest human capital level in the country (Tinagli, 2012).

The organisations

In this study, employees in four knowledge-based enterprises in different areas of the Oslo region were selected. The case organisations are located in areas with dense clustering of knowledge organisations and high commuter traffic on weekdays. Yet, the public transport services and employees' access to parking differ. Table 1 provides key information about the four cases. The individuals in these enterprises generally had higher education, and they conducted tasks that required advanced skills and knowledge within a certain area, where new knowledge,

representations or products were developed. (Note that, in oil and gas, offshore workers were excluded, and at the university administrative staff were excluded). Hence, they reflected the main criteria of knowledge-intensive work, as suggested above. The organisations are described in turn below.

Govern: Govern is a constellation of public administration enterprises located in the city centre. They have about 1700 employees at this location, and 65 per cent of them responded to the survey. More than half of the respondents, 54 per cent, have university degrees at the master's level or higher. Employees have relatively good access to parking, and some also receive financial support for public transport commuting fees.

Table 1

Techno: Located in Linderud, in the north of Oslo, Techno is an international company, especially known as a producer of electronic products. About 450 people work at the Norwegian headquarters, and about 42 per cent have university degrees at the master's level or higher. Fifty-seven per cent of the 750 employees responded to the survey. The enterprise is located close to a main access road to Oslo, and access to buses and a subway line are not far from the workplace. Employees have good access to free parking spaces.

Univers: Univers is a university located in Nydalen, in the north of Oslo, employing about 450 people, including teaching staff and administration[1]. Sixty-five per cent of the employees have university degrees at the master's level or higher. In this area, the public transport services are well developed, and subway and bus lines are close to the campus. The university is near a main access road to the city, and there are some free parking places, although not for all the staff.

OilGas: OilGas is an international oil and gas company located in Fornebu, 10 km west of Oslo's city centre, with a cluster of high-tech industries. This enterprise employs about 3000 employees, of which 75 per cent have a master's or PhD degree. There is good access to free parking, but access to the area by car is not especially good. There is only one main street leading out to this peninsula, and traffic from all directions, both public transport and private cars, has to run along this street.

[1] The survey included students, but they are excluded from the data analysed here.

Results

Table 2 gives a description of the sample and key variables used in the analysis. There are slightly more female than male respondents, and the average age is 45 years. Almost everyone in the sample has a driving licence, and 84 per cent had access to a car on the day of registration. The distance to work is 22 km on average, and 50 per cent of employees need to change bus or rail when they use public transport. Close to 60 per cent of the sample has education at the master's or PhD level, which is about twice as many as the average for the region. Working at home is widespread; over 40 per cent conduct paid work in their homes once a month or more. Almost one in three conduct work at the premises of other companies or on business trips, and approximately 28 per cent travel to meetings outside their enterprise's venues during the week.

The differences in transport mode for commuting trips are significant (Table 3). While about 80 per cent of the employees in Govern, located in the city centre, travel by public transport, only about 18 per cent of the employees at OilGas do so.

Table 2

Table 3

Techno and OilGas have much the same travel mode patterns, with relatively high numbers of car commuters, while Univers, located close to a subway station, has a significantly lower number of car commuters. Free parking was found to be available for about 40 per cent of the car commuters. As expected, the knowledge workers tended to have more relaxed boundaries for their work time than other employees did. This could involve flexible hours, with possibilities for individual variation in arrival and departure times. In the sample mean, arrival time was between 08:00 and 08:30 and departure was between 16:00 and 16:30, but one in three deviated from the average by two hours or more. There were significant variations between the enterprises (sig < .001); employees at Univers, for instance, tended to arrive later and leave earlier.

Multivariate analysis

A regression of expected key factors influencing the use of cars, public transport and walking/biking was conducted, including variables for home location, access to public transport services, distance to work and workplace location. In addition, a set of workstyle variables was added, including meetings during work hours and working from home (Table 4).

Much as expected from former studies, locational factors related to the workplace and residential area, as well as availability of public transport services, were of crucial importance for car-based commuting. Thus, in this area, the knowledge workers are similar to most other employees (as covered in earlier works). However, we also saw that the need to conduct meetings outside the premises of the workplace was related to a higher level of car-based commuting and lower level of public transport commuting. Thus, the mode of transport to and from work affected the mode of mobility during work hours. The relationship between transport for meetings outside the office and car-based commuting is illustrated in Figure 1. The number of days working at home had no significant effect on mode choice, but as expected, travel distance positively influenced the use of public transport and negatively affected biking and walking. As for the use of cars for commuting, driving to/from meetings was highest in Techno and lowest in Univers and Govern. This suggests that locational factors, as well as work assignments and workstyle, are important drivers for car commuting in our cases. To develop a finer grained picture of the car commuters' mobility behaviour, we take a closer look at the various dimensions of meaning and motives that are attached to the use of cars below.

Table 4

Table 5

Figure 1

A practice-based mobility typology

Based on a factor analysis (PCA), we first generated four key components, with slightly different sets of meaning and motivations for use of cars on the respondents' commute (Table 5). The input was a 12-item scale of relevant motives and meaning issues. The results included, first, a

utility-oriented dimension, where the need for flexibility and time were dominant. Second, aspects including the attraction and convenience of driving, as well as access to parking and routine use of cars, were highlighted. This represents an integration of more hedonistic values combined with facilities making car use easy and convenient. A third factor stressed the need for a car to conduct duties on the way to work, as well as a 'place' to relax. Here, aspects of stress and the need to take care of other duties on the way to work spurred car use. Finally, a fourth dimension was the need for a car for work task*s* as the key motivation, reflecting findings from the regression analysis, where work style was found to be important for car use. For the sake of simplicity, we label these motivation factors as *Utility, Convenience, Assignments* and *Work*.

The four motivational factors were included in a cluster analysis along with a wider set of variables, namely the following: working other places than at the office (full days), duties on the way to work, meeting outside the office during work hours, living area, access to free parking, working full days at work, flexibility in arriving/departing from work and distance to work. Based on the *two-step cluster algorithm*, six clusters were located with a fair degree of separation (silhouette measure = .2). The clusters had similar numbers of individuals in each, with 188 persons in the largest and 113 in the smallest.

Table 6

Table 6 displays the key characteristics of each cluster. The *first cluster* (Regular) includes a relatively conventional type of office worker, living outside the city and with good access to parking at work and little need for mobility during work hours. The motive and meaning of car use seem to be the need for fast transport and ease of use. The *second cluster* (Long-distance flexible) lives outside the city and has a high level of work assignments during the day, as well as working other places than the regular office. In the second group, to a large extent, the need for a car is driven by work tasks and assignments. The *third cluster* (Suburban routine) consists of employees living mainly in suburban areas who have a routinised use backed up by good access to free parking. This is somewhat similar to Regular, but individuals in this group live closer to the city, and therefore, they are also likely to have better access to public transportation. Their use of cars for work is more based on habit than necessity. The *fourth cluster* includes knowledge workers that need to run errands on their way to and/or from work (Suburban duty). As with the previous group, they are located in suburban areas, but they are mainly motivated by the need for flexibility in meeting everyday needs outside of work hours. The *fifth cluster* is a group of highly

mobile workers, using cars to move between assignments during the day but also using cars to conduct duties on the way to and from work (Mobile work). These employees seem to be driven by a number of work-related and private factors. Finally, the *sixth cluster,* Long-distance duty, is a group that commutes long distances and also has duties along the way. This group is also similar to 'Regular' but without easy access to parking and with heavier constraints regarding everyday duties.

Table 7

Looking at demography across these practice-based clusters, men are more frequently in the 'Mobile work' and 'Long-distance flexible' and women in the 'Suburban duty' groups. This echoes former studies' finding that men tend to have longer commutes and females more often deliver and pick up children at school or kindergarten (Frändberg et al., 2011; Roberts et al., 2011). The 'Mobile work' group was dominated by male employees, although there were no differences related to age or education. The only group with some clear differences related to age was 'Regular', which had a somewhat higher share of older employees (Table 7). One explanation for this could be that this is related to relocation patterns over the life stages. Former studies in the Oslo region have found that, as non-native families become more established and larger, they tend to move out of the city centre to suburbs and outside the city (Wessel & Lunke, 2019).

Enterprise practice profiles

Although the six clusters of commuters were prominent in all enterprises, the variations in constellations were significant (Figure 2). 'Techno', the enterprise with the highest share of car drivers overall, had a particularly high number in the two clusters 'Long-distance flexible' and 'Mobile work'. Their high number in the latter group is likely to be because their location in the outer suburb made it difficult to attend meetings outside the workplace without using a car, and many already had their car available at the workplace. The organisation Govern, which mainly consisted of office workers in the public sector, generally had low levels of car commuters. However, those who used cars were mainly in the 'Suburban routine' category, suggesting that this was highly driven by free parking and habit. The open-ended questions indicated that employees in this enterprise also used garage facilities for washing cars and storage of personal bikes. Employees at the university (Univers) had a particularly large share of 'Long-distance duty'

commuters, probably because they were recruited from a wider geographical area. OilGas was the only enterprise that had relatively equal shares of all types of commuters. One explanation for this could be that the location of this company made sustainable transport alternatives difficult for all groups of employees, as well as that this company had a more diverse set of work tasks and practices than the others did.

Figure 2

Used in this way, the typology displays different constellations of car commuters in the four enterprises, and as such, different enterprise profiles that may also be broken down at lower organisational levels (department units, etc.). In recent discussions about commuting, a tendency towards longer and more complex journeys has been noticed (Lyons & Chatterjee, 2012; Vincent-Geslin & Ravalet, 2016). The typology suggests that this is widespread in the Univers and Techno cases, as well as that this involves two slightly different types of long-distance commuting practices: 'Long-distance flexible', most typically in Techno, involved more car-based trips during work hours, while 'Long-distance duty', more common in Univers, was more constrained by private assignments on the way to and from work. Another much-discussed trend has been an increased spatial mobility among knowledge workers partly spurred by the use of mobile technologies at work (Fiore et al., 2014; Mascheroni, 2007). From this study, we see that car commuters with high mobility during work hours relate to two different practices ('Mobile work' and 'Long-distance flexible'), both most commonly seen in the Techno case.

Discussion

Earlier studies of knowledge workers commuting have largely addressed qualities of the knowledge workers' residential areas and workplace locations, as well as characteristics of their work. These studies have provided evidence that particular groups of knowledge workers, compared with other workers, tend to have different preferences when it comes to choice of residential location and need for proximity to partners and colleagues. Some recent studies have also found that cultural and lifestyle-related factors may also affect residential choice, and therefore, mode choice (Frenkel et al., 2013b). The results presented in this paper add to these

studies, providing insights on the way daily car commuting is truly performed in knowledge-intensive enterprises and the variation in individuals' commuting practices.

Contribution to the field

Along with several earlier studies, we find that transport facilities related to workplace localisation and residential areas are crucial for knowledge workers' use of private cars for work. However, the results also highlight that certain aspects of their daily needs and assignments are important for car use, such as meetings during work hours outside the office. In our study, the practice of using cars is not a simple decision made by the workers or as an opportunity offered by the materiality of their surroundings; it also relates to routines at work and home. This supports the few earlier practice-oriented studies of commuting behaviour (Cass & Faulconbridge, 2016; Holley et al., 2008; Julsrud, 2013; Lyons et al., 2007), indicating that employees have other assignments at work (meetings outside offices; tasks that demand the transport of heavy cargo), and in their private lives (dropping children on the way to work; shopping and errands) that make up 'bundles of practices' (Shove et al., 2012). As we have seen from our analysis, work travels are connected to the coordination of multiple work and family activities, which produce a regularity and rhythm in individuals' everyday lives. Some groups of knowledge workers, such as those in the Suburban duty cluster, are constrained by private assignments, making a switch to public transport, for instance, more complicated.

The benefit of the practice approach is that it opens for a novel understanding of how policy actions can be implemented to help curb car-based commuting in KIOs. Following a practice theory framework, measures may be directed towards various combinations of meaning, materiality and competence of commutes. Although the practices of commuting may be similar, the meaning behind them may differ, as was the case for 'Mobile work' and 'Suburban duty'. At this point, this study replicated findings from other recent studies of commuters, finding that similar attitudinal structures may be linked to very different travel behaviours (Bösehans & Walker, 2020; Mendiate, 2020).

Implications and policy measures

To develop policies that can curb car-based mobility among knowledge workers, it will be valuable to focus on the different groups outlined here. Employees with practices similar to the 'Regular' cluster should in particular be targeted with better public transport services or additional services that make alternative transport practices more relevant and attractive than private car use

is. This seems to be a particularly relevant measure, as these employees have relatively few meetings in the office during the day and few assignments on their journey to work. Yet, the development of high-frequency public transport services depends on their economic viability, which may be challenging in outer districts. The development of transport hubs with easy transit from car to public transport is a good strategy to develop greener travel practices for this group of commuters.

The 'Long-distance flexible' group comprises employees with very high mobility during work hours in conjunction with a long commuting distance. A combination of the improvement of public transport development with better access to low-carbon mobility alternatives at the workplace (i.e. electric cars) may be efficient. It is currently a growing trend in Norway that enterprises in the private and public sectors make available pools of electric cars at the workplace to improve their carbon footprint (Julsrud & Standal, in press). Many in this group are also home workers, suggesting that they have work tasks that are suitable for this. Further use of electric communication applications and organisational policies to support this could be relevant measures.

Commuters in the 'Suburban routine' cluster are likely to have access to relatively good public transport services, given that most of them live in suburban and central areas of Oslo. The most efficient way to curb car-based commutes would probably be to take away free-parking opportunities at their workplace, since this, along with convenience and routine, seems to spur the use of cars. Previous studies have documented that eliminating free parking is among the most efficient policies to reduce car-based commuting (Christiansen et al., 2017; Hess, 2001).

Employees in the 'Suburban duty' group have practices that are quite similar to those of the previous group, although they are more constrained by everyday assignments, making a shift to public transport, walking and biking harder. Yet, many are located in central parts of the city, and access to lighter electrical vehicles, such as electric (cargo) bikes and smaller electric cars, may be relevant measures. A well-developed network of public transport in the city and reduction of free parking benefits would also make a shift to sustainable commuting modes simpler for people with this type of practice.

The 'Mobile work' group, with its high level of mobility during the workday and assignments on the journey to and from work, is probably hard to target only by improving public transport services. Use of privately owned (or possibly shared) electric vehicles is probably a better option. Yet, if the mobility at work is extensive, and the journey to work is long, the infrastructure for charging these vehicles should be considered.

To reduce car-based commuting for employees in the 'Long-distance duty' group, development of more efficient public transport services or information about the current services could be helpful. Given that personal duties that need to be completed on the way to/from work are often conducted in the local community, the development of parking facilities for cars and bikes at local transport hubs would probably be effective.

As evident from the above, policies to curb car-based mobility must be initiated at several levels. At a local governmental level, location of workplaces and 'business clusters' should consider infrastructures for walking, biking and public transportation and parking facilities. Such relatively well-known measures, however, must be backed up by continuous organisational efforts to make public transport more convenient, invest in low-carbon vehicles at the workplace and make it less attractive to use private cars that run on fossil fuel. To initiate intervention and trigger transformations, organisations and managers in charge must be involved in transforming the established commuting practices. Local initiatives to eliminate free parking for employees, as well as campaigns that support the use of public transport and biking to work, can be used to transform practices. In these processes, the local 'communities of practice' (Brown & Duguid, 2001; Wenger, 2000) and the wider network of relationships that are typical for knowledge workers need to be activated. In this way, transformations in practices can be stimulated by bottom-up processes capitalising on community resources.

Limitations and future work

This study used a quantitative approach to capture some issues related to commuting by car as a social practice, and six general practice forms were extracted across four enterprises. However, it should be stressed that, to obtain a rich and dynamic picture of the social practice of commuting, this approach is clearly insufficient. It needs to be supported and followed up by investigation using qualitative approaches. Neither does this study present a total picture of factors that influence knowledge workers' commuting mode choice. Underlying dimensions of learning have not been captured in any depth, and it is likely that this may have influenced commuting behaviour in our sample. To the extent that new mobility modes, such as car sharing or e-bikes, are used for work travels, this adds new dimensions of technology and competence (Julsrud & Farstad, 2019). The aim of this study has been to take some first steps towards analysing commuting through the lens of practice theory on a general level, although based on case studies situated in a specific context. We think that this is a fruitful avenue for further studies of commuting in urban regions, and future studies in this field should try to uncover more of the

complexity and diversity involved in knowledge workers' travels and the variations related to the enterprise type and location.

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Table 1. *Enterprise sample details*

Enterprise	Business	Location	Emloyees (approx.)	Sample	Gender (females)	Age (average)
Govern	Public adm	Oslo centre	1700	794	50	47
Techno	Engineering	Oslo - North East	750	425	25	45
Univers	University	Oslo North West	450	297	60	45
Oilgas	Oil & gas	West of Oslo	3000	979	40	47
All			5900	2495	43.7	46

Table 2 *Description of the sample of employees in the enterprises. Percent*

Variables	Percent	Numbers
Enterprise		
Govern	31,8	794
Techno	17	425
Univers	11,9	297
Oilgas	39,2	979
Employees residential area		
Oslo city	18,9	472
Oslo muncipality	28,2	704
Outside Oslo	52,8	1319
Gender		
Female	41,8	1042
Male	58,2	1452
Education		
Primary and bachelor level	40,8	1019
Master and PhD level	59,1	1475
Age		
29 and younger	7,3	182
30-549	51,8	1293
50 and older	40.9	1019
Quality of public transport		
Can travel directly to work	47,5	1184
Have to change bus/rail	50,5	1259
Work style		
Homework (>1 day per month)	44,6	1112
Travel to meetings (>1 time per week)	27,8	693
Mobile work (at other ent. premises)	31,7	790
Work during travel	16,3	407
Duties on the way to work	1048	42
Resources		

Access to car at home	87,7	2188
Free parking at workplace (car users)	41,7	1041
Distance to closest public transport stop km (Mean)	2,85	
Commute time/distance		
Distance to work Km (Mean)	22,4	
Time to work, minutes (Mean)	*35,2*	

Table 3. *Main transport mode on journey to work in the enterprises. (percent)*

	Mode				
	Walk/bike	Car driver	Public transport	Other	Sum
Govern	9,6 %	7,5 %	80,1 %	2,8 %	100,0 %
Techno	9,5 %	67,7 %	18,5 %	4,3 %	100,0 %
Univers	17,8 %	32,3 %	43,4 %	6,5 %	100,0 %
OilGas	6,9 %	53,4 %	35,1 %	4,6 %	100,0 %
All	*11,0 %*	*40,2 %*	*44,2 %*	*4,6 %*	*100,0 %*
Oslo Muncipalty	25,0 %	31,0 %	40,0 %	4,0 %	100,0 %
Akershus County	11,0 %	60,0 %	25,0 %	4,0 %	100,0 %

Table 4. *Binary logistic regression on commuting by car, public transport and walking/biking*

	Private car			Public transport			Walk & bike		
	B	Wald	Sig.	B	Wald	sig	B	Wald	Sig.
Education level[a]		0,935	0,627		4.581	.101		19.403	.000
Upper sec.	0,147	0,668	0,414	.163	.968	.325	-1.044	8.332	.004
University bachelor	0,089	0,523	0,469	.243	4.406	.036	-.775	14.199	.000
Living area[b]		68,417	0,000		83.765	.000		2.581	.275
City centre	-1,228	61,435	0,000	1.376	80.496	.000	-.369	2.493	.114
Muncipality	-0,055	0,200	0,655	.376	8.701	.003	-.230	1.214	.271
Workplace[c]		421,998	0,000		429.746	.000		24.807	.000
Govern	-3,001	321,020	0,000	2.089	278.211	.000	.405	3.169	.075
Techno	0,565	16,102	0,000	-1.067	45.497	.000	.986	14.582	.000
Universe	-1,021	44,295	0,000	.512	11.827	.001	1.068	18.838	.000
Meetings outside office (1)	0,493	16,757	0,000	-.444	14.944	.000	-.131	.474	.491
Duties on the way to work (1)	1,067	103,828	0,000	-.835	69.613	.000	-.558	10.924	.001
Gender Fem(1)	0,025	0,052	0,819	.208	4.216	.040	-.689	15.239	.000
Homework(1)	0,131	1,590	0,207	.030	.090	.765	-.254	2.161	.142
Distance to work	-0,004	3,039	0,081	1.009	101.282	.000	-2.446	222.988	.000
Distance to PT	0,312	19,348	0,000	-.091	1.902	.168	-.325	4.801	.028
Age	0,008	2,297	0,130	-.104	1.539	.215	.115	.728	.394
Constant	-1,073	12,722	0,000	-2.625	56.759	.000	3.127	37.426	.000

Reference categories: [a] University master/PhD; [b] Outside Oslo; [c] OilGas

Table 5. *Motivational and meaning factor components among car users. Principal component analysis with 6 iterations. (Only factor scores above 0,3 are displayed)*

	Factors			
	Utililty	**Convenience**	**Assignments**	**Work**
It is fast	0,635			
Other reason	-0,600			
It is flexible	0,495			
I used the car to a transit point	-0,334			
Public transport is insufficient developed		-0,679	-0,302	
The parking facilities at work is good		0,619		
Routine and habbit		0,443		
I like driving		0,402		
The car gives me an opportunity to relax			0,617	
It is cheaper than public transport			-0,455	
Needed the car to bring/ pick up children or other assignments	-0,398		0,441	-0,435
Need the car in my work				0,774

Table 6*. Clusters of car commuters*

	Regular	Long distant Flexible	Suburban routine	Suburban duty	Mobile work	Long distant duty
	C1	C2	C3	C4	C5	C6
Size	*16 %*	*17,40 %*	*12,00 %*	*15,00 %*	*19,60 %*	*20 %*
Work outside office (mobile work)		***			***	
Duties on the way to work				***	***	***
Travel assignments during work hours	*	***	*	*	***	*
Living_area_City		*	*	**	*	
Living area_suburban		*	**		**	
Living area_outside city	***	**			***	***
Meaning of car use_Utility	**	**	**			
Meaning of car use_Responsible				***	***	*
Meaning of car use_Work need		**			*	
Meaning of car use_Convenience			***	*		
Free parking	**	*	**	**	*	*
Homework full days (M)	2	4	2	2	3	2
Distance home - work (M)	21	30	11	11	18	21

*Table indicators: * Low; ** Medium; *** High*

Table 7*. Cluster belonging, gender, education and age. Percent.*

	Regular	Long distant Flexible	Suburban routine	Suburban duty	Mobile work	Long distant duty	Total
Gender***							
Female	46.3%	20.9%	42.5%	53.2%	27.2%	43.1%	38.1%
Male	53.7%	79.1%	57.5%	46.8%	72.8%	56.9%	61.9%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Education**							
Upper secondary	14.8%	7.4%	13.3%	7.8%	9.8%	13.8%	11.1%
University bachelor	28.2%	30.7%	22.1%	29.1%	28.8%	24.5%	27.4%
University master/PhD	57.0%	62.0%	64.6%	63.1%	61.4%	61.7%	61.5%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Age**							
30 and younger	2.0%	3.7%	7.1%	3.5%	4.3%	0.5%	100,00 %
30-50	45.6%	58.3%	52.2%	58.9%	50.5%	62.8%	100,00 %
50 and older	52.3%	38.0%	40.7%	37.6%	45.1%	36.7%	100,00 %
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

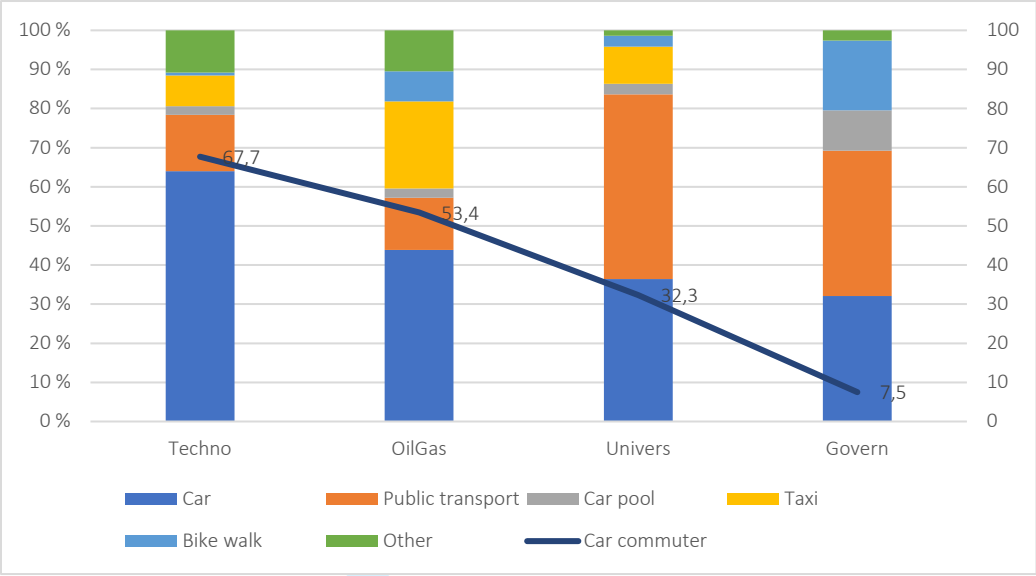

Figure 1. Transport for meetings during work hours and commuting by car (P<.001).

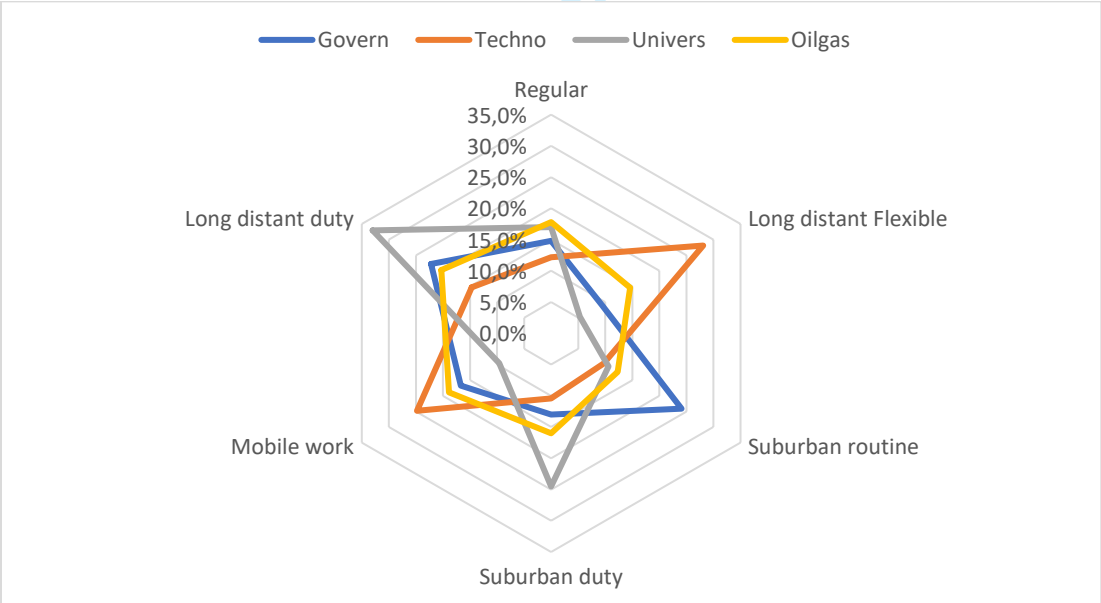

Figure 2: Enterprise profiles based on cluster distribution. percent