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The full article can be viewed here.

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Net effects on CO_2 emissions of relocating freight facilities to the city edge

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This is a summary of a study that investigated the impact on net carbon dioxide (CO_2) of relocating warehouses from central urban areas to more peripheral areas, while replacing the space with living and working spaces that would otherwise be located at the edge of the city. Although the study showed that both warehouses and inhabitants generated less traffic and CO_2 emissions when located in the city centre, the analysis revealed that the net CO_2 benefit favoured relocating inhabitants and employees to central areas to replace freight facilities.

When allocating city space, land use planning and transport planning must be taken into consideration to optimise the use of resources in a way that most effectively contributes to societal goals. One such goal high on the agenda is reducing carbon dioxide (CO_2) emissions. Research indicates that increasing the population density in central urban areas can contribute to reducing transport volume and demand, so reducing CO_2 emissions. However, doing this, would involve moving other facilities, such as freight facilities, to peripheral areas. As with the relocation of workers and inhabitants, studies have also shown that relocating freight facilities to the city edge will also generate more traffic, so increasing CO_2 emissions. The study highlighted in this article investigated what the net effect on CO_2 emissions would be if freight facilities were moved to the edge of a city and whether it is an effective strategy in reducing CO_2 emissions.

There has been a clear trend in moving freight facilities away from city centres to open up space for urban development and making the inner urban region more attractive and liveable.

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This has included developing housing, workplaces, shopping and leisure instead of freight facilities. In parallel with this, the logistics industry has also evolved, and has more optimised processes and organisation that enables it to move operations to the periphery of an urban area. Furthermore, land prices in central urban areas might not be worth the cost for logistics companies compared to the far cheaper prices at urban edges. Although studies have investigated the CO_2 effects of urban development and of relocating freight centres, there has been no conclusive research on the net CO_2 emissions resulting from such a move.

This study established two scenarios to investigate this subject. In Scenario 1, the freight centres remain in the central area, while dwellings and workplaces are in the peripheral area. In Scenario 2, the opposite is applied. The study investigated the mechanisms and scenarios around two cases – the Norwegian cities of Oslo and Trondheim.

Three key mechanisms triggered by the relocation of warehouses to peripherical areas were identified as:

- changed local distribution transport distances;
- changed long-haul transport distances;
- changed modal shares if access to rail terminals or ports changes.

The magnitude of the impact of these mechanisms is context dependent. The change between the scenarios could result in shorter transport distances due to well-developed transport links or cause longer transport distances due to reduced access and more detours.

Similarly, the travel distances for inhabitants and employees using cars and public transport will feed into the analysis. One general observation was that inhabitants were more likely to travel further distances – and more often by car – the further out of the city centre they lived or worked. Overall, this results in densely populated cities and urban areas generating less traffic per inhabitant than is the case for less densely populated areas.

The study began the analysis by collecting data on freight flow patterns from a range of firms that have locations in city centres and at the outskirts. Pre and post relocation data was also available. Using the national freight model (NFM) for Norway, the study calculated the transport activity in tonne-kilometre generated by the freight centres. The NFM is a freight transport network model that optimises delivery frequencies, shipment size, transport routes, mode chains, transfer zones and sizes of vehicles. This requires and generates a lot of data, which was useful for the study. Further data was collected from Statistics Norway. The CO_2 emissions intensity was derived per tonne-kilometre, and also considered different types of vehicle, utilisation rates and delivery sizes.

Similar analyses were carried out to determine the transport-related CO_2 emissions generated by dwellings and workplaces when located in different areas of the cities. This included analysing the effects of location on the vehicle-kilometres (vkm) by private car and passenger-kilometres (pkm) by public transport. Geo-coded data from the National Travel Survey, which tracked the travel habits of about 60,000 people nationwide, was collected to understand this effect.

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Furthermore, the data was adjusted to reflect the modal splits and the type of vehicle was specified to account for trends such as electrification of transport. The density of employees and inhabitants in central areas was also defined based on the Central Register of Enterprises and population statistics.

The results of the analysis showed that relocating the warehouses to peripheral locations led to increased transport volumes and CO_2 emissions. In Trondheim, the transport volumes increased by just 0.3% and in Oslo by 0.9%. The CO_2 emissions from this shift increased by 0.5% in Trondheim and by 2.7% in Oslo. Although the CO_2 emissions generated by inhabitants or employees in peripheral locations varied depending on the particular area in in Oslo or Trondheim being considered, every case indicated passenger-kilometre and vehicle-kilometre increases amounting to at least twice or three times as much CO_2 emissions per person.

Comparing the effects on CO_2 emission changes from the shift of warehouses to the effects on CO_2 emission changes from the shift of living and working areas showed that relocating inhabitants and employees to central areas resulted in a net reduction in transport-related CO_2 emissions. The magnitude of the net CO_2 emissions change increased if more central warehouses moved to remoter locations that were previously living and working areas. Therefore, relocating warehouses from semi-central areas to the city edge results in less net CO_2 emissions reductions than moving warehouses from central areas to the city edge.

Comparing the reduction in CO_2 emissions from locating living or working spaces in central areas rather than peripheral areas with the reduction in CO_2 emissions from locating freight facilities in central areas rather than peripheral areas showed that the CO_2 emissions reduction from centrally located living and working spaces outweighed the CO_2 emission reduction of centrally located freight facilities by a factor between 10 and 18. The same comparison for semi-central and peripheral areas showed that the CO_2 emissions reduction was around 2 to 3 times greater for living and working areas located in semi-central rather than peripheral areas.

The study shows a conclusive result in terms of net CO_2 emissions savings. However, there are several factors that were not considered in this analysis, such as the need for smaller consolidation points around the city centre for the freight system. Furthermore, the cost of such relocations could be considerable and a major barrier to such a change. Nonetheless, the research and findings show that land use and transport planning play an important role in contributing to optimising urban land use, and to reducing CO_2 emissions and traffic.