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Drastic Greenhouse Gas Reduction Driven by Modest Changes from Solutions:

How Transportation Planning Could Limit Access Modes by Acknowledging the New Model, Better Communities and Discouraging Travel

Introduction

Our world is facing drastic changes by climate change directly led by greenhouse gas emissions, research shows such changes would only accelerate and intensify, which by the end of the century may lead to a 1-4% annual loss of GDP in the US alone (Jina). The transportation sector collectively emits 27.2% of the greenhouse gas of the total greenhouse gas of the United States in 2020, and it is the largest emission sector after surpassing the electric power industry in 2017 (EPA). These all shows an urgent need to drastically curl back emission in the transportation sector.

Various proposals have been proposed in regards of transportation planning to curl back emissions. However, often such proposals simplify the behavioral and psychological change involved, but also assumes intellectualize behavior. Studies have shown there is also “semi-conscious factors, embodied capacities and tacit know-how are often at least as important (Schwanen et al.).” Therefore, when we provide a variety of transportation mode as possible and focus of increase the options does not necessarily increase the adoption active transportation.

This essay would focus on improving proposals by limiting access modes on rethinking how to estimate trip demand under the post-pandemic paradigm, creating better communities, and discouraging unnecessary travel. I believe these proposals would have the power to drastically reduce GHG emissions as it focuses on building a smaller resistance compared to current proposals and focuses on forcing people from using the car to alternative transportations.

New Norm of the Shifted Trip Demand Paradigm – Redefining Metrics

With the advent of remote work from the pandemic, according to the *2020 National Household Travel Survey Data*, which was taken during the pandemic, only 16.5% of all passenger trips taken are work-related (Federal Highway Administration, *2020 National Household Travel Survey, U.S. Department of Transportation, Washington, DC*). The last research taken in 2017 shows 16.6% of work-trip and in 2009 shows 22.3% work-trip marks a continuous increase of non-work-related travel. With the continuous adaptation of both hybrid and remote work flow, as recent survey shows almost half of all US workers having some sort of remote work arrangements (Wigert and Agrawal), the trip demand paradigm has completely shifted from when our infrastructures were built.

Such a shift in trip demand should be seen as a once in a lifetime opportunity, similar when the time the Interstates were built, to reorganize our infrastructure for better efficiency and less GHG emissions. Especially when considering that when recent studies show that to addressing the needs of the Interstate Highway System will require more than a doubling of current investment to adequately improve the system's condition (TRIP). Therefore, we must seize the opportunity to redesign our transportation network.

With our national deeply invested into the "car-dependent transportation system," and to evaluate measure to break such a "self-reinforcing system (Mattioli et al.);" our nation must be able to correctly identify trip demand for both transportation planning and consequently the surrounding land use. With deep investment into the car-based infrastructure, where such infrastructure generates huge amount of GHG, the change to alternative mode is essential.

In order to maximize the reduction of GHG with new infrastructure resulted from the planed model identify, it is crucial to clearly define car-dependency. More specifically, we must be able to define the difference between “car-addiction” and “car-dependency.” The difference between “car-addiction” and “car-dependency” is that for “car-dependency,” an individual only viable option to the destination is the car; whereas in “car-addiction,” even when alternative mode is equally competitive, the individual still chose the car.

Various metrics were defined for “car-dependency” in various research, one of a popular metric is Vehicle Miles Traveled (VMT), where a higher VMT indicates a higher car-dependency. However, such a measure would not be accurate as it tends to ignore the local variations in income and economic development, in social and spatial characteristics, and in vehicle and fuel technologies (Zhang). An example of such would be the VMT would generally be lower in the area of a downtown walkable core, and the reason of such is maybe because residents there would not need to drive that far to their destinations instead of less car-dependency. One of a better developed concept, based on Zhang’s work is Zhao’s work on *Subjective Measure of Car Dependency*, where it created a measurement based on the hypothesis that “car dependency is related a lot on people’s intension (attitude), actual car use (behavior), and the intent to reduce car use (intention)”(Zhao).

However, such an assumption left out the fact that people made choices not only based on attitude, behavior and intention, when considering that the American saying “drive until you qualify.” In fact, most of the people that are living in car-dependent area are forced to drive, rather than would have an attitude, a behavior or an intension thought process behind their actions. Especially when considering that the urban sprawl was encouraged by Federal loans and tax credits (Mattioli et al.), to funnel the growth of the “Growth Machine,” highlighted in Molotch’s work (Molotch).

Therefore, the measurement of car-dependency must include factors to identify such a decision is force or non-force. A simple measurement of such could be how many times of the time required for the residents to complete the different trips by their trip purpose by alternative transportation compared to the automobile. An alternative measure could be comparing the time per mile that take the residents to complete the different trips by their trip purpose, if the region has a chronic issue of traffic.

On the other hand, in the current “car-dependent transportation system,” our society has a strong rooted car culture, where it is “a critical part of the frictionless mobility that has come to be an important part of social privilege (Mattioli et al.).” As a result, “many motorists continue to drive cars despite living in cities with functioning public transit systems, walkable streets, or networks of cycle lanes (Mattioli et al.),” which is one of the many semi-conscious factors that comes into our decision making of mode choices (Schwanen et al.).

Therefore, it is also important to have an indicator for those who are fortunate enough to have both a functioning system of transit and choose to drive a car, and as a result gaining an addition with it. In addition, car addiction is an important indicator for our new trip demand paradigm because of how our new communities were being built. Smart Growth, a range of strategies to guide land use and transportation plannings that is gaining tractions (Gerrit-Jan et al. Ch. 9; Smart Growth Network), could find such a metric essential to its successfulness as one of its principal is to diversify community transportation options. For example, the car addiction metric could be used a deciding factor on whether a mixed-use neighborhood should include a drive-thru. A simple example for such a metric could be how much is car dependency metric with respect to investment on pedestrian infrastructure.

With the increasing but still limited spending on non-car infrastructure, the above 2 metrics above could allow further reduction of GHG because it could better predict the effectiveness of such an infrastructure based on its community characteristics. Especially when considering that the majority of similar planning procedures with a focus on GHG reduction put a lot of focus on walkability metrics, which we are able to see improvement on pedestrian infrastructure. However, making walking more enticeable doesn't make a walking lifestyle feasible, nor making car-addiction infeasible. Therefore, we must focus on improving both the car-dependency metrics listed above and walkability together.

New Norm of the Shifted Trip Demand Paradigm – Adjusting for Distance

In addition to newer metric definition, the new paradigm changes the predominant trip purpose, where more trips are taken as non-work-related trips. This means on average a shorter trip distance, as the average commute and non-work-related trip is 7.5 and 5 miles respectively (Federal Highway Administration, *2017 National Household Travel Survey, U.S. Department of Transportation, Washington, DC*). Our infrastructures need to be adapted with a such a change and reinvent how trip decision are made in regards of the short-distance non-work-related trips. Therefore, in order to use such a shift as an advantage to reduce GHG, we should encourage drivers to not to use their vehicle for short-distance trip, and replacing short-distance trips with transit, encouraging the adaptation at-home delivery services, and spacing out freeway access points.

To adjust the reduction of the trip distance, one of such ways to tackle is by increase short distance transit service, in especially a flexible transit system (Nourbakhsh and Ouyang). As transits are more competitive on shorter distance on time and a flexible transit system could develop a cost savings for the agency, in addition with lower GHG than personal vehicle. However, this would only be true when such a service was priced correctly, especially that the fare is not on a flat rate, ideally it would be a rate by distance (Cervero). Arguably, the transit agency should be subsidizing the shorter distance trip so that they would be able to serve as a feeder route for their longer distance service to further enhance the GHG emission reduction.

Another recent advent during the pandemic is advance of delivery services to home due to stay-at-home orders and self-isolation requirements issued by the government to minimize travel. Such a service allows residents to use their vehicle for short-distance travel to amenities surrounding the neighborhoods. Although delivery service still releases GHG, as the deliver are still made using a motorized vehicle, studies have shown that it has the ability to decrease GHG when compared to picking up the same items using the automobile (Heldt et al.; Siikavirta et al.). This is especially true, given that the delivery has reach a certain scale (Brown and Guiffrida). Therefore, it is crucial to encourage deliveries for cutting down GHG associated with transportation.

To further discourage short distance traveling on the personal vehicle to reduce GHG, limiting viable accessibility for personal vehicle in shorter trips is a direction that transportation planners should not oversee. However, when it comes to limiting the accessibility of the automobile, it would be difficult to push such a policy without significant push-back from the “car-dependent transportation system (Mattioli et al.).” To circumvent such a push back, it is important that the solution should be able to accept by all 5 reinforcing interconnections car-dependent transportation system listed in Mattioli’s work.

One of such ways that would meet all the criteria is to space the access and exit points of a freeway so that would make long-distance travel better and shorter-distance travel non-viable. In this solution, we did not affect the automotive industry and the car culture. However, we improved the car infrastructure and potentially improve both land-use patterns and public transportation. By removing access and exit points, we allow less cars to enter the freeway, and essentially the freeway would move faster due to the extra capacity from the less conflict points. With the extra space because of the removal of ramps, space is available to expand without land-acquisitions. As traffic move faster due to less conflict points and possible increase capacity, we would be able to justify such a move as improving car infrastructure.

Though it may seem unimaginable that such a proposal would work, studies have shown its feasibility, with the earliest study in 1960s in Detroit and the recent studies in 2001 in Hawaii shown results backing up previous statements of speed increase (Gervais and Roth; Prevedouros). Previous studies also shows that there is only miniscule effect on traffic spilling onto the neighborhood street and additional traffic onto neighboring ramps, given if such a closure is planned correctly.

In addition to improving traffic in the freeway, closing the freeway ramps also presents an opportunity to use Smart Growth approach to develop a more sustainable community. For example, the Detroit studies also shows closing a freeway ramp would also allow a neighborhood to have lower pollution and safer streets, and therefore more local streets could be closed for pedestrian or bike access. As the occupied land of the freeway ramp would not be always required to be used to expand the freeway, the empty plot may present an opportunity for the community to build more affordable housing, or a right of way of transit projects. Especially when considering that after the freeway ramp closure, the time of using transit on short distance trip would be even more similar to driving as more driving would need to be local after the ramp closures.

With the shift in trip demand, it is essential for us to adjust the dated infrastructure and policy to not just to maintain to the current standards, but also to ensure that they meet current demands. Although it would be tempting to always expand the infrastructure, cutting down the footprint of the infrastructure to adaptive with current demand, using new technology and methods would be a better approach. Adjusting according to the demand shift is the one of the critical ways to maintain a sustainable development, and such development resulting a reduction of GHG.

Minimal Disconnected Walk-Centric Neighborhoods

Comparing with other mode choices, every mile that was travel shifted from non-active transportation to active transportation such as walking and cycling would avoid the emission of GHG by non-active transportation, and lead to a general reduction of GHG emitted. Such travel mode currently only accounted for 1% of all miles traveled (Federal Highway Administration, *2020 National Household Travel Survey, U.S. Department of Transportation, Washington, DC*), and if more miles were traveled by active transportation, more GHG emissions could be avoided. Thus, encouraging active transportation is one of the main priorities to combat climate change.

One of the ways to encourage active transportation is by improving the build environment to increase physical activity, as studies shows people that live in neighborhood would encourage such mode choices (Frank et al.). Therefore, whether an area is walkable or not – known as "walkability" has become an essential factor for planners and transportations planners alike, as encouraging active transportation not only lower GHG emissions, studies has also shown an inverse correlation between vehicle miles travelled (VMT) and walkability (Frank et al.), which is essential to curb down GHG emissions, as light-duty vehicle alone accounts of over 15% of GHG emissions (EPA).

Smart Growth, a range of development and conservation strategies to guide land use and transportation plannings has reshaped neighborhoods and their transportation options as it gains tractions (Gerrit-Jan et al. Ch. 9; Smart Growth Network). More importantly, it explicitly supports the creation of a walkable neighborhood. As a result, cities has densified as population has grown and land area has not, and such land-use policy support walking by making it a viable way of trip mode (Gerrit-Jan et al. Ch. 9).

However, just that one's lifestyle could be adopted by walking, does not make one's lifestyle not drivable. Arguably, a walk-centric lifestyle – a lifestyle that involves very few trips on modes other than walking – only exists because it is rationale to do so, similar to other lifestyle. For example, because its residents' lifestyles are not realistic to drive or the alternative of driving is much better. Therefore, areas that are dominated by walk-trips, encourages walkability not only because there is improvement of the walking infrastructure, but also it often takes away some of the feasibility of other modes, such as driving. Such an example could be seen in Barcelona, where after its initial implementation of "the superblock," which involves both improving pedestrians access and closing access for personal vehicles saw the private motorized transport share to be reduced by 19.2% (Mueller et al.).

Though Smart Growth's approach has successfully driven up active transportation, the focuses on diversifying transportation choices, does not eliminate the feasibility of driving (Smart Growth Network). Such an approach made other mode choices forced to compete with the already extremely car-dependent surroundings, especially in terms of speed and comfort (Filion and McSpurren). Resulting that the car still dominating the suburbs, when the walkable centers are having persistent pedestrian fatalities and injuries (Gerrit-Jan et al. Ch. 9). In order to shift such a transportation change to reduce GHG, "residential density policies must be deployed over long periods and unfold at local and metropolitan levels simultaneously" (Filion and McSpurren). Even if other mode maybe able to compete with the car, the fact an individual can choosing the car as a travel mode may be related to other factors such as symbolic factors means that the Smart Growth approach fails to maximize the reduction of GHG (Schwanen et al.).

Asides from lifestyle adoption, political opposition is a key reason that Smart Growth should be revised. Pursuing density policies that Filion and McSpurren has stated is difficult due to various political reasons related to surrounding area interests (Filion and McSpurren). In addition, studies have shown that it is politically difficult to move away from existing “car-dependent transport systems,” as such system is “a deeply self-reinforcing system,” and “immune from economic and political pendulum swings”(Mattioli et al.). Therefore, developing projects in areas that are not affected by such reinforcing system would be one of the possible solutions politically.

Minimal Disconnected Walk-Centric Neighborhood (MDW) is a disconnected neighborhood that focuses solely on a walk-centric lifestyle, meaning that other trip modes would be non-viable in such a proposed minimal mixed-use neighborhood. This means not only the residents can perform such a lifestyle on foot, as that they must perform such a lifestyle on foot as it is the only viable way. The minimal disconnected aspect of such a neighborhood allows it to face the least resistance of the surrounding environments, as both local resistance and car dependence culture would affect the walk trips rates. In addition, the principal MDW, would allow in theory private developer build it in far-flung areas with low barriers when compared to development that are under heavy regulated and expensive urban areas.

Idealistically, all neighborhoods should accommodate all needs that all the needs of each resident, including work, leisure etc. However, the footprint of such a neighborhood would be too big and would attract resistance from the surroundings, especially it would require a large amount of land of acquisition. Therefore, a MDW should be as minimal in size as possible, and it should aim to maximize development density.

Being minimal in size and disconnected from the local surroundings, a MDW must have an excellent non-car connection to a walkable core to be successful, ideally a core that can fulfill all the needs that were not able to provide in the MDW. The connection must be a transport system that would not be mirroring the shortcoming of the ones promoted in Smart

Growth, a transit connection that would have no competition by the car. Such a connection may seem to be a significant investment initially. Due to everyone that is riding such a system are forced to be dependent riders, by not creating and funding roadways that a typical subdivision or a road improvement projects that Smart Growth neighborhood needs. As a result, the neighborhood has essentially a profitable public business with not much additional cost from the developers. In addition, such a connection usually involves with connecting with a job center, with a reliable travel time, and thus further increase the viability for calling such a neighborhood home.

A simple example of a MDW would be a small island that is closed to a metropolitan core with ferries as the only transportation option. An island usually has a dense core, near the ferry pier, which provide most of the amenities that the residents need. When needs are not met, residents can take the ferry to the mainland coast – which usually are a walkable and early-developed area in a town. Studies have shown that even a greenhouse gas emission per passenger mile in a ferry is a fraction of the ones in the personal automobile (Meza et al.).

Repricing Mobility to Discourage Travel

In the United States currently, on average per passenger mile, personal vehicle emits 0.47 pound of CO_2 per mile (EPA). With the personal vehicle sector emission taking 57% of GHG emissions, it is essential that we are able to lower the use of it to lower the pollution. One of such ways of reducing it is to use pricing it to a market equilibrium including the negative externalities, which was first outlined by economist Arthur Pigou, as a Pigouvian tax equal to the negative externality (Pigou).

However, GHG emissions does not only occur behind tailpipe of a vehicle, it also involves the building maintaining the infrastructure for such a use. By some estimates, over a life span of a freeway mile, on average equal the climate footprint of about 2 typical US residents (Williams-Derry). Therefore, the externalities of driving do not only occur on the tailpipe pollution, some of the other externalities that were mentioned in studies includes the congestion that the driving produces (Santos and Fraser).

Therefore, road pricing is often regards one of the effective ways to balance externalities listed above. Because it not only reduces the emission of vehicles, it also relief the pressure of expanding such an infrastructure. Road pricing has been successfully introduced in numerous cities, such as Rome, London etc. (Santos and Fraser) with some positive benefits, and also some drawbacks. Some of the benefits includes easing congestions and pollution, and drawbacks includes how the cost of the externalities are shifted towards the lower-income (Santos and Fraser).

However, the main issues of implementing road pricing projects are the local oppositions towards equality, as they people have different definitions of equity and it is difficult to take care all of them (Levinson). Even when such a concern was taken care of, the previously mentioned self-reinforcing car-dependent transportation system would be a major deterrence force towards such a pricing as it cuts down accessibility of the automobile.

One of such approach has been subject to increasing debates, known as Road Use Charge (RUC), is an approach to tax vehicle user per mile driving. Researchers have been debating, instead of the current fuel tax, the government should instead charges road use charge per mile as the increased adoption of more efficient vehicles (Parry; Weatherford).

One of the concerns of implementing RUC is equity concerns, which is also prevalent of other choices of road charges. Studies have shown such a charge may be impactful to the lower income bracket, as they generally require a longer commute comparing to other income brackets. The same study also pointed out that RUC makes respondent more aware of the travel cost, and potentially may change their daily travel needs to lower it (Lazarus et al.). However, increasing evidence that other, more-than-rational factors, such as symbolism and affects, play an important role in travel practices, and economic pricing may not as effective as it seems (Schwanen et al.).

In more recent years, various research and State programs are pushing the use of RUC. Oregon, Utah and Virginia, currently have an active program on road use charge, which participation are voluntary. Where Colorado, Hawaii, Minnesota, Washington and California have completed their respective pilot programs for the charge (California Department of Transportation). Various pilot and real life implementation have shown that such a model is practical, and generates much needed tax revenue and have the ability to price more accurately mobility (California Department of Transportation).

Though such a charge is possible, the approach that agencies are currently taking may not be strong enough to convince driver to adopt such a pricing approach and generate enough local support. In current programs, all programs only charges using a flat-fee per mile approach, which does not price the time and the location of driving. While the location of driving could be price enforced by toll booths and toll roads, realistically the time of driving would be best enforced by a GPS system. Research has shown that if time and location of driving are better factor, respondent would think it would be a fairer system (California Department of Transportation).

The most recent California trial shows that the technology for pricing time and location is possible, where it listed using fuel station, EV-chargers, ride-share accounts and insurance payment for such a pricing method (California Department of Transportation). However, adding such a tax on top of current fuel tax would not be favorable among residents, especially when considering the self-reinforcing car dependent transportation system. Therefore, I believe that when implementing such a charge must start with a cap with no higher than the current fee level, which encourage enrollments.

The effectiveness of RUC to tackle emissions and congestions remains to be seen, but it is certain that if a negative externality was charged against mobility, there is certainly an adjustment force to adjust it to equilibrium (Pigou). As a result, vehicle would travel less and there will be GHG reduction. However, only if a feasible framework is widely adopted, we would be able to evaluate the successfulness of such a RUC. Therefore, I believe to better price mobility for traveling, we must first be able to enroll everyone into the cost.

Conclusion

The section above provides some of the small changes of transportation planning could results in big savings in GHG emission. More importantly, most of the proposal could be implemented with lower resistance from the “car-dependent transportation system.” Though car-addiction may prove to be an issue in the new demand paradigm, it is important that we remain optimistic that with the new measures that would be much more appreciated in the car-dependent region could be shifting the mindset of those who are car-addicted. Due to space constrains, whether such a measure would be correlated with infrastructure performance metrics, such as the conversion rate of transit choice riders has not been proof in the essay. Although the above sections have provided enough theory-based evidence to proof the importance of separating car-dependency and car addiction, I believe it is crucial for quantitative research to be done to further validate the assumption above.

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