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A comparison of methods to reclassify trip purpose within trip chains

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Abstract

Household travel surveys and other surveys typically include a substantial number of trips classified as “return to home” which do not give any indication of the main purpose of the original destination from which they are returning. This presents a problem when this data is used to calculate VKT by purpose as the VKT will be underestimated for all other purposes. This paper outlines a methodology for generating trip chains which are then used to recode trips. This paper uses data collected from a longitudinal (10 week) GPS study of driving behaviour in Sydney, Australia to assess the differences in computing VKT using various methods. This is done for recoding both trips classified as “return to home” and all trips within trip chains. The results show that all recoding methods result in a substantial increase in VKT attributed to both work and social/recreation with smaller gains for other purposes. These purposes are further emphasised when all trips in a chain are recoded.

1. Introduction

The collection of trip purpose data often results in a significant proportion of trips being classified as “returning home” rather than the main purpose of the trip chain as a whole. This complicates the comparison of Vehicle Kilometres Travelled (VKT) by trip purpose by not including the return leg in the calculation of VKT. VKT comparisons are a useful measure of travel behaviour that are often required outputs for many household travel surveys and increasingly travel behavioural change studies. While some household travel surveys code trip purpose on the basis of both origin and destination (such as “Work to Shopping” or “Home to School”), this paper describes a process for the recoding of trip purpose when purpose is coded based solely on the destination purpose.

This paper describes the development of a methodology to facilitate the reclassification of trip purpose within a trip chain in order to compare VKT calculations between trip purposes. Trip purposes were reclassified by finding the most important purpose within each trip chain and then reclassifying either the last trip in the chain (i.e., “returning home”) or all trips in the chain to the most important purpose.. The data used for this analysis was taken from a longitudinal (10 week) GPS study of driving behaviour in Sydney, Australia. The aim of the study was to facilitate, predict and detect changes in driving and encourage safer driving practices through kilometre-based charges that varied based on the drivers themselves and how much, when and how they drove. The study comprised a five-week ‘before’ period of monitoring to establish how motorists drove normally, followed by a five-week ‘after’ period of monitoring in which charges were levied and changes assessed. Financial incentives were then paid to motorists for any reductions in charges between the two five-week periods (Greaves, et al 2010, Greaves and Fifer 2010). Only data from the five-week ‘before’ period was used in the analysis presented here.

1.1. Coding of return to home in household travel surveys

The coding of a substantial proportion of trips as “return to home” (or similar) has been identified as a problem in both the Sydney Household Travel Survey (HTS) and the National Household Travel Survey (NHTS) in the United States (McGuckin and Nakamoto 2005, Transport Data Centre 2009). To reduce the proportion of trips coded as “returning home”,

the Transport Data Centre (TDC) recodes the responses to the Sydney HTS using a “priority purpose” hierarchy (further discussed in Section 2) (Transport Data Centre 2009). This eliminates the problem of trips being coded as “return to home” but does not address how much VKT should be attributed to each destination. In the past, the NHTS has addressed the problem of “return to home” by identifying the main purpose of the trip chain during the interview. More recently, the NHTS has adopted a different approach by coding trips based on both origin and destination purposes such as “home to work” or “work to school” (McGuckin and Nakamoto 2005). Although this method results in different issues, it does eliminate the problem of trips being coded as “return to home” with no indication of where they are returning from.

2. Methods

During the 10 week study period, participants were required to access a website regularly to confirm their recorded trips and provide some further trip information. Using the online interface participants selected the main purpose of each trip using a number of predefined categories (Greaves et al. 2010). In addition, a purpose of “returning home” was used to designate the return trips or the last trip within each trip chain. However, calculating VKT based on this classification of trips understates VKT for each of the purposes since the VKT for return trips is excluded and therefore results in an inaccurate reflection of driver behaviour. To reduce this problem, the trips which had been originally classified as “returning home” had to be recoded to the main purpose of the trip chain. This required a number of steps which were automated by developing a number of GIS-based routines.

The recoding of trip purpose involved three main processes (outlined in Figure 1). First, a base or “home” location had to be identified for each participant to delineate trip chains. This location was identified using one of two methods. The first method found the centroid of the end points for all trips designated as “returning home” and then checked to see if all “returning home” trips finished within a 100 metre radius of the centroid. If one or more trips were found to have finished outside a radius of 100 metres, the trip furthest away was removed and the centroid recalculated. This step was repeated until all trips finished within a 100 metre radius of the centroid. This was done to ensure that any trips which had been mistakenly designated by participants as “returning home” did not impact the calculation of the participant’s home location. If fewer than five trips designated as “returning home” finished within 100 metres of the calculated location, a second method was used. The second method was used to find the single location where most trips (regardless of purpose) finished. This involved the use of two nested loops. The outer loop iterated through each trip and was used as the location to which the other trips would be compared. The inner loop iterated through all other trips and checked if the trip finished within 100 metres of the current trip in the outer loop. The trip end for which the highest number of trips finished within 100 metres was then selected as the participant’s home location. The primary difference between the two methods are that the first method takes into account only trips designated as “returning home” while the second method looks at all trips based on the assumption that the location with the highest number of trip ends is where the participant lives. These two methods are shown in Figure 2. All trips were then processed into trip chains using the process outlined in Figure 3. This process used the home location identified using one of the two previously described methods as the delimiter between trip chains. It iterated through each recorded trip in chronological order and checked if the trip finished within 100 metres of the home location. If this was the case then the trip would be marked as the last trip of the chain with the following trip being marked as the first trip of the next chain. It is important to note that the end of the trips was used primarily because of the “cold-start” problem, which refers to the time taken to acquire a signal at the beginning of trips, and hence lost GPS data.

Figure 1: Flowchart of main processes

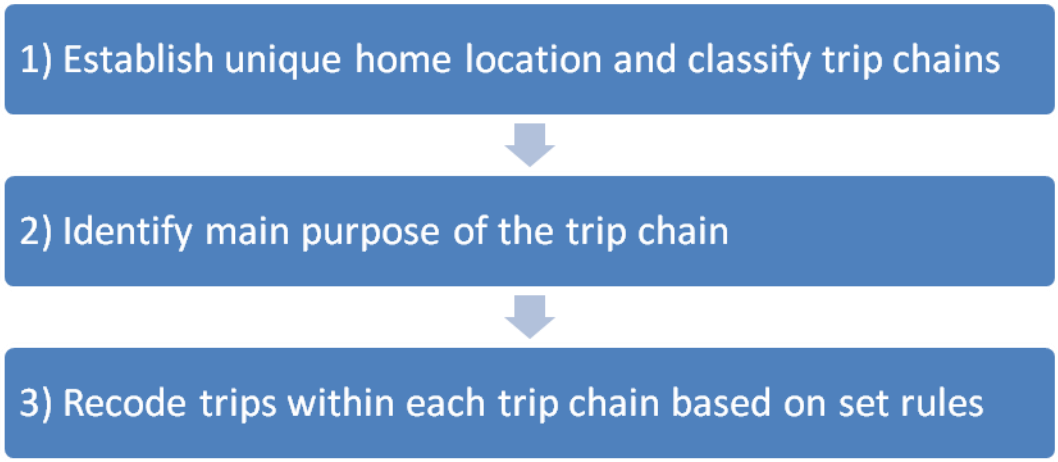


Figure 2: Methods for finding home locations

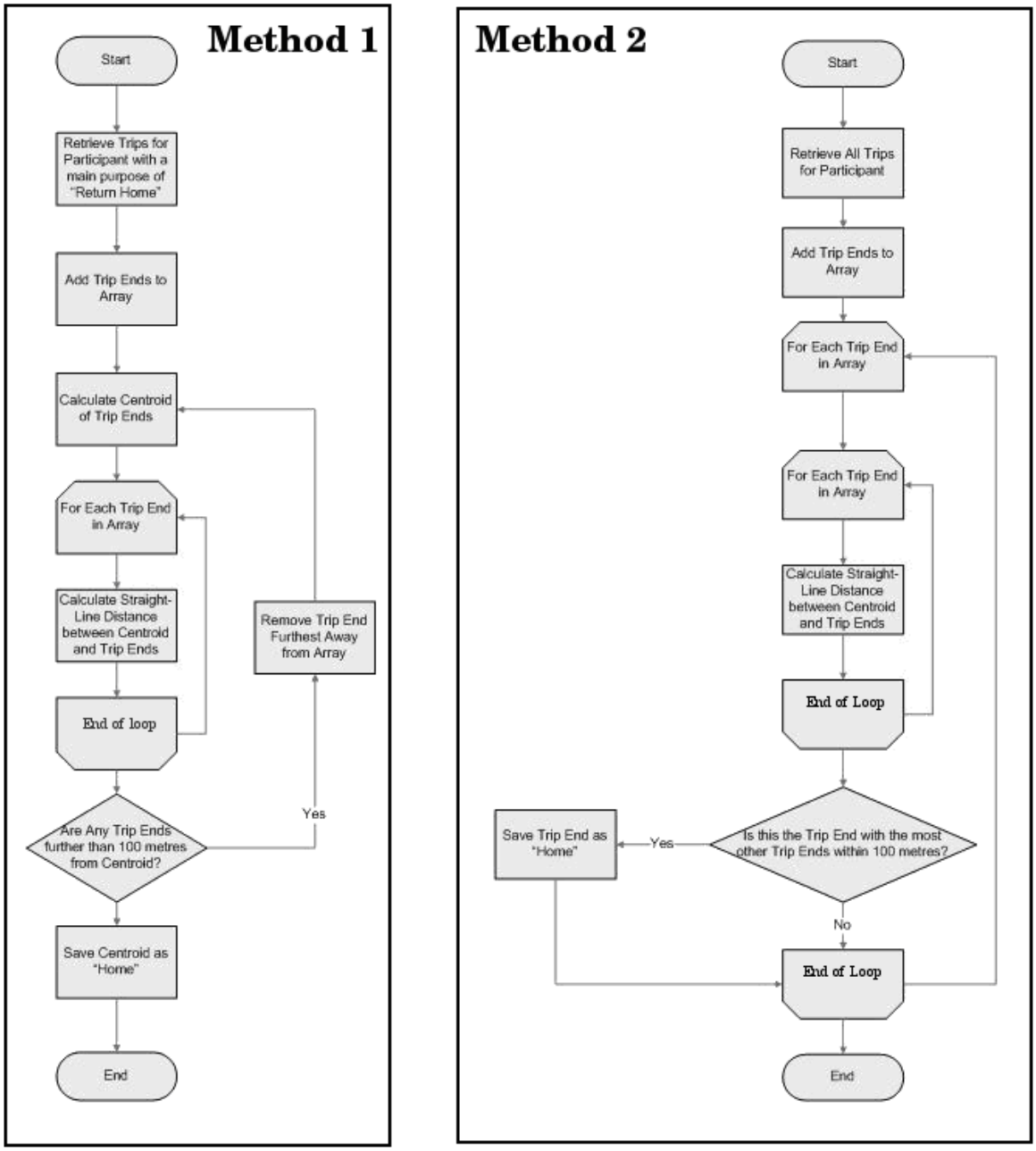
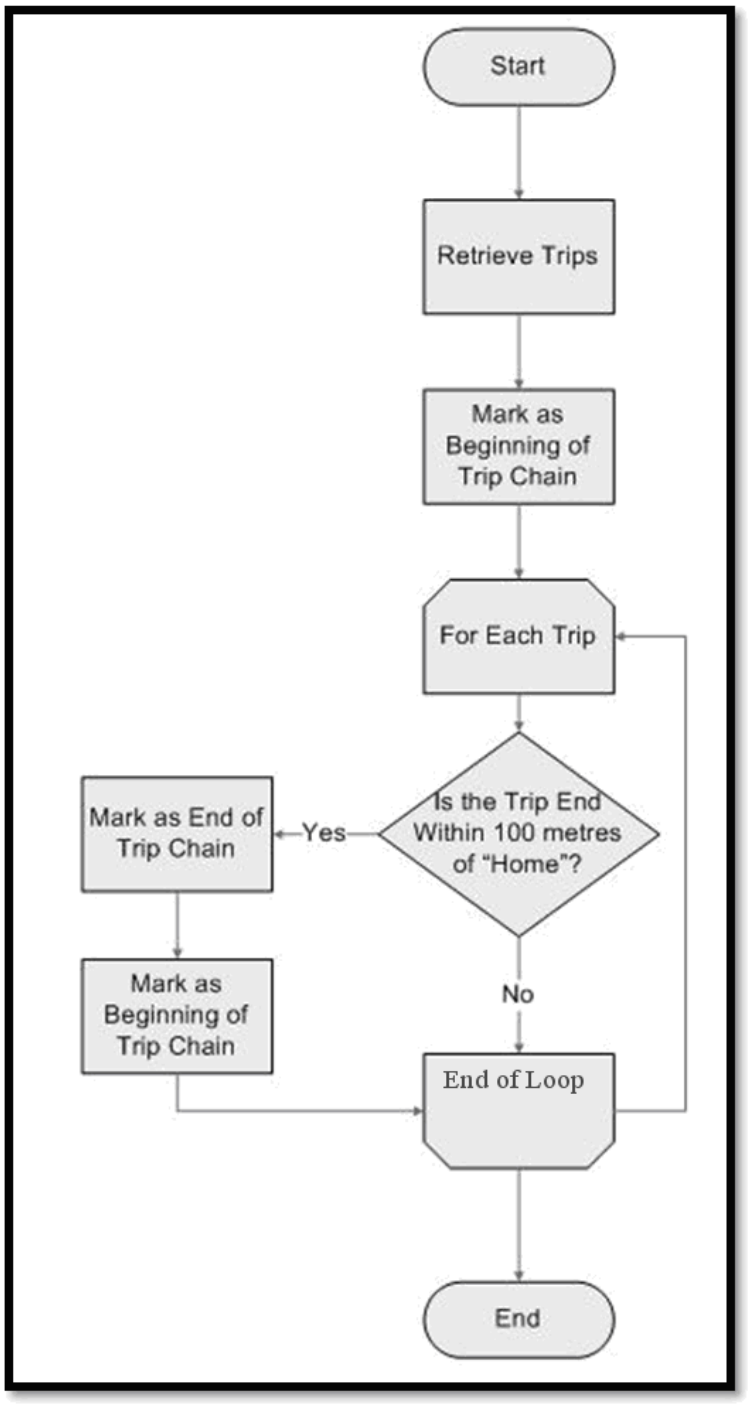


Figure 3: Process for finding trip chains



Following the classification of the trip chains, the main purpose of the trip was then identified. A number of options of how best to select the main purpose were considered (Table 1). Three different rules were applied to select the main purpose, including using the previous purpose within the trip chain, a priority purpose selected based on the hierarchy used by the Transport Data Centre (TDC)[1] (Transport Data Centre 2009) in its household travel survey (Figure 4) and finding the purpose at the destination where the most time was spent. It must be emphasised that the primary aim of the recoding was to compute VKT by purpose to give a more accurate representation of the VKT. This means that some of the methods used would not be appropriate if the primary consideration was different (such as on which days people travel). In particular, the recoding of all inbound and outbound trips would likely not be appropriate for many purposes.

Table 1: Summary of recoding methods

Method	Recode	Applied rule	Description
Base			
1	Return to Home (RTH)	Previous purpose	*Recode the RTH trip with the previous purpose in the trip chain.*
2	Return to Home (RTH)	TDC hierarchy	*Recode the RTH trip with the priority purpose (selected using the TDC hierarchy) within the trip chain.*
3	Return to Home (RTH)	Most-time at destination	*Recode the RTH trip with the purpose for the destination where the most time was spent within the trip chain.*
4	Outbound / Inbound	TDC hierarchy	*Recode all outbound and inbound trips with the priority purpose (selected using the TDC hierarchy) within the trip chain.*
5	Outbound / Inbound	Most-time at destination	*Recode all outbound and inbound trips with the purpose for the destination where the most time was spent within the trip chain.*

Figure 4: TDC purpose hierarchy

Once the main purpose of the trip chain was identified, trips within the trip chain were then recoded based on one of five methods (outlined in Table 1). These five methods are divided into those in which only the RTH trip[2] was recoded and those in which all outbound and inbound trips in the trip chain[3] were recoded. This distinction is important as they make use of different assumptions. Recoding all trips is an implicit assumption that trips (and VKT) to destinations other than the one with the main purpose would not have been made were it not for the main trip. In contrast, recoding only RTH suggests that trips to all destinations in the chain would have been made at some point.

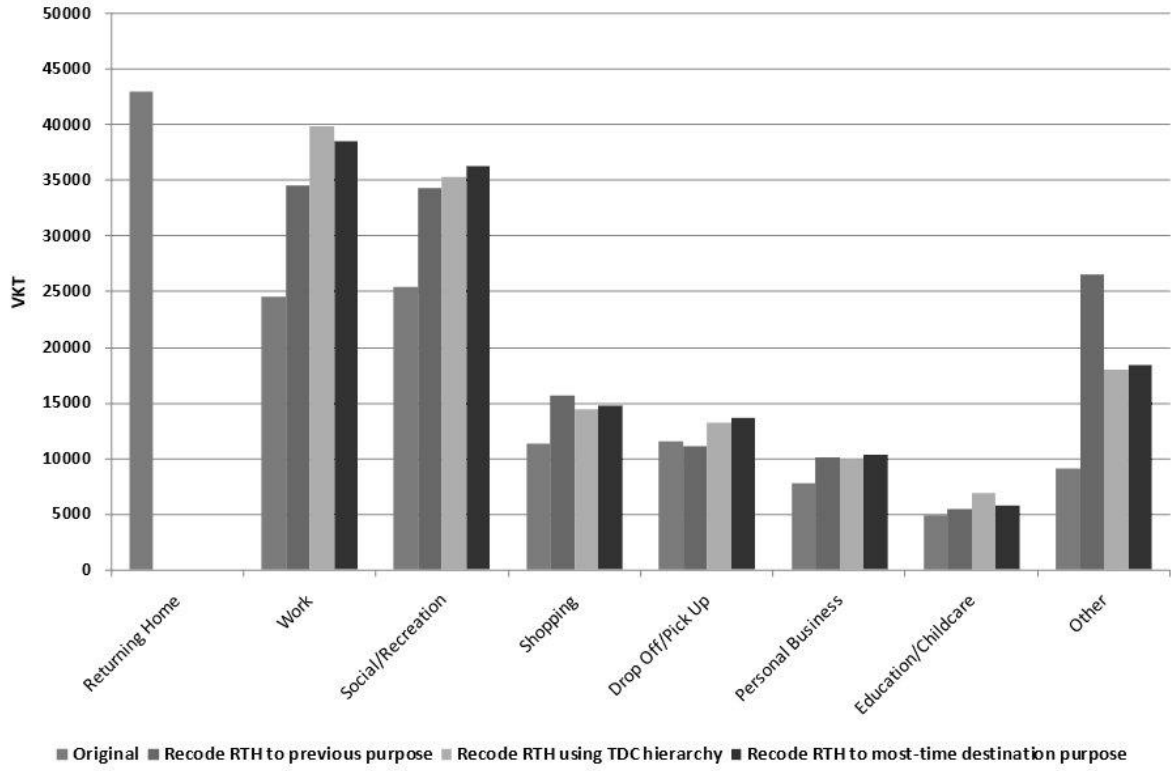
[1] If the Trip chain was greater than 24 hours in duration and included the purpose Holiday / Vacation, then Holiday / Vacation was deemed the highest purpose in the hierarchy.
[2] If Return to Home (RTH) was not the last trip in the trip chain then it was reclassified to “Other”.
[3] If the distance of any trip within the chain was greater than 1.5 times the distance of the opposite leg of the chain then the original purpose was kept.

3. Results

3.1. Recoding of return to home

When trips selected as RTH are reclassified the VKT assigned to all other trip purposes (as expected) increases. However, the extent of this increase varies depending on the method, with some methods emphasising certain characteristics which are more common to a particular purpose. The impact of each method can be seen in Figure 5. Unsurprisingly, both work and social/recreation trips see the greatest increase in VKT regardless of reclassification method due to their large proportions of VKT before reclassification. In contrast, VKT for personal business increases only slightly which is likely due to personal business trips being made in combination with purposes of higher importance. The large increase in trips classified as "other" when trips are reclassified to the previous purpose is a result of the penultimate trip of the chain having also been originally classified as "Returning Home", "other" or involving a stop for fuel. The same effect is not seen with the other two methods which both use a hierarchical system, either based specifically on trip purpose or on the time spent at each destination.

Figure 5: VKT by trip purpose after recoding of returning home

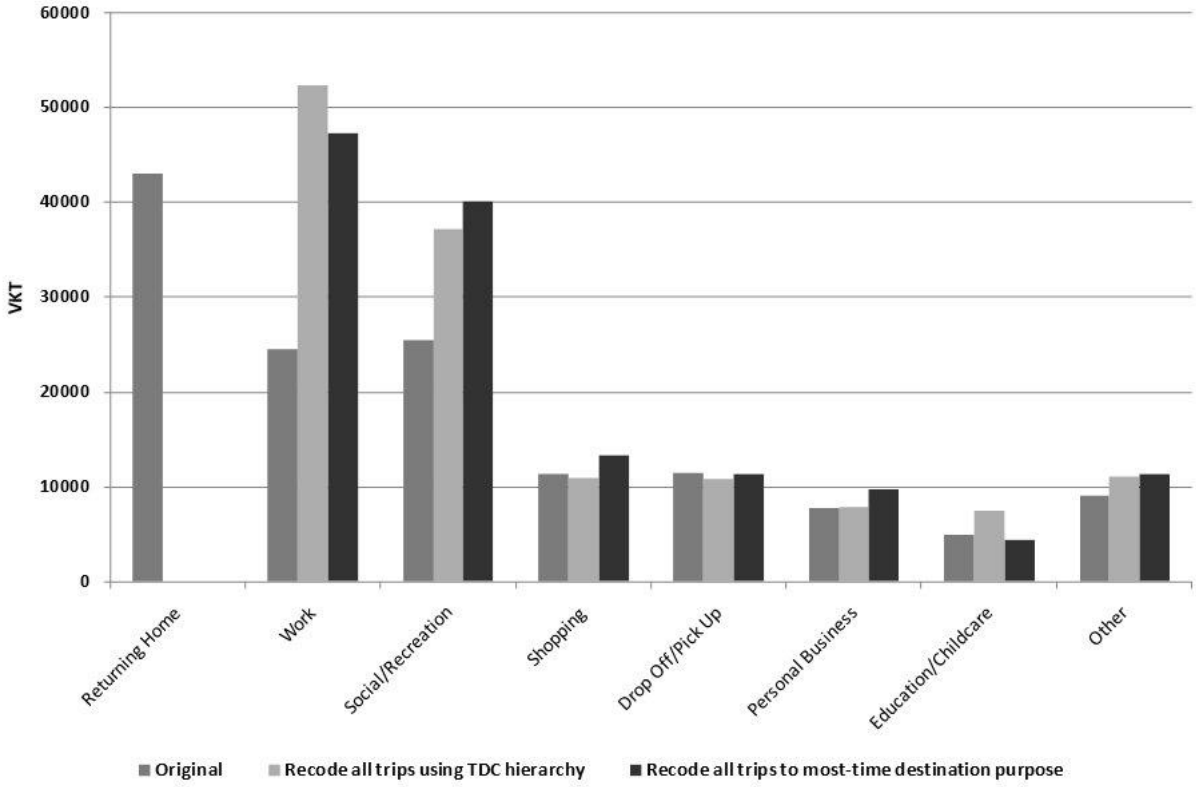


3.2. Recoding of all trips

Reclassifying all trips to the main purpose identified using the two hierarchical methods resulted in significantly different results from only reclassifying the last trip in the chain (see Figure 6). This was done using only the TDC hierarchy and the most-time destination methods because using previous purpose would not be possible when multiple trips in a chain are reclassified. It must be emphasised that the purpose of the trip was not reclassified if it was clear that a destination did not only require a small detour but had instead required substantial additional travel. In contrast to the reclassification of the last trip in each chain, VKT assigned to each purpose did decrease for some (albeit different) trip purposes for each method. Much of this reduction resulted in an increase in VKT for work and social/recreation. The position of these purposes in the TDC hierarchy and the amount of time generally spent

at work and doing social activities meant many trips were reclassified to these purposes. Interestingly, the proportion of VKT classified as work is lower when the most-time destination method is used rather than the TDC hierarchy method. The difference between these two values is an indication of how often more time is spent at a social (or other) activity than at work on the same trip chain. However, work is still clearly the dominant purpose in most chains which is likely a result of a combination of the longer than average distances involved in work trips and the importance attached to work as an activity.

Figure 6: VKT by trip purpose after recoding all trips

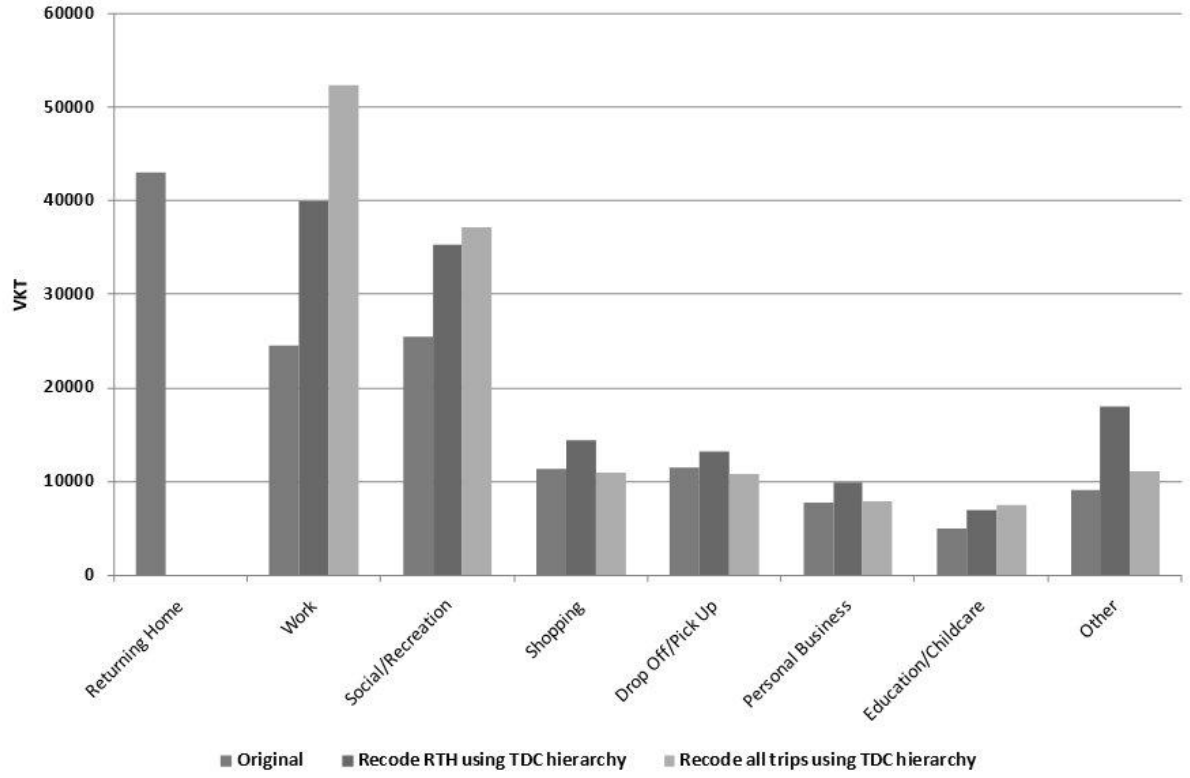


3.3. Comparison of recoding return to home and recoding all trips

Comparing the reclassification of only the last trip in each chain (RTH) to the reclassification of all trips in each chain using only the TDC hierarchy method clearly shows the difference between these two recoding procedures (see Figure 7). Reclassifying all trips within a chain to the primary purpose further emphasises the importance of work and social/recreation trips in people's daily lives as well as giving a clearer indication of how much of an individual's travel consists of trip chains involving a single main destination with a number of stops to side destinations. Interestingly, education is the only purpose other than work and social/recreation to see an increase in VKT when all trips are reclassified. This is a result of its high position in the TDC hierarchy.

These comparisons have shown how significantly the reclassification of trips impacts the distribution of VKT across trip purposes. Although the largest differences are between the recoding of the last trip and the recoding of all trips, there is also some variation between how trips are recoded (i.e., the rules applied). Because of these large differences, the intended usage of the analysis is likely to influence which method is ultimately chosen. For instance, if the data set is to be used to look at the correlation between the destination and the time of day then recoding only the last trip of the day would likely lead to a more accurate result.

Figure 7: VKT by trip purpose after recoding using TDC hierarchy



4. Conclusions

This paper examines the possible methods that can be used to recode trip purposes within a trip chain to facilitate a comparison of VKT for travel surveys. Three different rules were applied to select the main purpose, including using the previous purpose within the trip chain, a priority purpose selected based on the hierarchy used by the Transport Data Centre and finding the purpose at the destination where the most time was spent. These rules were then applied to recoding either the last trip within a trip chain (RTH) or all the trips within the trip chain. The findings suggest that the recoding procedures lead to an increase in VKT for primarily work and social trips. This is due to both the applied rules for selecting the main trip purpose and the nature of the trips chains exhibited by Sydney drivers. Ultimately the rules and recoding method chosen will depend on the objectives of the analysis being conducted.

References

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