

# WEBSITE NAVIGATION STRUCTURES: ELICITING MENTAL MODELS USING CARD SORTING



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### **Abstract**

This study aims to gain insights into the relationship between mental models and navigation structures, providing valuable insights and recommendations for more intuitive and user-aligned municipality websites. To examine the extent to which existing navigation structures on municipality websites align with its users' mental models, the first objective is to determine the average mental model. This was conducted using an open and remote card sorting technique. The results were then analysed by cluster analysis and the mental model was represented by seven clusters, five ambiguity groups, and six isolated items. The second objective is to assess the alignment between the elicited mental model and an existing navigation structure. To do so, a visual comparative analysis was conducted against the municipality website of Amsterdam. Despite some differences, the website structure was revealed to have a moderate level of alignment with the elicited mental model. In the case of misalignment, design recommendations were proposed to bring the navigation structure closer to users' mental model. Limitations aside, this research contributes to a current gap in literature towards optimal navigation structures for municipality websites. Future research is recommended to conduct a usability assessment of proposed structure and include a more extensive set of items.

*Keywords:* municipality websites, e-government, information architecture, usability, mental models, card sorting.

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## Introduction

Websites, much like modern-day libraries, have revolutionised how individuals acquire knowledge. That is to say, the proliferation of the internet has transformed websites into one of the primary resources for information. In particular, *municipality websites* have become the main channel for information concerning local government services and communications (Schmettow & Sommer, 2016). Municipal websites exclusively fall under *e-government* systems, which employ information and communication technologies to allow efficient access and delivery of governmental services and information (Lee, 2010). However, the task of organising the massive amounts of data stored in municipal websites is a complex task that requires careful consideration of various factors (Correa et al., 2018). In fact, a prevalent challenge in the field of information architecture is the organisation of information such that users can locate their desired information intuitively (Schmettow & Sommer, 2016).

Schmettow and Sommer (2016) highlight that given the prevalence of municipal websites, one may assume that their content be somewhat similar. However, this is not the case. Schmettow and Sommer (2016) point out that differences in the structure may be due to the different perceptions held by individuals, such as those by employees versus citizens, in how they conceptualise and prioritise information. Similarly, Kotamraju and van der Geest (2012) report that many e-government services are less user-friendly than intended, with around half of European users expressing only moderate satisfaction, due to the lack of user involvement in the design. Consequently, Rasool and Warraich (2018) argue that to ensure a sense of uniformity across e-government websites and make information retrieval as user-friendly as possible, standardisation in this regard is fundamental. While the need for a standardised guideline on designing navigation structures for e-government websites is heightened, it is crucial to acknowledge that such a comprehensive standard does not currently exist (Schmettow & Sommer, 2016).

Furthermore, a current issue in municipal websites is the lack of accessibility, with 'access' referring to the possibility for access rather than the facility of use (Perdomo et al., 2017). According to Perdomo et al. (2017), this implies that the design of a website takes into consideration all potential users without excluding those with individual limitations, such as those with disabilities, language constraints, and so on. There exist international laws that prohibit discrimination against individuals with disabilities in several areas, among these is to ensure that governmental services are accessible to all. In the Netherlands, this is addressed under the Equal Treatment Act on the grounds of disabilities or chronic illnesses (WGBH/Cz)

(*Wet Gelijke Behandeling Op Grond van Handicap of Chronische Ziekte*, n.d.) and is further emphasised by the Web Accessibility Directive (EU Directive 2016/2102) which was transposed into Dutch Law (*Web Accessibility | Shaping Europe's Digital Future*, n.d.). As can be seen, there is still a significantly low level of compliance among municipality websites (Velleman, 2018).

Having said that, municipality websites must adopt a multifaceted approach. They must be easy to navigate for a variety of users and abide by accessibility regulations (Serrano-Cinca & Muñoz-Soro, 2019). Furthermore, they must provide relevant information in an efficient and engaging manner, such as emergency warnings, current news, and public announcements (Serrano-Cinca & Muñoz-Soro, 2019). Thus, though it may not be necessary for municipality websites to follow an identical design, it may be advantageous for local governments to follow a similar navigation guide that is intuitive for users. As a result, adopting a similar navigation structure could enhance user engagement, allowing residents convenient access to municipalities' information and services (Kincl & Štrach, 2012).

### **Information Architecture and Usability**

As stated above, organising information on a website in a way that is comprehensible for users is a recurring challenge in the domain of information architecture. Information architecture particularly refers to the blueprints of a website – detailing how information is structured, labelled, and ultimately, presented to users so that they can navigate through the website with minimal cognitive effort (Gullikson et al., 1999; Perdomo et al., 2017). For example, it examines how users search for content, where the content is placed, how they skim through webpages, how these webpages are organised, and how users interact with menu items. Additionally, rather than using the search function, Katz & Byrne (2003) and Bergman et al. (2008) found that users prefer to browse the navigation structure when searching for information. Ease of navigation plays a crucial role in assessing how much material is read, how satisfied users are, and whether they are likely to return (Gullikson et al., 1999). Hence, a central aspect of information architecture is the influence on users' ease of navigation.

Expanding on this, the challenge faced in information architecture gives rise to a broader usability concern. ISO (1998) defines usability as, “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”. This definition implies that a design is only useful if its respective end users can understand it as intended. According to Huang and Benyoucef (2014), e-government websites exhibit a wide range of usability issues, such as inconsistent

formats, poor navigation capabilities, and disorientation. These issues may stem from challenges faced by information architects in crafting a navigation structure that effectively organises content, maintains consistency, and ensures user-friendly navigation (Nalawade & Dayaker, 2014). Consequently, if a website's information architecture fulfils the needs and expectations of its intended users, overall navigational ease and usability can be improved (Sinha & Boutelle, 2004).

Furthermore, it has been found that usability plays a central role in determining the credibility of a municipality website. Bussolon (2009) discovered that individuals who had difficulty finding content and navigating the website undermined its credibility. Huang and Benyoucef (2014) also indicated that usability problems on a website may have a detrimental impact on e-government credibility. This includes reduced satisfaction, a shift in attitude towards e-government systems, and increased reservations regarding the use of the information and services available on the websites (Huang & Benyoucef, 2014). Therefore, to increase user satisfaction and foster trust in e-government websites, it is crucial to consider credibility issues in the context of e-government usability.

### **Mental Model**

To reiterate, improved usability and navigational ease on a website occur when its information architecture align with the needs and expectations of its target audience (Sinha & Boutelle, 2004). This can be done through studying the intended users' *mental model*. To elaborate, when a user interacts with a website, they do so carrying certain predetermined expectations. These may be determined by their past experiences with other websites and platforms, individual knowledge, or perceptions that they use to engage with their surroundings (Jones et al., 2011). This results in a mental construct as to how they believe they should browse the website to find information or access features. If this process is unsuccessful, it would lead to user frustration, reduced user engagement, missed opportunities to showcase certain content or services, and so on (Huang & Benyoucef, 2014). Hence, it may suggest that the website's navigation structure does not match its users' mental model.

Several studies endorse the use of mental models to improve usability. Roth et al. (2010) stress that by developing an understanding of users' mental model, usability designers can create web interfaces that align with how users envision the system to perform. Olaverri-Monreal and Gonçalves (2014) further support this notion by claiming that learning users' mental constructs are fundamental to design a system that is tailored towards their expectations. Additionally, as previously mentioned, Kotamraju and van der Geest (2012)

found that there is a lack of user input throughout the design process of municipality websites. However, by using mental models, this concern is directly addressed. Altogether, various researchers emphasise that when the design of a user interface resonates with the intended users' mental models, a much more intuitive user experience can be provided.

### **Card Sorting**

To gain insights into users' mental models, an effective strategy often employed is *card sorting*, where mental models of the target group are studied to design or assess the information architecture of a website (Spencer & Warfel, 2004; Schmettow & Sommer, 2016). In this empirical approach, researchers select items that represent the content of the website onto digital or paper cards. Participants are then requested to categorise the cards into piles that are meaningful to them. To explore new insights, participants freely create categories in an *open card sorting*. Conversely, to evaluate the efficiency of an existing system, participants sort the cards into pre-defined categories in a *closed card sorting* (Spencer & Warfel, 2004; Schmettow & Sommer, 2016). The goal is to assess if resulting categories align with users' mental models and preferences, guiding the design of a website's information architecture.

Furthermore, card sorting has been found to provide valuable user input. According to Spencer and Warfel (2004), it helps address basic questions in information architecture such as whether users grouping preferences (by subject, process, etc.) and provides insights into users' needs, core categories, label suggestions, and so on. Schmettow and Sommer (2016) further highlight that this approach allows for an evaluation of the perceived semantic proximity within information items. Widely applicable and effective, card sorting optimises user experience by providing informative feedback (Schmettow & Sommer, 2016).

### **Research Aims**

Although the widely held belief is that that navigation structures are most efficient when they mirror the mental model of its intended users, Schmettow and Sommer (2016) found conflicting results. They investigated the relationship between browsing performance and the alignment of mental models with navigation structures on municipality websites. Through a card sorting and various search tasks, the subsequent data analysis revealed that a match between mental models and website structures had no impact on browsing performance. This study builds on these findings by examining the extent to which existing website structures align with mental models, if any. Given the limited research on establishing a uniform navigation structure tailored to municipal websites, understanding the



role of mental models in building improved navigation structures, brings researchers one step closer to the developing a standardised navigation guideline (Jong & Lentz, 2006).

The first aim of this study is to determine the average mental model of residents in the Netherlands in the context of municipality websites, using an open and remote card sorting technique. The second aim is to assess the extent to which the elicited mental model is aligned with the navigation structure on an existing Dutch municipality website, that being the municipality of Amsterdam (*Home - Gemeente Amsterdam*, n.d.). In the case that differences arise, design recommendations will be recommended that further align its information architecture to individuals' mental model.

## Methods

### Participants

This study included 76 participants, with the inclusion criteria specifying individuals aged 18 and above. Participants were recruited through two distinct approaches. Firstly, through convenience sampling, where friends and family were invited to participate. They received a brief introduction and a direct link to the study, through the *WhatsApp* messaging platform, resulting in 42 participants. In the second approach, students were recruited via the *Sona System*, a test subject pool of the Behavioural, Management and Social Sciences Faculty at the University of Twente (UT). The resulting 34 students who participated were each rewarded with 0.25 Sona credits.

Out of the 76 respondents, 35 were excluded because of incomplete participation, creation of unserious labels (such as “money drainers”), and a discrepancy in the number categories. The discrepancy included either too many categories (>15), often with single-item categories without effective grouping, or too few categories (<5), typically with large groups that showed unclear differentiation among items. The final sample sums up to 41 participants.

Participants ranged in age from 18 to 36 years old ( $M_{age} = 21.3$ ,  $SD_{age} = 3.28$ ), with 10 males and 31 females. The latest educational achievement of eight of the participants was a bachelor's degree and for the remaining participants it was a high school degree. Twenty-five were Dutch, six were German, and the others were from countries including Australia, Indonesia, Canada, UK, Spain, South Korea, and Japan.

### Item Selection

Items selected for the card sorting study each represent an individual element within a website's navigation structure, such as a menu item, link, or any other interactive element that can be clicked on to access content or perform a function. The items chosen were based on 10 Dutch municipality websites (see Appendix A). These websites were selected due to

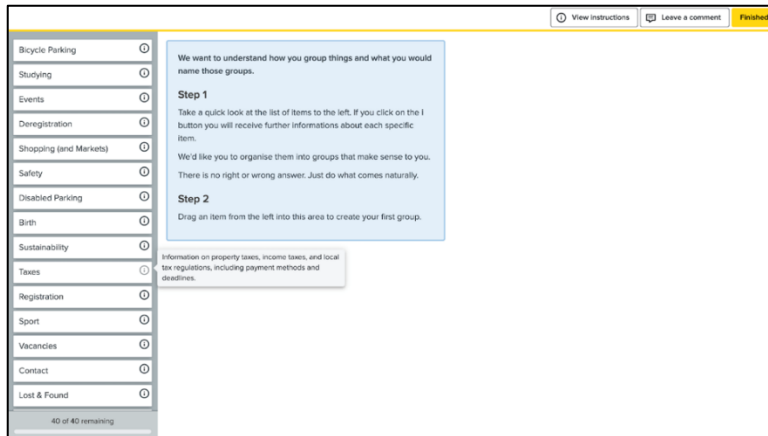
their wide distribution throughout the Netherlands, as well as their distinct navigation structures and design. For example, on the homepage of the municipality of Tilburg, items were organised based on user functions, employing an ‘I want to...’ perspective. Conversely, the municipality of Amsterdam organised items by distinct informational categories such as City Counter, Parking and Travel, and so on (see Appendix B). These websites were selected because, despite their differences, they showed comparable content.

The items were selected according to a set of criteria and their prevalence on Dutch municipal websites. They were established from content intended for public use, as opposed to content aimed at businesses. The frequency with which items featured in menu items, headings, or subheadings on the selected websites guided the selection of items, such as *taxes* which was found on nine out of 10 websites. This frequency was recorded as *count*, representing the total number of occurrences on the websites (see Appendix C). After this initial selection, the items were further refined based on three criteria: (1) merging cards with similar information, such as grouping ‘recreational activities’, ‘cultural events’, and ‘spare time’ into a single card called ‘leisure’; (2) excluding cards that consisted solely of non-informative content, such as ‘english site’ or ‘cookies’; and (3) omitting cards that contained broad or vague information, such as ‘subjects’.

Subsequently, the items were reviewed to confirm their mutual exclusivity and relevance, ensuring that they match the information typically sought by visitors to municipality websites. Following few necessary adjustments, the list comprised 40 final selections. The selection of 40 items was a deliberate choice to minimise participant fatigue and align with the recommended range of 30 to 40 items for a more effective card sorting experience (Card sorting, 2013). Descriptions were also crafted for each item to provide clear explanations and mitigate any potential misunderstandings (see Figure 1). These descriptions were formulated based on the content found within each category on the municipal websites. The complete list of items with their corresponding descriptions can be found in Appendix C.

### **Figure 1**

*Cards and Descriptions as seen on Optimal Workshop*



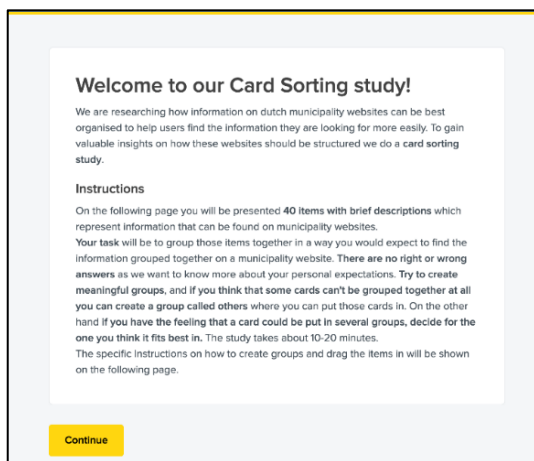
*Note.* Each card (item) can be found on the left side, whereas the corresponding description can be found on the right side of the item, only after clicking on the circular information icon beside the card. For example, see *taxes*.

## Materials

To conduct this study, an open, unmoderated, and remote card sorting study was executed through *Optimal Workshop* – an online tool for card sorting (Optimal Workshop, n.d.). Since Optimal Workshop enabled the study to be conducted on any electronic device, participants could participate from any location at any time, provided they had an internet connection. Upon receiving the study link, participants were directed to the study's page on Optimal Workshop. The initial screen welcomed and introduced participants to the study through a concise text (Figure 2). Participants were then asked to provide their consent, and upon agreement, they could proceed with the study (refer to Appendix D). A pre-questionnaire followed, concerning participants' demographics, including age, gender, ethnicity, and highest education attainment (see Appendix E). To process the collected demographic data, Microsoft Excel was used.

## Figure 2

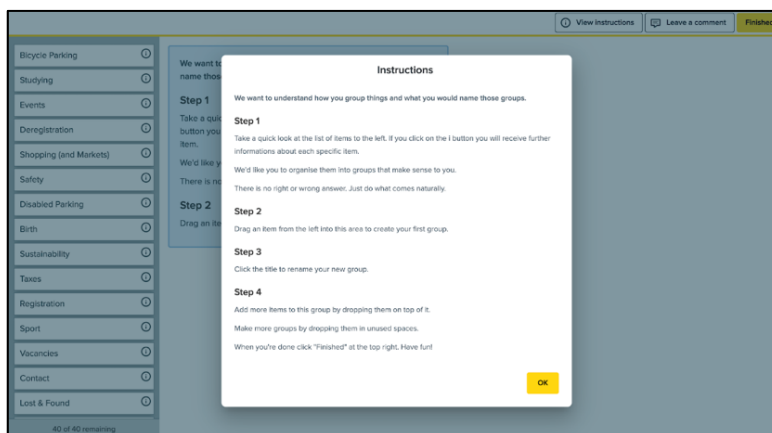
### *Introduction to study as seen on Optimal Workshop*



Afterwards, participants received specific instructions for the card sorting study (see Appendix E). The instructions, shown in Figure 3, specified that all 40 cards on the left column should be moved to the right side of the page, which served as a blank canvas for participants to create logically meaningful categories. The order of the cards was randomised for each participant. The only requirement for categorisation was that it made sense to the participants. If they encountered cards they found challenging to group, they were instructed to include them within a designated category named *others*. These instructions could be revisited by clicking on ‘view instructions’ on the top right corner of the card sorting page.

### Figure 3

*Instructions as seen on Optimal Workshop*

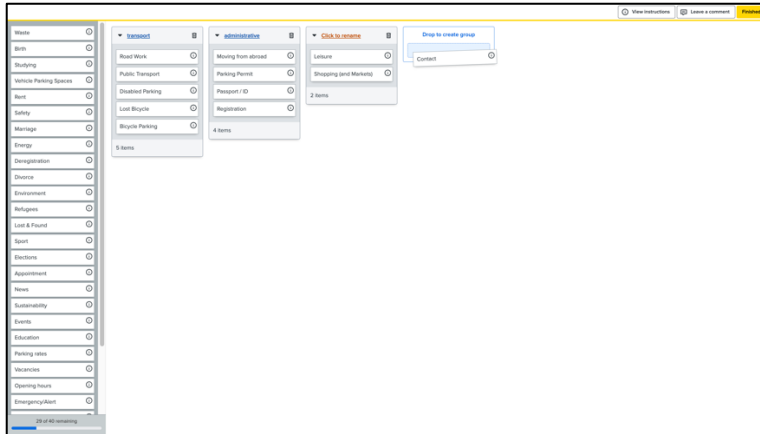


### Procedure

Dropping an item onto the canvas automatically generated a new group. Participants could then extend these groups by dragging more items onto them. This is displayed in Figure 4. After assigning items into a distinctive group, participants were prompted to provide a label for each group. This process continued until all the items were categorised and labelled. Participants then proceeded by clicking on ‘Finish’. If any cards remained ungrouped or any group did not have a label, the study could not be officially finished. At the bottom of the list of items, the remaining number of items left to be categorised can be seen. On average, participants took 15:24 minutes to complete the study. Upon completion, participants were directed to a thank you screen, where they received appreciation for their participation, were informed of the study's completion, and were invited to contact the researchers if they had any questions or comments, thus concluding the study.

### Figure 4

*Creating Groups on Optimal Workshop*



## Data Analysis

### Cluster Analysis

As described earlier, data entries that were considered non-meaningful were excluded from the data set. The exclusion criteria, supported by Righi et al. (2013), involved assessing the clarity of each category created and the quality of associated labels. After excluding data that was deemed inappropriate for further analysis, a *cluster analysis* followed – a statistical technique used to classify items into groups based on their level of similarity (Backhaus, 2023). To perform a cluster analysis, a *similarity matrix* is required, which measures the degree of similarity between pairs of items (Schmettow & Sommer, 2016). Optimal Workshop automatically generated a similarity matrix, also known as an *items x items matrix*, where it revealed how participants of this study grouped items together and how often (Optimal Workshop, n.d.).

Following this, Optimal Workshop also created a *heatmap*, a visual representation of the similarity matrix. Here the items lay on both, the x- and y- axes, and the colour in each cell represents the *similarity score*, a quantification of the degree of similarity, between two items (Schmettow & Sommer, 2016). High similarity scores are indicated by the intensity of the colours in the heatmap. Consequently, the darker the colour and the larger the cluster, the higher the consensus on which cards belong together. Notably, when the heatmap was examined, dark blue regions along the right edge of the triangle visualisation were identified, but also some dark areas within the body of the map. Those located on the right edge are known as *clusters*, which represent the items frequently grouped together.

On the contrary, the off-diagonal clusters represent *ambiguities*, those that do not fit neatly into a single category. The presence of ambiguities implies that participants had different interpretations when sorting the cards, thus indicating that there may be opposing mental models present. Those with a similarity score of 25% or lower were categorised as

ambiguity groups. By identifying these clusters within the heatmap, it became possible to gain insights into the mental models of the participants.

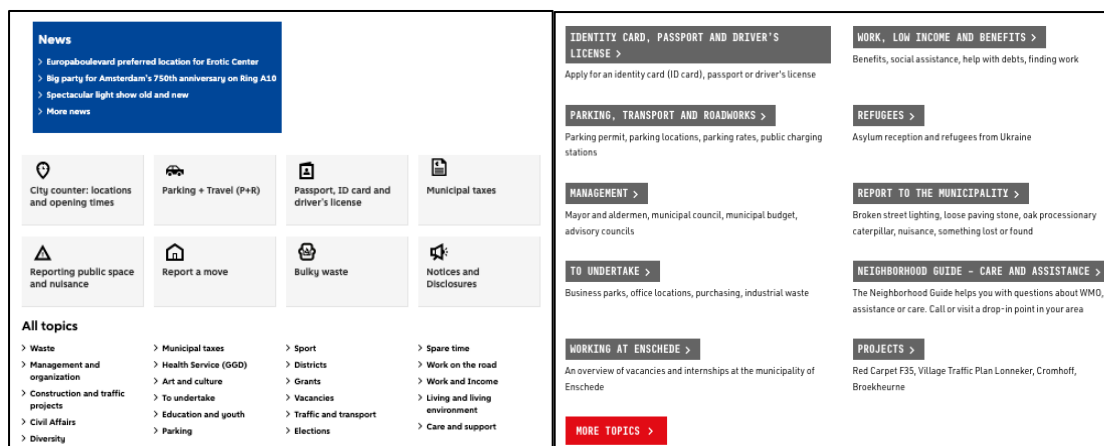
### *Comparative Analysis*

Once users' average mental model was attained, a comparative visual analysis was conducted to attain an understanding of the extent of congruency between the mental model and current municipality website navigation structures. To do so, the clusters and ambiguities identified in the mental model were matched against the groups displayed on the homepage of the municipal website. The cluster labels and items per cluster were then compared to those corresponding to the related topics on the webpage.

To choose a website for analysis, the ten websites underwent a strategic comparison. On the homepage of some websites, the topics were displayed as lists, such as in Enschede, whereas for others they were displayed as groups, such as in Amsterdam (see Figure 5). All websites, with the exception of Enschede, organised topics into groups. The aim of this analysis was to compare existing groupings to users' mental model, thus leading to the deliberate exclusion of Enschede. Following a preliminary examination of the structural layouts of the remaining websites, the municipality of Amsterdam was selected.

**Figure 5**

### *Structural Contrasts: Grouped vs. Listed Information*



*Note.* The website on the left is from the municipality of Amsterdam, where the topics are categorised into groups. The website on the right is from the municipality of Enschede, where the topics are displayed in the form of a list.

As Amsterdam is the most populated city in the Netherlands, its website likely hosts a diverse user base. Examining the alignment between the mental model and navigation structure on Amsterdam's website could disclose how well the website meets the diverse interests and requirements of its visitors. Larger municipalities like Amsterdam often include

more extensive information on their websites, which provides a rich dataset for evaluating alignment with users' mental models. It was also the only website where the English site was translated from Dutch to English, rather than the English site only showing information that the municipality deems relevant to English speakers, such as tourist information. The choice of Amsterdam's website is not intended to diminish the importance of other municipalities but is guided by strategic considerations. This focused approach allows for a thorough examination of municipality of the degree to which the navigation structure of municipal websites matches users' mental representations.

## Results

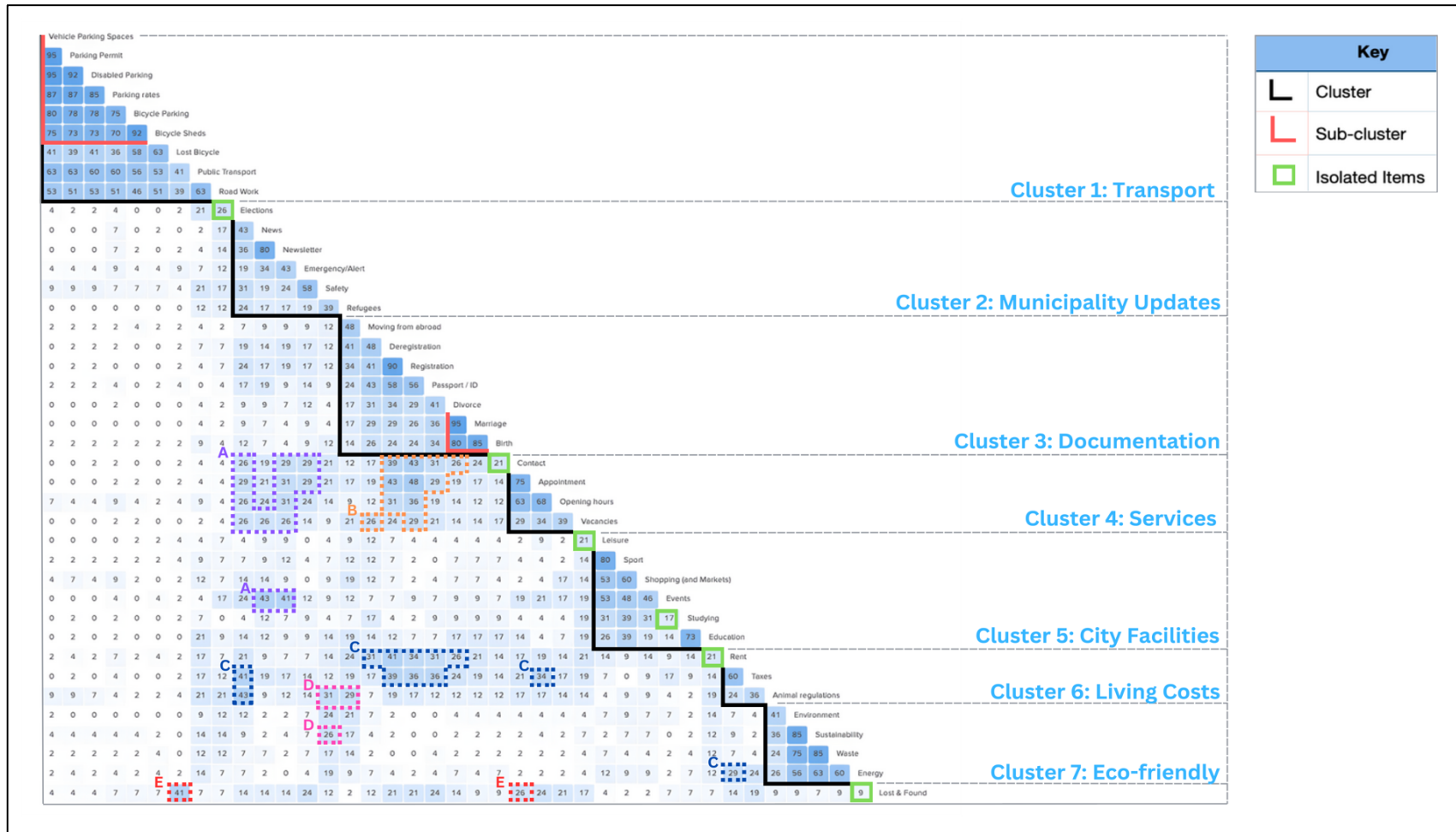
The results have been divided into two sections. The first section, part A, addressing the first objective of this research and the second section, part B, addressing the second objective. Further details are outlined below.

### Part A. Understanding Users' Mental Model

The first aim of this research paper was to elicit the mental model of users that visit Dutch municipality websites. To attain this mental model, a cluster analysis was conducted, in which a heatmap was generated based on the card sorting results of all participants (shown in Figure 6). This heatmap serves as a representation of the navigation structure that users expect to find when they visit municipality websites in the Netherlands. Namely, participants created a minimum of five categories up to a maximum of 12, with a median eight categories per participant. However, when the aforementioned cluster identification techniques were applied, five ambiguity groups and seven clusters were identified, in which two clusters was further divided into sub-clusters. Subsequently, a separate group, labelled *Isolated Items*, was created for the items that had the lowest similarity scores on the diagonal axes of the heatmap. Since they were below 25% and present on the diagonal, they were deemed unsuitable to be grouped with either cluster or ambiguity group. In the following section, a detailed interpretation of the heatmap has been provided. First, an overview of the clusters and their assigned labels has been outlined, followed by an examination of the ambiguities found, and to sum up, the isolated items are explained.

**Figure 6**

*Heatmap of participants' (n = 41) mental model for Dutch municipality websites*



*Note.* The thick black outline represents the main clusters, in which red outline within represents the sub-clusters. The green outline indicates the isolated items and the colourful dotted lines each indicate an ambiguity group (A-E).



### *Clusters in Detail*

The following text reveals how seven distinct clusters were formed, each exploring specific user groupings. Each cluster has been labelled in Table 1, where the items belonging to each cluster have been outlined as well. The descriptions below each unveil the similarity measures (similarity scores or colour intensity), relationships between items, and any additional noticeable patterns within each cluster.

**Table 1**

*Clusters derived from the heatmap*

<i>Cluster 1</i>	<i>Cluster 2</i>	<i>Cluster 3</i>	<i>Cluster 4</i>	<i>Cluster 5</i>	<i>Cluster 6</i>	<i>Cluster 7</i>
<i>Transport</i>	<i>Municipality Updates</i>	<i>Documenta- tion</i>	<i>Services</i>	<i>City Facilities</i>	<i>Living Costs</i>	<i>Eco- friendly</i>
Vehicle parking spaces	Road work	Moving from abroad	Contact	Leisure	Rent	Environment
Parking permit	Elections	Deregistration	Appointment	Sport	Taxes	Sustainability
Disabled parking	News	Registration	Opening hours	Shopping (and Markets)	Animal Regulations	Waste
Parking rates	Newsletter	Passport/ ID	Vacancies	Events		Energy
Bicycle parking	Emergency/ Alert	Divorce		Studying		
Bicycle sheds	Safety	Marriage		Education		
Lost bicycle	Refugees	Birth				
Public transport						
Road work						

*Note.* The sub-clusters are distinguished by the short horizontal line in between the main cluster groups.

**Transport.** The first cluster in the heatmap, denoted as ‘Transport’ includes a sub-cluster known as ‘Parking’. The cluster comprises vehicle parking spaces, parking permits, disabled parking, parking rates, bicycle parking, bicycle sheds, lost bicycles, public transport, and road work. The sub-cluster involves the first six items, as they share the highest agreement scores within this cluster. Their exclusive categorisation under the label ‘Parking’ served as justification for the sub-cluster's formation. Notably, the items that exhibit the highest similarity score are vehicle parking spaces linked to parking permits and disabled parking, scoring 95% each. Conversely, the lowest similarity score, at 36%, is observed between parking rates and lost bicycles. Participants grouped all transport-related items into this cluster, making it largest cluster comprising nine items.

Users likely formed this cluster based on semantic reasoning. They created a category for all transport-related matters, regardless of the mode of transportation (bike or car), emphasising a perceived connection between different aspects of transportation. Moreover, this grouping reflects common user needs, specifically related to mobility and accessibility. These items address similar aspects of daily life, such as finding parking, using public transport, and dealing with road work. Thus, participants considered the practical or everyday context in which these items are encountered. Additionally, given that the items in the sub-cluster are either associated with parking or contain the term parking, their connection may also be because of semantic similarities. As such, this cluster can be regarded as an umbrella category for any concerns pertaining to transportation.

**Municipality Updates.** The second cluster, labelled ‘Municipality Updates’, comprises six items, including elections, news, newsletter, emergencies/alert, safety, and refugees. The highest similarity score of 80% is evident between news and newsletter, whereas the lowest score, 17%, is between news, refugees, and newsletter. However, the second highest measure is 58%, and the remaining items are coloured with a much lighter shade of blue. These similarity measures indicate that this cluster is relatively weak, especially in comparison to Transport, which is largely covered in darker shades of blue. Items within this cluster indicate a shared interest for important municipal matters and general updates, such as news in the region.

There exist a few potential reasons for the grouping of these items. One reasoning lies in users’ perceived importance and timely characteristics of the items. Further reasoning could be due to semantics, such as for the relationship between news and newsletter, as both include the word ‘news’. However, a critical factor for grouping these items together may have been due to recent events in the Netherlands. During the time that individuals were

participating in this study, they were simultaneously facing the Dutch election for the new House of Representatives (Dutch: *Tweede Kamer der Staten-Generaal*). The winning party, a far right-wing populist group, led by Geert Wilders, advocated for significant restriction on asylum and immigration (Cotton et al., 2023). This topic dominated the news, especially on the matter of how Wilders wants to diminish all refugees living in the Netherlands (Pascoe, 2023). Hence, these events may have played a significant role in the grouping of this cluster.

**Documentation.** The third cluster, marked ‘Documentation’, contains a sub-cluster titled ‘Life Events’. In total, the cluster comprises seven items. The cluster includes items such as moving from abroad, deregistration, registration, and passport/ID, while the sub-cluster specifically includes divorce, marriage, and birth. The highest similarity score found is 90%, identified between deregistration and registration, and the lowest similarity score is 14%, between refugees and birth. The items in the sub-cluster were found to have high similarity scores, ranging from 80-95%, and generally displayed a relatively high colour intensity within the cluster, as presented on the heatmap. Mainly, this cluster highlights interconnected life events and related documentation processes.

Users may have grouped these items together, driven by the common requirement for official documentation. The necessity for official paperwork, be it for personal life events or general documentation purposes, could have prompted these associations. However, users may have specifically clustered life events items highly due to their association with significant milestones in one’s personal life. Thus, bringing cause for a sub-cluster. Essentially, these groupings appear influenced by bureaucratic documentation processes.

**Services.** The fourth cluster, labelled ‘Services’ consists of four items. These are contact, appointment, opening hours, and vacancies. In this cluster, the highest similarity score is 75%, observed between contact and appointment, whereas the lowest similarity score is 29%, between contact and vacancies. Excluding vacancies, the remaining items range from 63% to 75%. Therefore, vacancies exhibits a low correlation to the other items in this cluster. Nonetheless, this cluster is representative of practical matters related with municipality services.

This cluster's formation can be explained by functional and procedural practicality pertinent to those who need to communicate with the municipality. This is explanatory for the grouping of contact, appointment, and opening hours. However, the strong similarity score between contact and appointment suggests a close association, reflecting user expectations for an efficient process of contacting and scheduling appointments. The lower correlation with vacancies indicates a less direct association to the other items, possibly due to its distinct

description as a job opportunity. Despite that, it may have still been considered as an informative service offered by the municipality, thus relating to this cluster.

**City Facilities.** The fifth cluster, known as ‘City Facilities’, consists of six items. These being leisure, sport, shopping (and markets), events, studying, and education. The highest similarity score found in this cluster is 80%, among leisure and sport. In contrast, the lowest similarity score is 14%, among events and education. The overall correlation within this cluster is comparatively varied, with the second-highest similarity score being not more than 60%, between the items sport and shopping (and markets). These measures may be representative of a diverse and less cohesive cluster.

This is possibly because of the diverse and multifaceted facilities offered by the city, such as those for leisure and education. Users may have grouped these items together based on their shared association with city amenities and services available for public use. The lower similarity scores highlight the distinctiveness of each item, further emphasising the diversity of facilities and the multifaceted interests of users. Altogether, this cluster appears to capture a range of city-related activities and services.

**Living Costs.** The sixth cluster, referred to as ‘Living Costs’ is the cluster with the fewest number of items. It consists of three items – rent, taxes, and animal regulations. In this cluster, the range is from 60% to 24%. The highest score representing the relationship between rent and taxes and the lowest representing the relationship between rent and animal regulations. The remaining relationship is between taxes and animal regulations, scoring a similarity measure of 36%. Although the similarity scores are not as prominent in this cluster, there seems to be a common theme among the item relationships.

That being, financial considerations and living arrangements. The stronger relationship between rent and taxes suggests a recognised connection with housing expenses and financial obligations to the municipality. On the other hand, the associations with animal regulations may be related to its description regarding licences or permits required for pets. As a result, living costs represents users’ considerations of financial aspects related to their residential situation.

**Eco-friendly.** The final cluster, the seventh, has been labelled as ‘Eco-friendly’. It is comprised of four items, including environment, sustainability, waste, and energy. The highest similarity score, 85%, is between environment, sustainability, and waste. Contrastingly, the lowest measure, 24%, is between animal regulations and waste. Though animal regulations has been grouped in Living Costs, it also shares notable associations with

the items in this cluster. The recurring theme here relates to users' perceptions of environmental concepts and protocols.

Consequently, the predominant theme of this cluster is centred around ecological considerations and environmentally friendly practices. The high similarity scores among environment, sustainability, and waste highlight users' recognition of the interconnectedness of these environmental concepts. In addition, the item animal regulations may have a double meaning, in which in this case, users may have perceived animal regulations with broader environmental concerns due to the perceived impact of certain animal-related activities on the ecosystem. For example, regulations regarding wildlife conservation, habitat protection or vegan and vegetarian practices.

Furthermore, the inclusion of the item energy (described as current energy prices) might also be due to broader environmental considerations. While energy prices may initially appear more aligned with financial considerations, users may have interpreted it within this cluster based on the idea that sustainable and renewable energy sources enable eco-friendly practices. Thus, the item energy may have economic implications, but its placement in this cluster indicates that users may be more aware of the environmental repercussions of energy-related decisions and costs. Nonetheless, this cluster reflects users' recognition for a thematic coherence among environmental concerns.

### ***Cluster Labels***

As mentioned above, participants were tasked with labelling the categories they created. These labels have been outlined below in Table 2, followed by an explanation for each chosen title. The labels were screened and only those that differed by phrasing or grammar were merged. In addition, the most common and semantically related labels were prioritised.

**Table 2**

*Proposed labels*

<i>Cluster 1</i>	<i>Cluster 2</i>	<i>Cluster 3</i>	<i>Cluster 4</i>	<i>Cluster 5</i>	<i>Cluster 6</i>	<i>Cluster 7</i>
<i>Transport</i>	<i>Municipality Updates</i>	<i>Documentation</i>	<i>Services</i>	<i>City Facilities</i>	<i>Living Costs</i>	<i>Eco-friendly</i>
Vehicle	Information	City Hall	Services	Activities	Finances	Eco
Parking	Events	Bureaucracy	Contact	Leisure	FAQ	Nature

Transport	News	Documenta- tion	Communic- ation	Facilities	House- hold	Sustain- ability
Traffic	Municipality news	Administra- tive matters		Explore the city	Daily costs of life	Environ- mental
Infrastructure	Government Updates	Personal information Big life events Family matters		Arts & culture Daily life	Other	Other

*Note.* The suggested label for the sub-cluster is divided by the horizontal line in between the other labels.

Firstly, five labels were frequently suggested for cluster one. These included labels such as vehicle, parking, transport, traffic, and infrastructure. Although all suggestions were deemed plausible, the most relevant and frequently mentioned were parking and transport. As mentioned above, participants independently grouped the items within the sub-cluster together and labelled it as parking. Therefore, to maintain clarity and semantic coherence, the main cluster was ‘Transport’, while the sub-cluster was titled ‘Parking’.

Secondly, there were approximately five recommendations for cluster two. Participants suggested information, events, news, municipality news, and government updates. From these suggestions, it was clear that users expected a label focused on updated information and the municipality. Therefore, it was deemed that ‘Municipality Updates’ would be the most appropriate label.

Thirdly, the labels for cluster three were separated into those relevant for the cluster and the sub-cluster. As explained earlier, the cluster refers to bureaucratic documentation processes and the sub-cluster refers to those related to family matters. The proposed labels for the cluster involve city hall, bureaucracy, documentation, and administrative matters. ‘Documentation’ was chosen as the final label since it captures the clear administrative characteristic of the proposed labels.

Regarding the sub-cluster, the proposed labels include personal information, big life events, and family matters. Though these labels were also assigned to the main cluster, they

were reassigned to the sub-cluster because they were more closely related to the context of the sub-cluster. Consequently, ‘Life Events’ was chosen as it was consistently highlighted by participants. This choice was reinforced by the definition provided by the Cambridge Dictionary – the significant events in one’s life, such as marriage or birth (*LIFE EVENT | Meaning in the Cambridge English Dictionary*, 2019). Thus, forming an appropriate umbrella term for these items.

Moreover, the suggested labels for cluster four include contact, services, and communication. Though all suggestions may be considered accurate, the chosen label ‘Services’ is a more inclusive representation of the information and processes facilitated by the municipality. This is because it may give the impression that there may be more than merely contact or appointment, making room for other services offered to be included as well, such as vacancies. Hence, ensuring that users comprehend the cluster's content by reducing potential ambiguity.

Furthermore, label recommendations for cluster five consists of activities, leisure, facilities, explore the city, arts and culture, and daily life. Based on these suggestions, the final label, “*City Facilities*” was created. This is because it accurately reflects the urban amenities and services encapsulated within the cluster. It goes beyond a singular focus and acknowledges the multifaceted aspects of city life, including recreational activities, cultural events, educational opportunities, and so on.

Entering cluster six, suggestions encompass finances, FAQ (frequently asked questions), household, daily costs of life, and an umbrella category labelled ‘others’. There is a significant variation between these suggestions. Specifically, the label ‘others’ originated from a suggestion by the researchers mentioned in the instructions of the study, advising participants to use it if they are uncertain about a label. Nevertheless, alternative labels were also suggested, leading to the combination of user suggestions (household and daily costs of life) into the final category, termed ‘Living Costs’.

Concluding with cluster seven, proposed labels include eco, nature, sustainability, environmental, and other. Notably, the emphasis in these labels centres around environmentally conscious concepts. The labels sustainability and environment were excluded as titles for the cluster, as they are the labels for the items involved in this cluster. However, to remain in line with user expectations and accurately capture the theme of sustainable living, a similar title was given. That being, ‘Eco-friendly’.

### ***Ambiguities in Detail***

In total, five ambiguity groups were created, alphabetised from A to E. They can be found in Figure 6, by the dotted and colourful squares surrounding the items. The following text highlights how these ambiguity groups came to be and its corresponding features.

**Ambiguity A.** Firstly, Ambiguity A (purple), represents eight items. These include elections, news, newsletter and emergency/alert from Municipality Updates, as well as contact, appointment, opening hours, and vacancies from Services. The similarity score ranges from 26-31% in which the highest measure is associated between newsletter, appointment, and opening hours. Though this range indicates a relatively weak association among the items, a reasoning for this grouping may have been due to the elections happening in the Netherlands at the same time as the study was being conducted, as explained above. The associations between the two cluster groups could be attributed to individuals, possibly refugees, immigrants, their friends or relatives, perceiving a need for municipal services in light of the election outcome favouring the party advocating for their departure.

**Ambiguity B.** Secondly, Ambiguity B (orange), encompasses nine items. This is comprised of deregistration, registration, moving from abroad, passport/ID, divorce from Documentation, as well as the aforementioned items from Services. The range is from 26-48%, with the strongest relationship shown between registration and appointment. This range indicates a broader range compared to Ambiguity A, suggesting a more diverse set of relationships among the items within this ambiguity group. Notably, the strongest relationship that was discovered, may be due to the need for an appointment to complete one's initial registration in a municipality. The other relationships may also stem from the likelihood of requiring certain Services during Documentation processes. This ambiguity collectively illustrates an alternative mental model, where Services and Documentation are combined into one category.

**Ambiguity C.** Thirdly, Ambiguity C (blue), is a combination of 11 items from distinctive clusters. This consists of elections from Municipality Updates, the same items mentioned in Ambiguity B from Documentation, appointment from Services, and finally, energy from Eco-friendly. These items were all found to have associations with the items from Living Costs, ranging from 26-43% in which the highest score related to elections and animal regulations. Since this group involves items from various clusters, it can be considered as a cross-cluster association. Despite the minimal semantic reasoning between these items, the relations shared between them, particularly with Living Costs, suggests that there exists a common theme among them. Further research is required to determine whether



these relationships share sufficiently prominent similarity measures to form an alternative cluster altogether.

**Ambiguity D.** Next, Ambiguity D (pink), is made up of sustainability from Eco-friendly, animal regulations from Living Costs, and refugees and safety from Municipality Updates. In this group the range is between 26-31%, with the highest measure between safety and animal regulations, and the lowest between safety and sustainability. Moreover, refugees and animal regulations were grouped together with a score of 29%. The recurrent theme observed in these relationships is related to safety – safety for animals, refugees, and a sustainable environment. This ambiguity suggests the potential for a grouping dedicated to safety, concerning the well-being of people, animals, and the environment.

**Ambiguity E.** Lastly, Ambiguity E (red), is the smallest ambiguity group, encompassing three items. This includes lost bicycle from Transport, contact from Services, and lost and found (categorised into isolated items). There are two relationships in this group. One between lost and found, as well as lost bicycle, adding up to a similarity score of 41%. The other relationship is between lost and found, and contact, adding up to a score of 26%. The reasoning behind these associations may be due to practicalities surrounding how to recover lost items and lost items themselves. The small size of this ambiguity contributes to the specificity of the theme, indicating the need for further research to ascertain the extent and depth of the theme.

### ***Isolated Items in Detail***

The group ‘Isolated Items’ was generated for the items that did not fit into clusters nor ambiguities. These are the lowest scores on the diagonal axes of the heatmap. There are six item associations involved, shown on the heatmap by a light green square on the diagonal. These are road work and elections (26%), birth and contact (21%), vacancies and leisure (21%), events and studying (17%), education and rent (21%), and energy and lost and found (9%). There are some reasonings for these groupings. For example, participants may have associated road work and elections if they perceived it as part of the municipality’s efforts to improve infrastructure. Furthermore, birth and contact might have been related due to the potential need for assistance in registration of the newborn. In addition, vacancies may have been related to leisure in terms of available job placements in recreational activities or events during local holidays. Moreover, there could be a connection between events and studying, due to school events usually taking place. Adding on to this, education and rent may have a connection because students who move away from home to study would be interested in the rent costs and related housing information of the foreign country. Lastly, no connections were

found in the perceived relationship between energy and lost and found. Nevertheless, further research is necessary to determine the extent of these relations.

## Part B: Applying User Mental Models to Website Design

To conduct the comparison with the municipality website of Amsterdam, a comparative analysis was performed. Though 10 websites were used for the foundation of this study, one website was chosen to conduct this comparison. This choice allowed for an in-depth comparison, yielding specific results that contributed to a more thorough understanding of the alignment between users' mental model and the navigation structure of the chosen website. As a result, the congruency level between them could be determined. The results have been outlined per cluster below, along with proposed design changes.

**Transport and Parking.** Upon comparing the Transport cluster from the mental model with groups labelled similarly on the website's homepage, four distinct categories were identified – Construction and traffic projects, Parking, Traffic and Transport, and Work on the road (refer to Figure 7). Overall, some unnecessary repetition and inconsistencies within these categories was found and it was apparent that the categories on the webpage do not align with the Transport mental model. Changes are required to bring about alignment.

**Figure 7**

*Amsterdam's Transportation and Parking Categories*

All topics			
> Waste	> Municipal taxes	> Sport	> Spare time
> Management and organization	> Health Service (GGD)	> Districts	> Work on the road
> Construction and traffic projects	> Art and culture	> Grants	> Work and Income
> Civil Affairs	> To undertake	> Vacancies	> Living and living environment
> Diversity	> Education and youth	> Traffic and transport	> Care and support
	> Parking	> Elections	

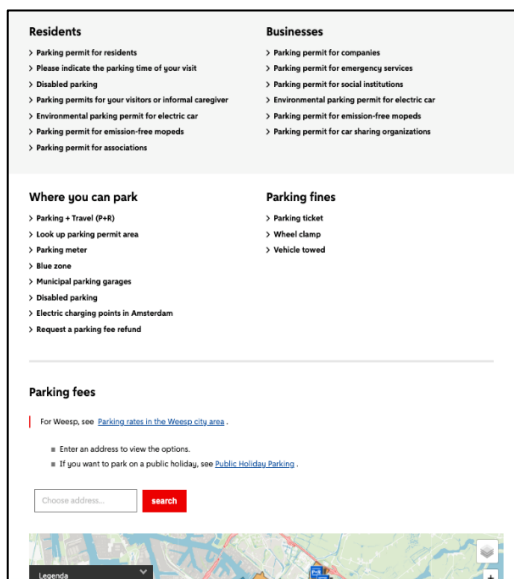
Firstly, information related to transport appears scattered across these website categories, rather than having a specific transport section as recommended by the mental model. For example, the 'Construction and traffic projects' category covers street blockages, road interruptions for public transport, and construction on pedestrian and cycling paths. However, both 'Traffic and transport' and 'Work on the road' also provide information related to road work. To align with the mental model, it is suggested that information across all the categories be combined into one extensive cluster of Transport. For instance, with road work information consolidated into a dedicated sub-cluster, with additional subsections within if necessary.

Additionally, 'Traffic and Transport' also shows information regarding bicycle and electric vehicle parking, while all other parking information is found in 'Parking'. Within the 'Parking' category, there are four distinct subsections (refer to Figure 8) which contain

information surrounding parking, permits, and parking fee refunds. To bring this structure closer to mental model, it is proposed that all parking information be merged into a sub-cluster of ‘Parking’ in the Transport cluster. These four topics can be collectively grouped under the Transport cluster, with road works and parking constituting a dedicated sub-cluster, and the other categories also organised as distinct subclusters under the overarching category Transport.

## Figure 8

### *Items within ‘Parking’*

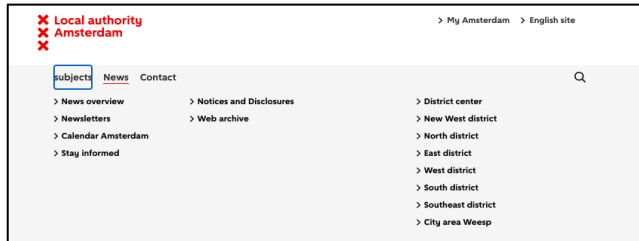


**Municipality Updates.** On the website, this has been labelled as ‘News’. It includes current news, ways to stay informed, and certain notices and disclosures (for urgent information) as seen in Figure 9. Additionally, it categorises information by district, providing district-specific news and events for Amsterdam. Notably, ‘Elections’ is independently featured on the homepage possibly due to the recent elections. However, ‘Refugees’ is found under the subject ‘Care and support’, specifically within the ‘Help for’ subsection, alongside assistance for individuals experiencing homelessness, dementia, and more. Although the information found under refugees is similar to that described in this study (resources available for housing, legal assistance, and community integration) there is further information available, such as volunteering. This perspective implies an effort to cater to both, practical requirements, and a more empathetic understanding of the matter, perhaps aiming to address the personal aspects of the refugee experience. Furthermore, information on safety protocols, such as the presence of surveillance cameras, was found under ‘Living and living environment’. Therefore, all the items included in Municipality Updates were not grouped together on the municipality website and thus, not aligned with the mental model. To

be more in sync with the mental model, it is proposed that these items be categorised into a broader category, Municipality Updates.

## Figure 9

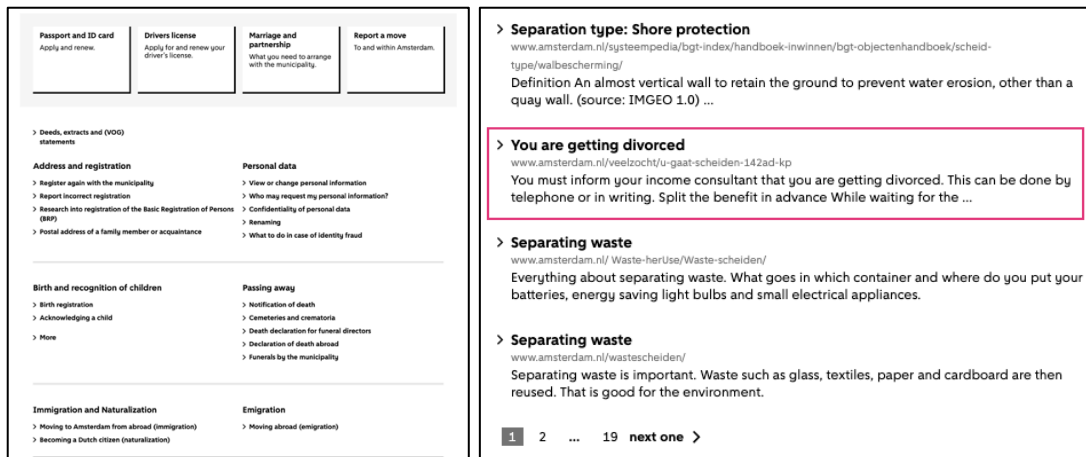
*Items within 'News'*



**Documentation and Life Events.** The category known as ‘Civil affairs’ on the homepage encompasses all items within the Documentation cluster and Life Events sub-cluster, excluding Divorce and instead, incorporating information on emigration. Upon investigating where divorce was located, it was only found through the website’s search bar after scrolling down on the page (see Figure 10). As a result, this section moderately aligns with the mental model. Changes include incorporating divorce into the categorisation and creating a sub-cluster for Life Events.

## Figure 10

*‘Divorce’ Search on the Website*



**Services.** On the homepage, this section is labelled as ‘Contact’, featuring information about city counter locations and opening hours. The category incorporates details about city hall opening hours, locations, and various communication methods such as mail, phone calls, and WhatsApp. However, it does not encompass the capability to schedule appointments, which might be dispersed throughout the site and included in specific categories where appointment-making is crucial. Additionally, vacancies has been included as a distinct topic. Therefore, this category also moderately aligns with the mental model.

Proposed changes to further synchronise with the mental model involve integrating information about vacancies and appointment procedures.

**City Facilities.** On the homepage, there are four distinct topics: 'Art and Culture,' 'Education and Youth,' 'Sport,' and 'Spare time' (refer to Figure 11). Despite their presentation as separate groups, the 'Spare time' section includes a subsection with links to both art and culture and sports. To better align with users' mental models, a suggestion is made to consolidate all these components into a single group labelled City Facilities. Notably, events are already included in 'Spare time.' However, the current exclusion of shopping (and markets) and leisure activities is evident. Ongoing events related to shopping and leisure are seemingly placed in the news sections for each District. Given the relevance of shopping markets and leisure activities in Amsterdam, a new subsection specifically dedicated to updated leisure activities, shopping, and market schedules in different areas should be placed under City Facilities. Thus, although these sections do not align with the mental model, the changes suggested allow to be closer to users' mental model.

**Figure 11**

#### Amsterdam's City Facilities

All topics			
> Waste	> Municipal taxes	> Sport	> Spare time
> Management and organization	> Health Service (GGD)	> Districts	> Work on the road
> Construction and traffic projects	> Art and culture	> Grants	> Work and Income
> Civil Affairs	> To undertake	> Vacancies	> Living and living environment
> Diversity	> Education and youth	> Traffic and transport	> Care and support
	> Parking	> Elections	

**Living Costs.** One related topic to living costs was identified, namely 'Municipal taxes'. Within this category, all tax-related information is encompassed (refer to Figure 12). However, no information pertaining to rent is currently included in this grouping or visible in the other topics. In addition, animal regulations has not been included in this section. This implies that the mental model does not align with the structure of this content on the website. Proposed changes involve the addition of relevant rental information for the Netherlands as well as information related to animal regulations in this context.

**Figure 12**

#### *Items within 'Municipal Taxes'*

<b>Residents</b> <ul style="list-style-type: none"> <li>&gt; Combined tax</li> <li>&gt; Sewage charges</li> <li>&gt; waste charges</li> <li>&gt; Real estate taxes (OZB)</li> <li>&gt; Movable space tax (RRB)</li> <li>&gt; WOZ value</li> <li>&gt; Precario demurrage</li> <li>&gt; Report changes</li> </ul>	<b>Entrepreneurs</b> <ul style="list-style-type: none"> <li>&gt; Sewage charges</li> <li>&gt; Cleaning right</li> <li>&gt; Real estate taxes (OZB)</li> <li>&gt; Movable space tax (RRB)</li> <li>&gt; WOZ value</li> <li>&gt; Precario terrace</li> <li>&gt; Precario demurrage</li> <li>&gt; Entertainment allowance</li> <li>&gt; Advertising tax</li> <li>&gt; Tourist tax</li> <li>&gt; Report changes</li> </ul>
<b>Payment and remission</b> <ul style="list-style-type: none"> <li>&gt; Pay tax bill</li> <li>&gt; Remission</li> </ul>	<b>To object</b> <p>You can object if you disagree with a municipal tax assessment.</p> <ul style="list-style-type: none"> <li>&gt; To object</li> </ul>
<b>Parking tax</b> <ul style="list-style-type: none"> <li>&gt; Parking ticket</li> </ul>	

**Eco-friendly.** The closest topics related to the Eco-friendly cluster were found in ‘Living and Living Environment’ and ‘Waste’. The ‘Waste’ category incorporates all information related to waste disposal, including guidelines on specific waste disposal and recycling. Meanwhile, items within ‘Living and Living Environment’ cover information relevant to animals, environmental and sustainable living, and energy (see Figure 13). Although animal regulations has been included in the cluster Living Costs, it was outlined that animal regulations also shares meanings with items from Eco-friendly. This interpretation was also seen in Ambiguity D. Hence, information regarding animal regulations in an environmental context has been included in this grouping. As a consequence, this grouping somewhat aligns with the mental model, though changes are required to completely align with the model. This means to combine the ‘Waste’ and ‘Living and Living Environment’ category into one labelled Eco-friendly.

### Figure 13

*Items within ‘Living and living environment’*

<b>Living</b> <ul style="list-style-type: none"> <li>&gt; Save energy, make your home more sustainable and improve it</li> <li>&gt; Looking for a place to live</li> <li>&gt; Ground lease</li> <li>&gt; Subsidies and financial arrangements</li> </ul>	<b>Living environment</b> <ul style="list-style-type: none"> <li>&gt; Safe city</li> <li>&gt; Clean city</li> <li>&gt; Green city</li> <li>&gt; Animals in the city</li> </ul>
<b>Building and renovating</b> <ul style="list-style-type: none"> <li>&gt; Zoning plans</li> <li>&gt; Self-build: design and build your own house</li> <li>&gt; Are you going to renovate? Tell the neighbors</li> </ul>	<b>Construction permits</b> <ul style="list-style-type: none"> <li>&gt; Splitting a house</li> <li>&gt; Extracting, merging and forming living space</li> <li>&gt; Environmental permit</li> </ul>
<b>Permits</b> <ul style="list-style-type: none"> <li>&gt; Housing permit for a social or medium-priced rental home</li> <li>&gt; Bed &amp; breakfast</li> <li>&gt; Private holiday rental</li> <li>&gt; Room rental</li> <li>&gt; Temporary rental</li> <li>&gt; Renting with purchase protection</li> </ul>	

**Ambiguity E.** In this ambiguity group, lost and found, contact, and lost bicycle were associated together. On the website, lost and found was located on the contact page. Furthermore, lost bicycle was located on the lost and found page. Therefore, aligning with the mental model.

## Discussion

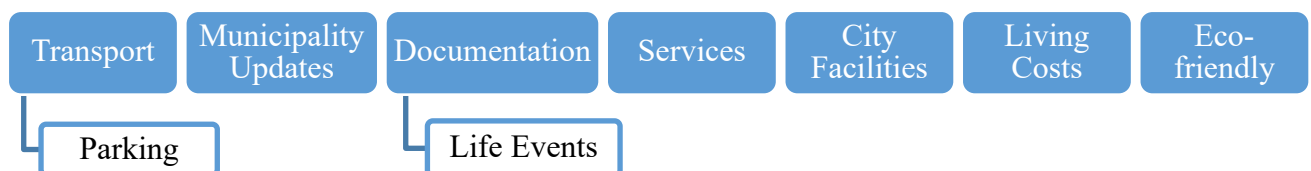
In the exploration of this study, the focus was on determining the alignment between existing navigation structures on municipality websites and the average mental model of their intended users. In the case of discrepancies, design recommendations would be proposed to bring the municipality website's information architecture closer to the elicited mental model. This objective was pursued through two approaches. Firstly, an open and remote card sorting approach was employed using items derived from 10 municipality websites to elicit the average mental model, with the results analysed through a similarity matrix heatmap. Secondly, a visual comparative analysis was conducted between the attained mental model and the navigation structure of a municipality website. That being, the Municipality of Amsterdam for an in-depth exploration into this regard. In the following section, the findings will be further interpreted considering existing literature, followed by a discussion of limitations and recommendations for future research, ultimately concluding the study.

### Findings

Overall, the heatmap revealed seven clusters, including two sub-clusters, and five ambiguities, representing the mental model of users navigating municipality websites. A visual representation of the proposed information architecture in accordance with this mental model is demonstrated in Figure 14. In addition to this, the analysis gave rise to the concept of isolated items, where a total of six such items were identified. These isolated items were characterised by the lowest similarity scores along the diagonal axes in the heatmap. Upon further interpretation, it becomes evident that the presence of isolated items serves as an indication that the item sample did not cover all categories, resulting in their low similarity scores. Nevertheless, the mental model attained offers a comprehensive understanding into users' expectations for a user-friendly navigation structure (Sinha & Boutelle, 2004).

### Figure 14

*Visual Representation: Proposed Information Architecture*



An influential factor in the categorisation of the cards was semantics and topic similarity, although this was not consistently applicable. Some items shared a double meaning, such as with animal regulations and refugees as explained above. The varied interpretations emphasise the subjectivity inherent in the way users organise information.

This complexity aligns with Bussolon's (2009) assertion that differences can arise between distinct user groups, and the same users can craft distinct categorisations for distinct objectives. Therefore, underscoring the importance of having a thorough understanding of users' mental model.

Subsequently, a comparison between the elicited mental model and current website structure of the Amsterdam municipality revealed a moderate alignment. Notably, four clusters (transport, municipality updates, city facilities, and living costs) did not align with the website's structure. However, three clusters and one ambiguity group (documentation, services, eco-friendly, ambiguity E) exhibited some alignment, indicating a partial congruence. The misalignment is attributed to the dispersed organisation of categories on the website, deviating from the mental model's inclusive menu structure, and the repetition of certain items across different categories, highlighting a need for enhanced consistency. To conclude, despite some differences, the existing navigation structure was found to have an average alignment with the elicited mental model.

Namely, this research was underpinned by the understanding that improving alignment between users' mental models and navigation structures may enhance the effectiveness and usability of municipal websites. However, this study built upon the research of Schmettow and Sommer (2016), whose findings indicated that an alignment between mental models and website structures had no impact on browsing performance. Alternatively, the insights gained from this study imply that there currently does exist some alignment, suggesting that the congruency level has changed. Therefore, indicating at a potential improvement since 2016.

This pattern of results is consistent with findings of studies conducted in recent years. Serrano-Cinca and Muñoz-Soro (2019) highlighted an observed improvement yet emphasise the need to improve the alignment with users' needs and findability of information on municipal websites. Furthermore, Herendy (2018) focused on user centred design for public administration websites, which validated the use mental models in constructing a website that meets users' expectations. For example, effective practices, such as card sorting tests, are demonstrated on websites like the British gov.uk site (Herendy, 2018). Altogether, these studies support the results and methods used in this study.

Moreover, this study addresses the existing research gap in designing a uniform navigation structure for municipal websites. Scott (2005) and Kim et al. (2007) underscore the need for additional research in this field, in which the development for an official guideline for service quality is advocated for. Despite the limited existing research in this



area, the results of this study make meaningful contributions to advancing researchers understanding of the role of mental models in building user-friendly navigation structures.

### **Limitations**

Firstly, a limitation arises from the possibility that participants may not have fully read the descriptions provided in Optimal Workshop. For instance, ‘energy’ was categorised as ‘feelings’ despite having a description that explicitly indicated its relation to the current energy price situation. The small size of the icon for accessing descriptions may have contributed to participants overlooking instructions detailing the availability of descriptions. Similarly, the similarity in the labelling of items may have led participants to give less thought to the actual concepts. For instance, the grouping of the items ‘news’ and ‘newsletter’ may indeed be a result of such similar labelling, but the exact reasoning remains unclear.

Secondly, this study used 40 cards as recommended by card sorting literature, to represent items from municipality websites. It is important to note that municipality websites typically contain thousands of information items. Thus, this study was restricted to those 40 cards, representing merely a subset of the complete set of items. This limitation became particularly evident in the case of isolated items, which exhibited the lowest similarity scores, indicating a lack of similarity with any other cards in the study.

Thirdly, the timing of the card sorting study coinciding with the elections in the Netherlands could have influenced the results of the elicited mental model. Participants may have been affected by the pending political changes, shifting their focus and priorities during the study. Thus, the increased attention and information load related to the elections might have diverted their usual considerations about municipalities (Holton & Chyi, 2012). This raises concerns about the generalisability of the findings for the mental model beyond this specific timeframe, specifically for the cluster ‘Municipality Updates’.

### **Future Research**

Future studies could include a fuller set of items, presenting them to participants as a randomised sample. Instead of overwhelming participants with numerous items, researchers can create a comprehensive set and then randomise the cards for each participant. This approach, recommended by Wood and Wood (2008), ensures further coverage of items without exhausting participants. Although, sufficient participants must be collected address the entire set of items adequately (Wood & Wood, 2008). Moreover, further research can be conducted to specifically validate whether users prefer this updated navigation structure. This can be through a usability test in which the path to an information goal or number of clicks

on the webpage is measured (Afonso et al., 2013). Additionally, incorporating a ‘thinking out loud’ approach might provide deeper insights into users' mental models (Ichsani, 2017).

### **Conclusion**

This paper focused on determining the alignment between existing navigation structures on municipality websites and users' mental models. Through a card sorting study and subsequent cluster analysis, seven clusters and five ambiguities were found, representing users' average mental model. This was followed by a comparative analysis against the municipality website of Amsterdam. Consequently, a moderate alignment was revealed, indicating that improvements were made in recent years. To further align the navigation structure with the mental model, certain design recommendations were proposed. Additionally, despite the limitations, this study contributes to the research gap in developing a standardised navigation framework for municipality websites. To conclude, these findings enhance the understanding of the relationship between mental models and navigation structures, providing valuable insights and recommendations for more intuitive and user-aligned municipality websites. Further research in with a more comprehensive list of items and usability tests may yield more generalisable conclusions.

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## **Appendices**

### **Appendix A**

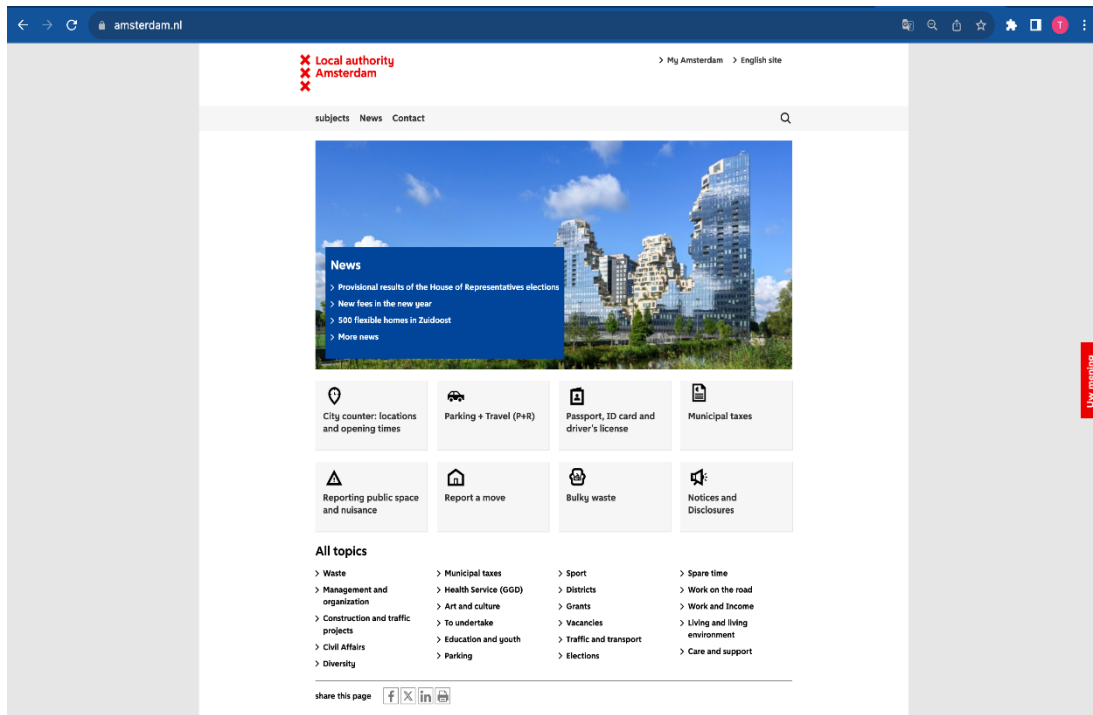
#### Dutch Municipality Websites Used for this Study

1. <https://www.enschede.nl/>
2. <https://www.amsterdam.nl/>
3. <https://www.tilburg.nl/>
4. <https://www.breda.nl/en>
5. <https://www.delft.nl/>
6. <https://www.utrecht.nl/>
7. <https://gemeente.groningen.nl/>
8. <https://www.gemeentemaastricht.nl/>
9. <https://www.denhaag.nl/>
10. <https://www.nijmegen.nl/>

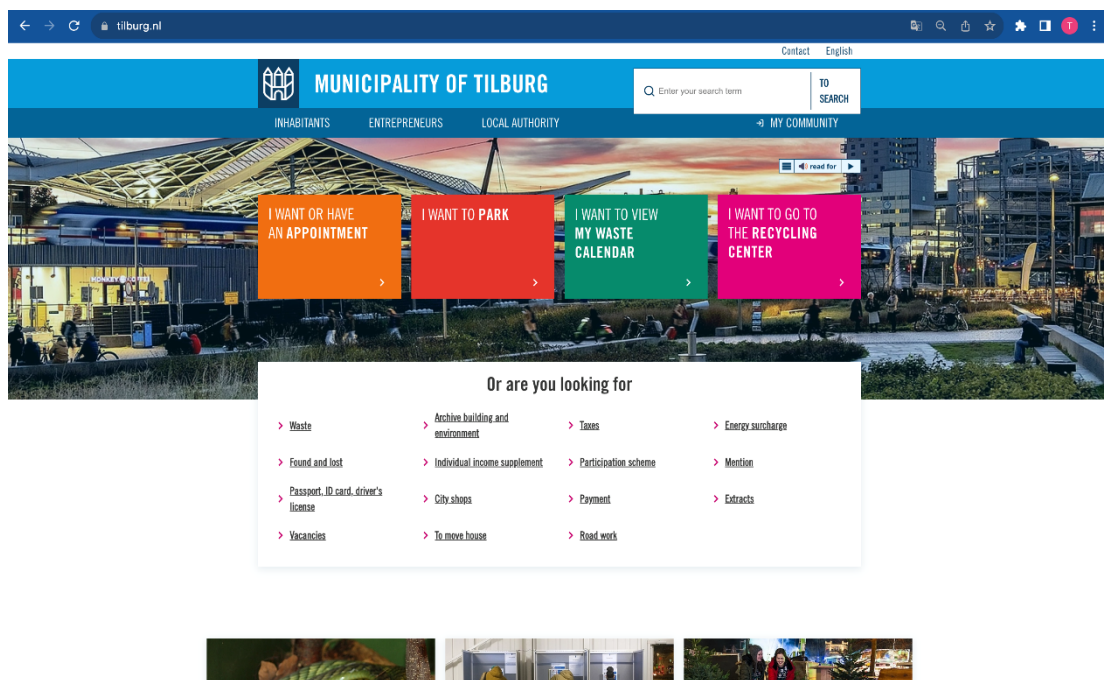
## Appendix B

### Comparing Navigation Structures

#### Municipality of Amsterdam



#### Municipality of Tilburg



### Appendix C

#### Items with their Corresponding Count and Description

#	English label	Count (/10)	Description
1	Taxes	9	Information on property taxes, income taxes, and local tax regulations, including payment methods and deadlines.
2	Refugees	8	Resources and support services for refugees, including information on housing, legal assistance, and community integration.
3	Vehicle Parking Spaces	7	Maps and guidance on available parking spots and parking garages.
4	Parking Permit	9	How to obtain parking permits, including eligibility criteria and application processes.
5	Road work	3	Updates on ongoing and planned road construction projects, traffic detours, and maintenance schedules.
6	Lost Bicycle	3	Reporting and recovery of lost or stolen bicycles, with tips on bike security.
7	Bicycle Sheds	8	Information on secure bicycle storage facilities and how to access them.
8	Leisure	9	Information on recreational activities, cultural events, and leisure opportunities.
9	Disabled Parking	10	Guidelines and permit application procedures for disabled parking spaces.

10	Energy	3	Information about the current energy price situation.
11	Lost & Found	5	Report and inquire about lost or found items.
12	News	10	Updates on local news, events, and important announcements in the municipality.
13	Emergency/Alert	2	Notifications and instructions in case emergencies.
14	Vacancies	7	Listings of job vacancies and career opportunities within the municipality.
15	Birth	10	Information on birth certificates, registration, and related services.
16	Public Transport	10	Resources and opportunities for public transportation services, including buses, trams, subways, and commuter trains.
17	Marriage	10	Marriage licence requirements, application procedures, and related information.
18	Passport/ ID	10	Passport and identification card application, renewal, and document-related services.
19	Sport	10	Information about sports facilities, athletic programs, and recreational sports opportunities.
20	Divorce	10	Resources and information on divorce processes and legal requirements.
21	Safety	7	Information about safety regulations such as camera surveillance or areas with a ban of drugs.

22	Shopping (and Markets)	2	Details about local markets, shopping districts, and consumer services.
23	Parking rates	7	Current parking fee structures and rates for different parking zones.
24	Events	9	Listings of upcoming events, festivals, and cultural activities in the municipality.
25	Deregistration		The process and requirements for cancelling or changing your residence registration.
26	Waste	7	Guidelines on waste disposal, recycling, and hazardous waste management.
27	Environment	4	Initiatives, conservation tips, and information on local environmental efforts.
28	Registration	7	Requirements and details as to how to register as a citizen of the municipality.
29	Rent	5	Rental property listings, tenant rights, and rental assistance programs.
30	Animal regulations	3	Information on pet licensing and animal regulations such as fishing permits.
31	Elections	3	Information on upcoming elections, voter registration, and polling locations.
32	(Opening) hours	7	Operating hours of municipal offices, services, facilities.
33	Contact	4	Access to contact information for various municipal departments and services for inquiries, complaints, or assistance.

34	Sustainability	6	Initiatives, programs, and resources aimed at promoting environmental sustainability.
35	Studying	4	Information about different study opportunities and related topics.
36	Education	5	Finding schools for different levels of education.
37	Bicycle parking	7	Guidelines and locations for bicycle parking facilities in the municipality.
38	Moving from abroad	8	Report your move, getting information about what needs to be done as a new citizen.
39	Newsletter	3	Subscription to a newsletter for receiving regular updates on municipal news, events, and important information.
40	Appointment	2	Scheduling appointments for municipal services such as legal consultations, permit applications.

## Appendix D

### Informed Consent

#### Before you start...

To take part in this study, please read and agree to the following:

##### Contact Details

For any questions or further information you can contact the researchers Tasneem Ramchand and Can Erdogan under the following emails: [t.ramchand@student.utwente.nl](mailto:t.ramchand@student.utwente.nl) & [c.erdogan@student.utwente.nl](mailto:c.erdogan@student.utwente.nl) or their Supervisor Marlise Westerhof under the email [m.westerhof@utwente.nl](mailto:m.westerhof@utwente.nl).

##### Taking part in the study

- I have read and understood the study information, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.
- I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.
- I understand that taking part in the study involves categorising cards into groups.

##### Use of the information in the study

- I understand that information I provide will be used for student reports and perhaps for a journal publication or conference report.
- I understand that personal information collected about me that can identify me, such as my name will not be shared beyond the study team.
- I understand that the study will follow anonymous data collection to minimise the threat of a data breach, and protect my identity in the event of such a breach.

##### Future use and reuse of the information by others

- I understand that the de-identified information that I provide will be erased within the next 6 months.

#### I have read and agree to these terms

Please take note of Optimal Workshop's [Privacy Notice \(opens a new tab\)](#).

- Yes
- No

Continue

## Appendix E

### Participant Instructions

**Link:** <https://e80om0ml.optimalworkshop.com/optimalsort/e56s50ll>

**Title:** Welcome to our Card Sorting study!

**First Message:** We are researching how information on Dutch municipality websites can be best organised to help users find the information they are looking for more easily. To gain valuable insights on how these websites should be structured we are conducting a card sorting study. On the following page you will be presented 40 items with brief descriptions which represent information that can be found on municipality websites. Your task will be to group those items together in a way you would expect to find the information grouped together on a municipality website. There are no right or wrong answers as we want to know more about your personal expectations. Try to create meaningful groups, and if you think that some cards can't be grouped together at all you can create a group called others where you can put those cards in. On the other hand if you have the feeling that a card could be put in several groups, decide for the one you think it fits best in. The specific Instructions on how to create groups and drag the items in will be shown on the following page.

**[Informed Consent — see Appendix D]**

**[Pre-questionnaire: Demographics]**

Question 1 of 4

What is your age?

Question 2 of 4

What gender do you identify as?

Question 3 of 4

Please specify your ethnicity

Question 4 of 4

What is the highest degree or level of education you have completed?



## Card Sorting Instructions

(unchanged, default instructions from *optimal workshop*):

We want to understand how you group things and what you would name those groups.

### Step 1

Take a quick look at the list of items to the left.

We'd like you to organise them into groups that make sense to you.

There is no right or wrong answer. Just do what comes naturally.

### Step 2

Drag an item from the left into this area to create your first group.

### Step 3

Click the title to rename your new group.

### Step 4

Add more items to this group by dropping them on top of it.

Make more groups by dropping them in unused spaces.

When you're done click "Finished" at the top right. Have fun!

### Thank you screen

Thank you for participating in our study!

If you have any questions or comments you can contact [t.ramchand@student.utwente.nl](mailto:t.ramchand@student.utwente.nl) or [c.erdogan@student.utwente.nl](mailto:c.erdogan@student.utwente.nl).

You may now close this window or navigate to another web page.