

How to reduce CO2 emissions from passenger traffic to and from events?

A sustainability tool for festivals – justification report



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Preface

Dear reader,

In front of you lays the Justification Report of Danique van Oort. This research is done for Logistics Community Brabant (LCB) and has been carried out as a graduation assignment for the bachelor International Leisure and Events Management at the Breda University of Applied Sciences. This research focuses on the reduction of CO2 emissions related to passenger traffic to and from events and it will be the start for a sustainable future for events by offering a sustainability scan for festival organizations.

I want to thank my colleagues at LCB for supporting me and guiding me through the process. I also want to thank the experts who have been present at the brainstorming session to share their meaningful insights and opinions on the topic. Lastly, I want to extend my gratitude to my family and boyfriend for their encouragement and support during the writing process.

I wish you a lot of pleasure in reading this document.

Danique van Oort
Breda, 29 May 2023

Executive summary

One of the biggest polluters within the mobility and festival sector are the CO2 emissions from passenger traffic to and from events. It starts to become urgent to reduce the CO2 emissions; it is obliged by the Dutch government to become climate neutral in 2050. Therefore, in cooperation with LCB, the sustainable mobility scan is developed as part of this research. The main question answered in this research is *“How can we reduce CO2 emissions from passenger traffic to and from an event?”*.

The sustainability scan is developed to give insights into the current CO2 emissions of an event. The scan makes it possible to see the total CO2 emissions per modality and the average CO2 emissions per person per modality, and it shows the total CO2 emissions and the average CO2 emissions per person in general. This way of measuring offers the possibility to see where the bottlenecks are and where to focus on to reduce the CO2 emissions. If repeated year after year, the scan will show a decrease or increase in CO2 emissions, and success or failure of the reduction of CO2 emissions can be measured.

There are other variables that play a part in the reduction of CO2 emissions. Besides gaining insights into the current CO2 emissions, this research also zooms in on the maximum duration the festival visitor is willing to travel per modality. These insights are gained by a survey. By understanding the willingness of the festival visitor, suitable measurements can be taken to steer the festival visitor to choose the most sustainable travel option. On the other hand, when understanding the willingness of the festival visitors, event organizations can offer sustainable travel packages by targeting their marketing. Another variable is the origin of the festival visitors. When knowing the maximum travel duration per modality and the origin of the festival visitors, an ideal situation (ideal modal split) can be created. In doing so, an event organization has a goal to work towards to.

The conclusion of this research is that the reduction of CO2 emissions depends on a few variables. These variables can all be controlled to get to the most ideal situation. This research has analyzed two festivals with the pilot version of the scan, 538 Koningsdag 2022 and Intents Festival 2022. It shows that it is possible to gain insight into the current situation and that the reduction of CO2 emissions is possible by implementing the right measurements. Lastly, this research offers the sustainability scan including a manual on how to use the scan, step-by-step. It also provides tips on how to reduce the CO2 emissions so festival organizations will be able to make a start in the reduction process.

Table of Contents

Contact information	2
<i>Student</i>	2
<i>Graduation company</i>	2
<i>University</i>	2
Preface	3
Executive summary	4
Table of Figures	7
Table of Tables	7
Explanatory list of definitions	8
1. Background information client	9
1.1 <i>Mission and vision</i>	9
1.2 <i>Building blocks</i>	9
2. Reason for research	9
3. The challenge	11
3.1 <i>Problem definition</i>	11
3.2 <i>Research objective</i>	11
3.3 <i>Research questions</i>	11
3.4 <i>Stakeholders and target group</i>	12
3.5 <i>End product</i>	15
3.6 <i>Competency domain</i>	16
4. Theoretical framework	16
4.1.1 <i>Design Thinking: The Double Diamond Model</i>	16
4.1.2 <i>Trial and error</i>	17
4.2 <i>Mobility management</i>	17
4.2.1 <i>Modal split</i>	17
4.2.2 <i>STOMP</i>	18
4.2.3 <i>The layer model</i>	18
4.3 <i>Influencing the behavior of the festival visitor</i>	19
4.3.1 <i>The pyramid of customer needs</i>	19
4.3.2 <i>Survey about the willingness of festival visitors</i>	20
4.3.3 <i>Ideal modal split</i>	20
4.3.4 <i>First and last mile</i>	20
4.4 <i>Conceptual framework</i>	21

5. Research method	21
6. Results.....	23
6.1 <i>The scope</i>	23
6.2 <i>The modal split and its impact on the environment</i>	25
6.3 <i>The sustainability scan</i>	25
6.3.1 Sustainability scan V1 and V2	26
6.3.2 Sustainability scan V3.....	27
6.3.3 Interview with Maarten van Rijn	28
6.3.4 Sustainability scan V4 and V5	30
6.3.5 Brainstorming session March 29.....	30
6.3.6 Sustainability scan V6.....	32
6.3.7 Last feedback LCB and the sustainability scan V7.....	33
6.3.8 Conclusion	34
6.4 <i>Analyzing 538 Koningsdag and Intents Festival</i>	34
6.4.1 Interview with Paul van de Coevering	35
6.4.2 Results of the survey	35
6.4.3 538 Koningsdag 2022	38
6.4.4 Intents Festival 2022	40
6.5 <i>Influencing the behavior of the festival visitor</i>	45
6.5.1 Pains	45
6.5.2 Gains.....	46
7. Conclusion	49
8. Limitations.....	50
9. Reflection	51
References.....	53

Table of Figures

Figure 1 emissions day event in the city.....	10
Figure 2 emissions multiple day event	10
Figure 3 Double Diamond model (Tschimmel, 2012)	16
Figure 4 The "Layer" Model (Van Rijn & Van Damme, 2011)	18
Figure 5 Pyramid of customer needs (Van Hagen & Van Hagen, 2011)	19
Figure 6 Conceptual framework	21
Figure 7 The "fun lane" by Van Rijn, personal communication (2023)	29
Figure 8 Trial and error process	34
Figure 9 Gender division survey results.....	36
Figure 10 Radius maximum travel duration around Chasséveld plus the most present municipalities	39
Figure 11 Origin 538 Koningsdag 2022	40
Figure 12 Radius maximum travel duration around Intents Festival per modality plus the most present municipalities.....	42
Figure 13 Cross-visits Friday Intents Festival	43
Figure 14 Cross-visits Saturday Intents Festival.....	43
Figure 15 Cross-visits Sunday Intents Festival	44
Figure 16 Origin Intents Festival 2022	44
Figure 17 Pains related to the Pyramid of Customer needs (Van Hagen & Van Hagen, 2011)	46
Figure 18 Gains related to the STOMP principles (CROW, 2021)	48
Figure 19 Visualization of the sustainable mobility process.....	49

Table of Tables

Table 1 Comparison 538 Koningsdag and Intents Festival	24
Table 2 Ranking choice of modality for a one-day event	36
Table 3 Influence of the variables - one-day event	37
Table 4 Ranking choice of modality for a weekend event.....	37
Table 5 Influence of the variables - weekend festival	38

Explanatory list of definitions

Modal split	Total number of trips for each modality within an area compared to the total number of trips for all modalities in that area.
Modal shift	The change in the division of the number of trips per modality compared to the total of trips.
Ideal modal split	The ideal division of the number of trips per modality compared to the total of trips.
Passenger-km	A unit of measurement that is equivalent to transporting a passenger over a distance of one kilometer.
Vehicle-km	A unit of measurement that is equivalent to transporting a vehicle over a distance of one kilometer.
Last mile	The last mile is the last part the visitor travels to reach the event. In this report the last mile is determined as the last 15-minutes radius around the festival.
Occupancy rate	The ratio of used capacity to the total capacity available.
Modality	Mode of transportation.
Weighted average	An average of multiple numbers that takes into account the varying degrees of importance.
K&R	Kiss and Ride.
Coach	A touring car or party bus. This bus picks the visitors up in a designated city or village and brings them to the entrance of the festival. At the end of the festival this same bus brings them back to their hometown. A paid ticket is usually necessary to enter the bus. In this document, the term “coach”, “touring car”, and “party bus” are used, but mean the same.
Postcode 4 level	The origin of someone is traced back to postcode level, for example, 4817 for Breda or 1109 for Amsterdam.

1. Background information client

This chapter is about the organization Logistics Community Brabant (LCB), the initiator of this graduation project. LCB is a collaboration between the Technische Universiteit Eindhoven, Universiteit van Tilburg, Nederlandse Defensie Academie, and Breda University of Applied Sciences. LCB was established in 2017 with the goal to connect theory and practice and offer a place where companies and educational institutes share knowledge (Technische Universiteit Eindhoven et al., 2017). Due to the ever-changing market in logistics, LCB wants to be fast and innovative to be ready to manage these changes well and be the frontrunner in logistics in Brabant. In doing so, they hope to make Brabant the market leader when it comes to combining knowledge and practice and offering fully sustainable logistical solutions. In the long term, LCB wants Brabant to be the number one logistical knowledge center in the world (Technische Universiteit Eindhoven et al., 2017).

1.1 Mission and vision

LCB has a mission to reduce the gap between knowledge and businesses and educational institutes to improve the effectiveness of current business models for and between businesses and the use of knowledge of educational institutes. With that, the vision of LCB is to be an innovative community for the logistics sector to whom can be reached and who forms a meeting place for businesses and educational institutes (Technische Universiteit Eindhoven et al., 2017).

1.2 Building blocks

LCB has set up eleven building blocks that together form their strategy. The eleven building blocks together form the sentence: *“Community met bedrijven centraal en slimme producten over een zestal thema’s die ook proactief aangeboden worden met als hoofdthema innovatie via one stop shopping ten behoeve van betere kennisstromen op basis van hoogwaardige communicatie, marketing en PR over de grenzen maar gevestigd in Breda”* (Technische Universiteit Eindhoven et al., 2017). LCB strives to be the innovative logistics company of Brabant and the connector of sector and businesses. Their goal is to innovate together today and tomorrow (Technische Universiteit Eindhoven et al., 2017).

2. Reason for research

The events industry is forced to become more sustainable. The biggest polluter is the movement to and from an event. Think about transporting goods and products, crew and artist traffic, and passenger traffic. These forms of movement all come together in the term mobility. Within mobility, it matters how goods or people are moved or transported. Traveling by airplane is more

polluting than traveling by bike, and the long traffic jams at the entrance of the event create more emissions than if these visitors would come by train (Green Events, 2021).

It is proven that almost 50% of the total CO2 emissions come from passenger traffic to and from an event (Milieubarometer, n.d.). Figure 1 shows the division of the categories of a one-day event taking place in the city and its share of the total emissions.

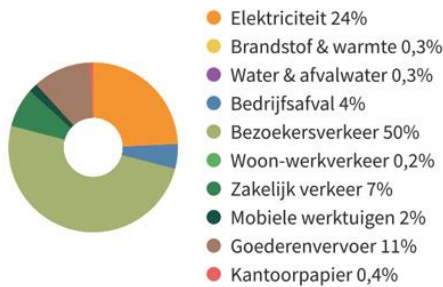


Figure 1 emissions day event in the city

Figure 2 shows the division of the emissions of a multiple-day event. As visible, the emissions from passenger traffic to and from an event are relatively lower than in Figure 1. On the other hand, the emissions from electricity and industrial waste are higher. A reason for this is that multiple-day events have a camping site. Fewer people have to travel back and forth and can stay camping, hence the lower passenger travel emissions. Higher emissions from electricity and industrial waste are because the event needs the electricity to run the campsite as well. Visitors also eat more, since they are staying multiple days, which leads to an increase in industrial waste (Milieubarometer, n.d.).



Figure 2 emissions multiple day event

As these statistics point out, it has become urgent to start reducing the emissions from passenger traffic to and from events. This causes the highest number of emissions, which can have serious effects on the future of events.

Currently, most festival organizations are focusing on sustainability by implementing plastic hard cups, offering tap water to reduce the purchase of plastic bottles, choosing local suppliers, and stimulating the use of public transportation (Moonen Packaging, 2020). There are Green Key criteria that steer event organizations in the right direction to become more sustainable, such as recycling waste and energy, choosing a sustainable location, promoting sustainable modalities to the event visitors, using local F&B suppliers, and offering sustainable food options (Effectivents,

n.d.). These measurements do promote sustainability; however, they do not give actual insight into how this affects the events industry. There is no hard data that proves the reduction of CO2 emissions. It first must be clear what the current impact is of the event sector related to CO2 emissions. The current impact is the baseline to which the results of the implemented sustainable measurements must be compared in order to conclude if the measurements have the right effects. This project develops a sustainability scan to measure the current impact of an event expressed in CO2 emissions; by completing the scan year after year, success or failure can be measured.

3. The challenge

This graduation project focuses on the CO2 emissions of passenger traffic to and from an event. Not only is passenger traffic the biggest polluter, but it is also necessary to decrease the emissions from this category in order to meet the goals of het Klimaatakkoord. The goal of het Klimaatakkoord is to reduce CO2 emissions related to mobility and become climate neutral in 2050. There is no focus on nitrogen and particulate matter in this project. It was decided together with LCB to first fully focus on reducing one type of emission and doing this the right way without losing focus. Key indicators of het Klimaatakkoord are: zero emissions, affordable, safe, comfortable, and easily accessible modalities for everyone (Ministerie van Economische Zaken en Klimaat, 2021). The complete infographic of het Klimaatakkoord related to mobility can be found in Appendix 2. The management problem that arises is formulated as follows:

“How can we reduce CO2 emissions from passenger traffic to and from an event?”

3.1 Problem definition

As mentioned, it is a must to first identify the key factors that form the foundation of the sustainability scan. Otherwise, the results of the scan would not be reliable and useful for the organizations. These key factors must be established and categorized first. Based on the key factors, meaningful conclusions can be made that will be relevant for the sector. The problem definition is:

“What are the key factors that form the foundation for the sustainability scan for passenger traffic to and from festivals?”

3.2 Research objective

The aim of this research is to define the key factors to measure how sustainable the modal split is in order to reduce CO2 emissions. The key factors need to be defined in order to create a relevant sustainability scan. The research questions below will help find the right information and form the setup for the theoretical framework.

3.3 Research questions

Based on the management problem and the short analysis of the challenge, the following research questions were set up:

1. What type of festivals does this research focus on?
2. Which factors determine the influence of passenger traffic on the environment?
 - a. Which variables are important when determining the modal split of festivals?
 - b. What is the impact of the different modalities on the environment?
3. What is the best way to set up the sustainability scan?
 - a. What types of assessment tools exist already?
 - b. What is the events sector missing related to sustainable mobility?
 - c. What are the key indicators to include in the sustainability scan?
4. How do festivals score regarding sustainable mobility?
 - a. What does the sustainability scan point out?
 - b. What information is missing in the results of the sustainability scan?
 - c. How can the results of the scan be translated in order to take the next step?
5. How can we influence the behavior of a festival visitor to choose a more sustainable modality?

3.4 Stakeholders and target group

For this project, the stakeholders and target group are the same. This project is not relevant to just LCB, it involves the whole events sector in the Netherlands. This means that there are a lot of stakeholders involved. Therefore, the overarching categories of stakeholders within this project are:

- LCB
- Educational institutes (e.g., BUAs)
- Event organizations
- Event visitors
- Mobility management companies
- Public transportation companies
- The Ministry of Infrastructure
- The Ministry of Economics and Sustainability
- Sustainability managers

These stakeholders were specified in order to get in contact with the right person or department within the organization. On March 29th, the first sustainability meeting took place. The attendees for this meeting were:

- Matthijs van Roekel (van Schaick, traffic and mobility management)
- Kiliaan Toorenaar (Close app, data sharing party)
- Robert-Jan van Dijk (Safety Group, mobility management)
- Wouter Giessen (TripService, traffic managers, and data collecting party)
- Eduard Vermolen (Pouw Vervoer, project management)
- Roy Hirs (HIRS Advies and the Dutch Grand Prix, mobility manager, and advisor)
- Frank Hommes (ProBro, mobility manager)
- Maarten van Rijn (MB Advies, event logistics specialist)
- Colleagues from LCB (Justin van de Pas, Sanne Kuipers, and Kevin Vermeulen)

Van Schaick, traffic and mobility management

Matthijs van Roekel was present to represent Van Schaick. They are specialized in traffic and mobility management, for both logistics and events logistics (Van Schaick, n.d.). They helped in the preparation phase of events and design, give advice, and realized the mobility plans. They have the expertise on how to design the event site in order to have a safe environment for all modalities.

BUAs

Breda University is a partner and the home of LCB. The BUAs has many experts within the logistics and events sector who can be of great help when creating the sustainability scan. BUAs also helps with financing projects of LCB. In exchange, LCB shares its knowledge and findings with BUAs to be co-creative, in line with the vision of LCB.

Close app, data sharing party

The CEO of the Close app, Kiliaan Toorenaar, joined us during the brainstorming session. The Close app is a data-sharing party. When buying a ticket for an event, the buyer receives a code that can be entered into the app. Here, the buyer enters the online environment of the event he is about to visit, and all relevant information can be found in it. The Close App gathers data from event visitors and shares information to make the visit to the event easier. The app can communicate with the users to gather information that is relevant to the event organization, such as the choice of modality. This way, the event organization knows what to expect and they can anticipate (Close, n.d.).

Public transportation companies

Public transportation companies, such as NS, offer safe and fast transportation. When organizing events, cooperation with NS, or other transportation companies, can be useful to reduce the usage of cars and stimulate the usage of trains or buses. The NS works on the safe transportation of people and actively works on making public transportation more sustainable (NS, n.d.-b). The NS also organized webinars about mobility management (NS, n.d.-a). They have the expertise on how to safely transport people from A to B and possess the right capacity to do this on a huge scale. Unfortunately, the NS was not able to join the brainstorming session on March 29th. Nevertheless, it is an important stakeholder to work close with when improving the modal split for festivals.

The Ministry of Infrastructure

The Ministry of Infrastructure is responsible for achieving the mobility goals of the Klimaatakkoord (Ministerie van Economische Zaken en Klimaat, 2021). They have knowledge about mobility within the Netherlands and have a vision of what must be done in order to achieve these goals. The choice was made to not invite someone from the Ministry to the brainstorming session, due to the fact that LCB wants to focus first on creating the scan and testing it without positioning themselves as the “bad guy” and going straight to the government before talking with the event organizations (J. van de Pas & S. Kuipers, personal communication). But LCB is fully aware that when the scan is finalized and ready to be used in the field, the Ministry, together with other governmental organizations, must be involved to bring the scan to the next level.

The Ministry of Economics and Sustainability

The Ministry of Economics and Sustainability strives for a venturesome and sustainable country. Their main goal is to achieve the goals set within the Klimaatakkoord; create the best opportunities to become more sustainable and find the best balance between the interests of businesses and consumers (Ministerie van Economische Zaken en Klimaat, 2021).

Safety Group, mobility management

Robert-Jan van Dijk was present during the brainstorming session to represent Safety Group. Safety Group is an organization with expertise in traffic and crowd control. The department Trigion is specialized in event mobility (Trigion, n.d.). During the preparation of your event, they will advise how to organize the mobility part of the event and they assist during the build-up. They have the right expertise on how to incorporate all facets of mobility management into an event (Trigion, n.d.).

TripService, traffic managers, and data collecting party

Wouter Giessen was present from TripService, a platform specialized in traffic and open data related to traffic. They work together with events and event locations to get insights into the current situations and give advice based on this. They monitor traffic flows and help events provide better services to their visitors (TripService, n.d.). With their insights into the traffic flows and expertise on how to work with events to provide the best mobility service, they will be of great relevance for the brainstorming session.

Pouw Vervoer, mobility, and project management

Eduard Vermolen was present during the brainstorming session, representing Pouw Vervoer. They are specialized in event transportation, national transportation, shuttle services, party busses, and ticket sale. Event organizations can hire them to organize touring cars departing from multiple national cities, or shuttle services bringing visitors from the train station to the entrance (Pouw Vervoer, n.d.). Eduard shared his view on how to organize bus transport for festivals and what they recognize in the sector regarding current developments.

HIRS Advies and the Dutch Grand Prix, mobility management and advice

Roy Hirs was present, representing his own company HIRS Advies and his role as mobility advisor and project manager for the Dutch Grand Prix (HIRS advise, n.d.). He has a unique view of mobility management and knows how to tackle any problem. He is the main mobility manager for the Dutch Grand Prix, which has a very complex mobility plan. During the brainstorming session, he gave relevant input and shows how to look at the challenge from a different angle in order to get the best results.

Probro, mobility manager

Frank Hommes represented Probro during the brainstorming session. Frank is a mobility manager and helps event organizations with setting up traffic and safety plans, he works for most events organized by This Is Live Group. Besides creating traffic and safety plans for events, they also help with license applications (Probro, n.d.). His expertise and experience are valuable for the project to get a better understanding of the current situation and developments.

MB Advies, event logistics specialist

Maarten van Rijn joined the brainstorming session as well on March 29th. Maarten is the writer of the book *Events Logistics*, and he was a lecturer at BUAs at the Academy for Logistics. MB Advies is specialized in optimizing processes and logistics, and Maarten is specialized in the optimization of events processes and logistics (MB Advies, n.d.). His expertise in the topic will help give better insights into how to shape the scan and the steps to take to implement the scan.

LCB

LCB is the main representative of this project and started the idea. Their mission and vision are to be innovative within the logistics sector and be experts in event logistics. Developing a sustainability tool for the events sector will be of great relevance for LCB since it is in line with their mission, and it can also make them a market leader.

Zicht op Data, data sharing party

Ruud Erhardt is the CEO of the company Zicht op Data, a company that collects data regarding movements in The Netherlands. They help us get insights into the passenger movements to and from the festival area. This is done by collecting GSM location data from people who have been around the marked festival area. They can create the modal split for us, based on what speed the GSM moves to the festival area. Zicht op Data makes the distinction between walking, bicycling, and car. The GSM data is received from everyone within a 15-minute radius of the marked festival area. With the GSM data, it is possible to see the origin of that person (with the municipality they came from), the duration they were in that certain area, and the choice of modality (walking, bicycling, or car) (R. Erhardt, personal communication, 2023). Besides the festival area, the parking area, K&R stand, taxi stand, bicycle parking, shuttle bus parking, touring car parking, and closest train station are marked on a map. Zicht op Data provides us with the GSM trackings found in all areas mentioned above and helps us find cross-visits between those areas. Those cross-visits are a confirmation that someone has chosen a certain modality; if someone was spotted at the train station and at the festival terrain, it is most likely he or she traveled by train (provided that the origin is not in the same city as the train station or festival area, since taking the train then won't make sense).

A force field analysis and power/interest matrix are made and can be found in Appendix 3.

3.5 End product

The desired situation is to be climate neutral in 2050 when it comes to passenger traffic (Ministerie van Economische Zaken en Klimaat (2021)). To reach that goal, it must be clear what the current situation is related to CO₂ emissions from passenger traffic. This is the foundation for the sustainability scan. The sustainability scan is the desired end product for this research and the start for festival organizations to improve their mobility plan to reduce CO₂ emissions. The scan is a checklist for festival organizations that must be filled in to gain insights into how sustainable their current mobility plan is focused on passenger traffic. The form the scan is an Excel file that calculates the CO₂ emissions per modality per person. A variety of questions are in the scan to help the event organization gain awareness. It is important that the form of the scan is clear and easy to use. The target audience of the scan is the festival organizations. Besides the

sustainability scan, a small manual is provided with a step-by-step explanation on how to use the scan and tips and tricks for event organizations to make the first step toward a climate neutral future.

3.6 Competency domain

This project is related to the competency domains of Productions and Stakeholder Management. It is related to Productions because the sustainability tool must be produced and shaped to improve the current situation without interfering with the experience of the event visitor. The tool must fit the values of the stakeholders who are involved in creating the scan which is why it is also related to Stakeholder Management. Together with a group of experts, a brainstorming session is held to come up with ways to shape the scan to make it valuable for the sector.

4. Theoretical framework

This chapter elaborates on the theories used in this research. Two theories form the foundation of the development of the sustainability scan: the Design Thinking Double Diamond theory (Tschimmel, 2012) and the trial and error theory (Young, 2008). These are explained in subchapter 4.1.1 and 4.1.2.

The rest of this research is divided into two main topics to which the theories relate: mobility management and influencing the behavior of the festival visitor. Subchapter 4.2 and 4.3 go into detail about which theories and models are used. Please see Chapter 5 Research method how the theories are implemented.

4.1.1 Design Thinking: The Double Diamond Model

A method that is used to create and validate the scan is the concept “Design Thinking”. Design Thinking is *“the ability to be at the same time analytical and emphatic, rational and emotional, methodical and intuitive, oriented by plans and constraints, but spontaneous”* (Tschimmel, 2012). A model used to describe the stages of Design Thinking is the 4 D model, or the so-called Double Diamond Model, see figure 3.

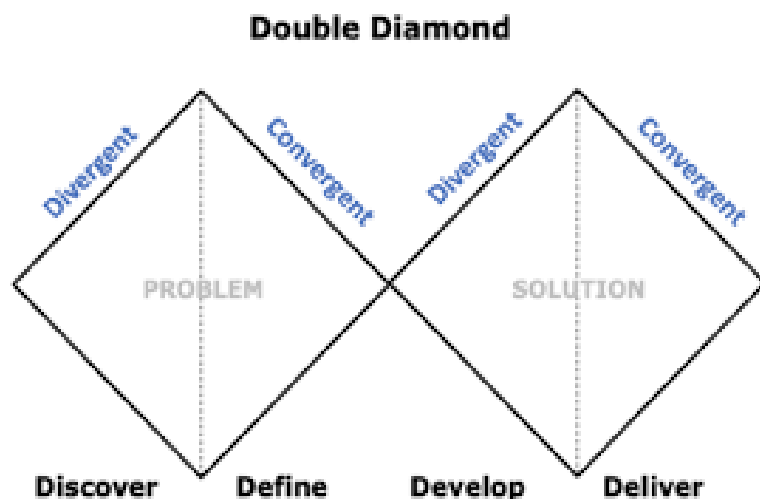


Figure 3 Double Diamond model (Tschimmel, 2012)

- In the first phase, the Discovery phase, the researcher is gathering new insights, opportunities, information and trends.

- The second phase, the Define phase, closes the first diamond. The first insights and opportunities are reviewed and discarded (Tschimmel, 2012). Questions the researcher asks himself could be “What is feasible?”, “Does it make sense?”. The goal is to create the fundament of the challenge (Choudhary, 2021).
- The third phase is the Development phase. It is again a divergent period in which concepts and prototypes are created and tested (Tschimmel, 2012).
- The fourth and last phase is the Deliver phase. The results are finalized, and the product or service is launched.

4.1.2 Trial and error

Learning via trial and error means trying out new strategies or methods until the desired outcome is reached (Young, 2008). After every attempt, every trial, new learnings, and insights are collected, the errors. These errors are taken into account when preparing for the next trial. This is repeated over and over until there are no errors left and the desired outcome is reached.

4.2 Mobility management

Mobility management is of great essence for a festival organization. There are multiple theories that help understand and support the concept of mobility management. In subchapter 4.2.1 the modal split is explained and what variables are included here (Van Wee & Anne Annema, 2014). In subchapter 4.2.2 the STOMP model is explained and how this can be used to influence the modal split. In subchapter 4.2.3 the layer model of Van Rijn & Van Damme (2011) is explained.

4.2.1 Modal split

A modal split is a tool that festival organizations use to see what the division of modalities is amongst the festival visitors. It shows what percentage will most likely travel by foot, by bike, by car, by public transportation, by shuttle service, by taxi or kiss and ride, or by coach. The division of the modalities is of high importance to the organization since they must anticipate to this by arranging enough parking spots or offering enough shuttle busses for example. The modal split is created before the event takes place and is based on multiple variables. These variables can be summarized as follows (Van Wee & Anne Annema, 2014):

- The needs and possibilities of the festival visitor
- The location of the event
- The resistance of the journey (time, effort, and costs)

If someone has his own car, he will most likely use this to travel to the event. However, if he does not have his own car, but is not able to travel home anymore due to the end time of the event, he must either find a place to stay or leave the event earlier to travel home by train. These aspects are taken into account when considering the needs and possibilities of the festival visitor.

The location of the event also influences the choice of modality. If the event is hosted in the city center, someone will most likely travel by train since finding a parking spot is hard. However, if the event takes place somewhere in the middle of nowhere, festival visitors will most likely come by car since that is the easiest.

The resistance of the journey consists of many variables, like time, effort, and costs (Van Wee & Anne Annema, 2014). But there are more variables to take into account here: when does it take place, day or night, and is it easily accessible (Green Events, 2021). If an event takes place in a rural area, it is hard to reach by public transportation and more visitors will come by car, since this is the easiest. However, if the festival organization will increase the costs of parking tickets and offer good shuttle services to the festival for a very low price, more visitors will choose the shuttle service instead of paying a high price for car parking.

4.2.2 STOMP

With the STOMP principles, sustainable mobility is promoted. STOMP stands for (CROW, 2021):

- Steps (walking)
- Two-wheelers (bicycles)
- On public transport
- Mobility as a Service
- Private car

When designing the mobility plan of your event, and with that creating the modal split, the STOMP principle helps to first focus on the most sustainable modes of transport and how these can be promoted. The organization must first start with organizing and analyzing the possibility for the visitors to travel by foot (steps). When the possibilities for this mode of transport are concluded, the second mode of transport is organized and analyzed, the two-wheelers (bicycle). The third step is to support public transportation. The fourth mode of transport is Mobility as a Service, which includes all the organized transportation to the festival. The last mode of transportation is the private car. This is the least wanted mode of transport since it creates the most emissions and is the worst for the environment. That is why it is the last step to consider, but nevertheless, it cannot be forgotten (CROW, 2021).

4.2.3 The layer model

The layer model (Van Rijn & Van Damme, 2011) is a model that visualizes the processes the festival visitor goes through. The chain starts when the visitor leaves home to go to the event and ends again at home. The chain is divided into four processes that are centered around the core (the red circle, the event), see figure 4.

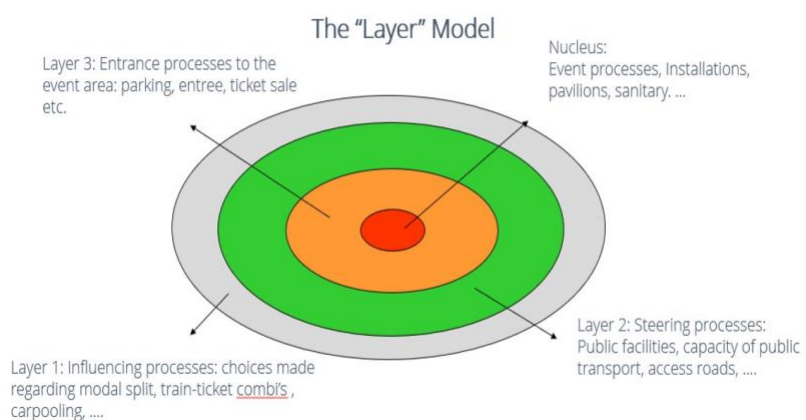


Figure 4 The "Layer" Model (Van Rijn & Van Damme, 2011)

- The first layer is about influencing the choice of the visitor; how is he or she moving to the event? What event organizations can do here is choose the location of the event wisely. Besides that, think about offering combination tickets, shuttle services, or cheap bus journeys (Van Rijn & Van Damme, 2011).
- The second layer is about controlling the choice of the visitors. They have made their choice of modality and it is up to the event organizers to direct the visitors towards the right parking spot.
- The third layer is about how the event site is designed in order to get access, for example, the ticket scanning at the entrance.
- The fourth layer, the core, contains all the processes on the event site; visitors come to see the artist, an attraction, catering, etc.

For events, it is the most interesting what can be done in the first and third layers. The first layer is the hardest to influence since most visitors know from the start what modality they want to use. Taking measurements to stimulate shared modalities or public transportation will help reduce the number of cars for example, but it is impossible to expect no cars will show up at the event. That is why the most progression can be made in the third layer. Here, the accessibility of the event is central. Festival organizations can for example place the shuttle bus stop at the entrance of the event, and the car parking a few minutes away. As well as ask for higher prices for car parking than for the shuttle service. Bicycle parking can be offered for free to stimulate this as well (Van Rijn & Van Damme, 2011).

4.3 Influencing the behavior of the festival visitor

The second main topic of this research is to influence the behavior of the festival visitor to go for a more sustainable modality. This can be done from the perspective of the organization or the perspective of the visitor. The STOMP theory and the layer model described in the previous part are already a connection between mobility management and influencing the behavior of the festival visitor. In 4.3.1 the pyramid of customer needs is explained (van Hagen & van Hagen, 2011). Subchapter 4.3.2 goes into detail about the survey that is held for this project and it explains the goal of the survey. In 4.3.3 the ideal modal split is explained, this is a follow-up on the regular modal split found in the previous part. In subchapter 4.3.4 the first and last mile method is explained.

4.3.1 The pyramid of customer needs

The pyramid of customer needs (Van Hagen & Van Hagen, 2011) is related to the pyramid of Maslow, various needs are ranked according to importance. The base of the pyramid is formed by safety and reliability. For visitors, these are the basic needs when it comes to choosing their mode of transport. Safety particularly means social safety in this context. Reliability in this context means that visitors get what they expect, the

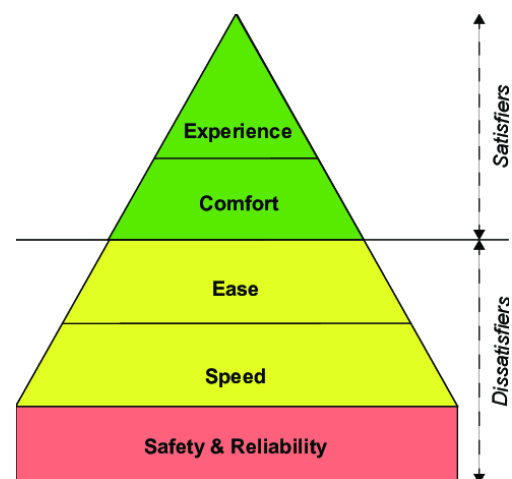


Figure 5 Pyramid of customer needs (Van Hagen & Van Hagen, 2011)

service must be available when and where the visitor wants. The second layer is speed, the visitor will choose the mode of transport with the shortest travel time from door to door. The next need is ease, i.e., convenience, and with little hassle. Providing the right travel information and signing helps to satisfy this need, the trip must be logical. The fourth layer is comfort, shelter at the bus stop, and the right pricing. The final need is a pleasant experience, a clean shuttle service, or a drop-off at the entrance (Van Hagen & Van Hagen, 2011).

4.3.2 Survey about the willingness of festival visitors

The second method used is a survey about the behavior and willingness of the festival visitor. In order to be able to influence the choice of the festival visitor, it must first be understood what the willingness is of the festival visitor to choose a certain modality. Without knowing the willingness and understanding of the decision-making process, it is impossible to influence the visitor's choice. A survey is chosen since a general understanding of the behavior of the festival visitor must be known; there is no need to have the opinion of just one, or a few, experts on this topic. Behavior is a very subjective topic and therefore as many opinions must be gathered to get a general idea of the target group (Baarda, 2020). An online survey reaches the most people in a short timeframe, which is why this form of collecting data is chosen. The survey can be found [here](#) and in Appendix 4.

The sample size is 377, which is based on a population of 20.000 people, an assurance level of 95%, and a margin of error of 5%. A population of 20.000 people has been chosen since the total population is not known, the survey will be sent out to all those who visit festivals and is shared on LinkedIn. In case the population is not known, a total of 20.000 participants can be assumed since a bigger population than this won't make much of a difference to the sample size (Alles Over Marktonderzoek, 2022).

4.3.3 Ideal modal split

The survey is supposed to help gain insights into the maximum duration festival visitors are willing to travel per modality to a festival. This information is crucial since an ideal modal split can be created with it. The ideal modal split shows the best and most sustainable division in modalities that fits the event (P. Van de Coevering, personal communication, 2023). The ideal modal split can be calculated by analyzing the origin of the festival visitors, the location of the event, and the available modalities. When you know that, in general, festival visitors are willing to walk no longer than 30 minutes, it can be calculated based on the origin of all visitors what percentages could come by foot in the ideal situation. This can be done for every modality. Creating an ideal modal split also motivates the festival organization because they know what they are trying to realize; it gives them a goal.

4.3.4 First and last mile

The first and last mile in logistics is defined as the first and last part of a journey from the start to the end. Research by the European Environment Agency (2020) shows that improving the first and last mile of the journey can lead to more sustainable transportation. According to Intertraffic (2020), people choose to travel by their car since public transportation and other shared

modalities entail too many difficulties. By optimizing public transportation, the first mile towards public transport, and the last mile after it, these modalities will become more attractive (European Environment Agency, 2020; Intertraffic, 2020). For event organizations, this technique is important. By offering tips to focus on optimizing the first and last mile, festival visitors will be most likely to make use of public transportation or other shared modalities instead of choosing their own private car.

4.4 Conceptual framework

Based on the theoretical framework, a conceptual framework is created and can be found in Figure 6.

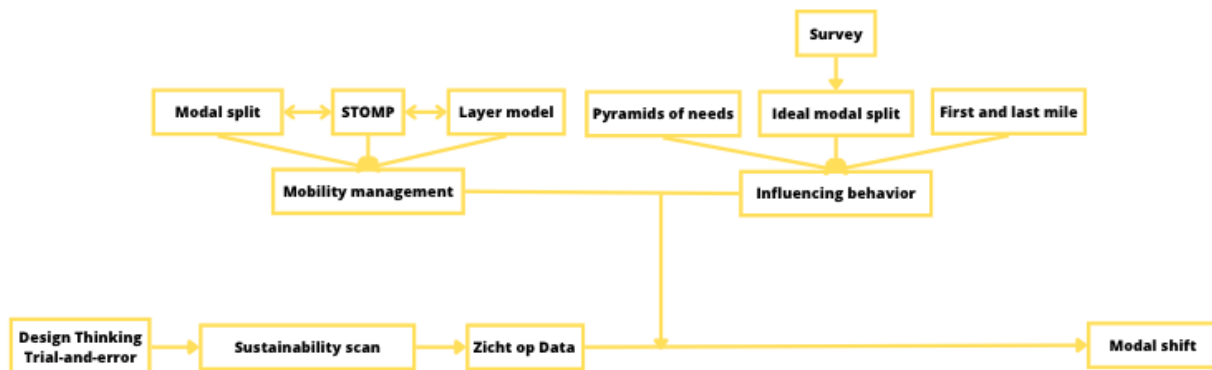


Figure 6 Conceptual framework

The sustainability scan is created by using the techniques Design Thinking (Tschimmel, 2012) and trial and error (Young, 2008). With the data received from Zicht op Data, the scan is tested on two real events. Based on the results of the sustainability scan, either mobility management (CROW, 2021; Van Rijn & Van Damme, 2015, Van Wee & Anne Annema, 2014)) must be applied, the behavior of the festival visitor (Van Roekel, 2019; Van Hagen & Van Hagen, 2011; Intertraffic, 2020; European Environment Agency, 2020) must be influenced, or a combination of both in order to reach a modal shift.

5. Research method

The research gap that this graduation project is focused on is to find a solution to make a sustainability scan for event organizers that is easy to use and gives insight into the current CO2 emissions of their mobility plan. Based on the result of the scan, relevant tips and tricks can be given to the organizers to improve their mobility plan. This project both requires desk and field research.

1. What type of events does this research focus on?

The first research question is answered by desk research and in consultation with my colleagues from LCB. This phase will determine the scope of this research and with that outlines the limitations of this research.

2. Which factors determine the influence of passenger traffic on the environment?

During the second phase, desk research and literature research was done. Relevant literature from Van Rijn & Van Damme (2015) and Van Wee & Anne Annema (2014) was used to learn more about the modal split and what factors play an important part in it. Other useful websites and CO2 emission calculators were used to determine the impact of different modalities on the environment (CO2emissiefactoren, 2023). A short expert interview is done to gather feedback regarding the first draft version of the scan.

The reason of research and research questions one and two are all part of both the Discover and Define phase of Design Thinking (Tschimmel, 2012). These questions focus on doing background research and gathering all information necessary, which is part of the Discovering phase (Tschimmel, 2012), in order to give value to this project. Then, the scope and the factors determining the influence on the environment are concluded in the Define phase (Tschimmel, 2012).

3. What is the best way to set up the sustainability scan?

In the third phase, the sustainability scan is created. This is done with the information gathered in the second phase. A draft version of the sustainability scan is created and shown during the brainstorming session on March 29, 2023. During this session, it was discussed what the current situation is, how festival organizations handle this, and the role of mobility and public transportation companies. A brainstorming session is a form of qualitative research. In this case, qualitative research is more suitable (Baarda, 2020). The goal of the session was not to gain a general idea of what the stakeholders believe but to get a deeper understanding of how they feel about the sustainability scan and what their motives are regarding its usage of it. Both information gathered from desk and field research, the literature, and the brainstorming session, are combined to finetune the draft version of the sustainability scan. This phase is related to the Development Phase of Design Thinking (Tschimmel, 2012). In this phase, all information gathered is used to develop the sustainability scan by using the trial-and-error method (Tschimmel, 2012; Young, 2008); new versions of the scan are created again and again to validate and thereafter finetuned again.

4. How do festivals score regarding sustainable mobility?

In the fourth phase, the validated sustainability scan from the third phase was tested on two events. The scan was tested with the data received from Zicht op Data, a company that specialized in analyzing data and has experience in mapping flows of people for festivals (Zicht op Data, n.d.). With this data, it is possible to track the movement of people to and from a certain location, the choice of modality based on the speed of the movement, how long they spend in a certain location, and what their origin is. Two festivals, 538 Koningsdag and Intents Festival, have been chosen to receive the GSM tracking data from, please see [chapter 6.1 The scope](#) for the justification of this choice. In this phase, most field research was done by brainstorming with the experts and colleagues to find out what needs to be improved to optimize the scan. This phase mostly required field research and brainstorming sessions because the outcome of the scan must be understandable for all parties involved.

5. How can we influence the behavior of the festival visitor to choose a more sustainable modality?

The fifth phase is the conclusion of all previous phases. It summarized all information gathered so far and based on that relevant advice is given to the festival organizations on how to improve their mobility plan to become more sustainable. To influence behavior, theories from Van Rijn & Van Damme (2015), CROW (2021), van Hagen & Van Hagen (2011), and the results of the survey are used. The scan is the baseline measurement for the events. It points out which modalities cause the most CO2 emissions, so event organizations know where the bottleneck occurs and where to focus on to reduce emissions. The different theories mentioned above are used to gain insight into how to stir the behavior of the festival visitor to choose a more sustainable modality. Together with the fourth research question, this phase is the last phase of Design Thinking, the Delivering phase (Tschimmel, 2012). Based on how the two festivals score, solutions, and tips are offered that conclude this research.

6. Results

This chapter answers the research questions. In 6.1 the scope of this research is determined. Subchapter 6.2 goes into detail about what variables are important when creating the modal split and its impact on the environment. These two subchapters are part of both the Discovering and Defining phase of Design Thinking (Tschimmel, 2012). During this phase, new information and insights, together with the research done during the start of this project for the Plan Of Approach, are gathered to determine the scope and the variables. In 6.3, the setup of the sustainability scan is explained by using the trial-and-error theory (Young, 2008). This step is part of the Developing phase of Design Thinking (Tschimmel, 2012). In 6.4 the sustainability scan is tested on two events. In 6.5, tips are given to influence the behavior of the festival visitor to come to a more sustainable modal split. These last two steps are part of the Defining phase (Tschimmel, 2012). In the end, a conclusion is drawn based on all results.

6.1 The scope

There are many different types of events, but they have one thing in common: it is all about the experience (Van Rijn & Van Damme, 2015). Other characteristics of events are:

- Time (season, day or night, duration)
- Location (indoor or outdoor, city or rural area)
- Size (number of visitors)
- Entrance (free or paid, tickets)
- Target audience (visitors, participants, guests, attendees)

A festival is a type of event. At festivals, the most important aspects are the music and the thrive to create a party; in other words, it is about the experience of the festival visitor. To give the people a nice and meaningful experience, the processes related to the organization of the event must be optimized. One of those processes where this research is focused on is the passenger traffic to and from the festival.

The above-named characteristics define the way the mobility plan is set up by the event organizer. The initial idea was to gather information on the 10 biggest festivals in North Brabant and use that as a benchmark for the festival sector. The 10 events were categorized by indoor/outdoor, city/rural, day/night, and day/weekend; all 10 events required a ticket and had 10.000+ visitors. The idea was that after the analysis, a general baseline could be created for similar events; it should have been clear that every weekend festival would have the same characteristics, regarding mobility, as any other and therefore analyzing a one-weekend festival could say a lot about the others taking place in North-Brabant. Gaining insights into the mobility plans of the festivals turned out to be more difficult than expected, most events did not want to share this information with us, but if they were open to sharing data, it was very basic and general data that would not help us to get insights into their mobility plan or modal split. At that moment, it was decided to include an external data party, Zicht op Data. They gather GSM tracking data and have experience with working for the festival sector. Their expertise is to gather data and translate that into useful information for organizations (Zicht op Data, n.d.); in this case, they collect all GSM data from pre-defined areas to get insight into how many people have been in that area, the origin of that person, the duration they were present at that area, by the speed the GSM trace travels through the area the mode of transport could be determined, and if there had been cross-connections between the GSM traces.

During the decision-making process of defining what data was needed from Zicht op Data and from which events, it was decided that 10 events would be too much data to analyze within the time frame of this research and buying the data of all the events is quite expensive (J. van de Pas & S. Kuipers, personal communication, 2023). Besides that, it was concluded by one of the experts during our brainstorming session on March 29th that there is no way these 10 events can be compared to each other. Every event is unique and therefore should never be compared to another event to base conclusions on, even if both events have a lot of similarities, they can never be compared to each other (R. Hirs, brainstorming session, 2023). From the 10 biggest festivals in North Brabant, two festivals have been chosen to request the data from Zicht op Data. For that reason, the pilot of the scan is tested on two events: 538 Koningsdag in Breda and Intents Festival in Oisterwijk. These events have been chosen because they differ a lot from each other according to the characteristics of Van Rijn & Van Damme (2015), see Table 1.

Table 1 Comparison 538 Koningsdag and Intents Festival

Characteristic	538 Koningsdag 2022	Intents Festival 2022
<i>Time</i>	April 27 12:00 – 22:30	June 2, 3 and 4 Festival: 14:00 – 23:00 Camping: 24/7
<i>Location</i>	Breda Chasséveld, city center	Oisterwijk Sportpark Den Donk, rural
<i>Size</i>	40.000	30.000
<i>Entrance</i>	Paid	Paid
<i>Target audience</i>	National audience 18 – 22 year Pop and dance music	International audience 18 – 35 year Harder styles

The reason that these two events are chosen is that LCB mostly operates in North Brabant, therefore they wanted to do the pilot of the sustainability scan within North Brabant. It is also interesting to see how two completely different events differ in the outcome of the pilot. Conclusions can be drawn regarding the impact of the characteristics; this does not mean that these events are seen as an example of similar events, but it is interesting to see if the pilot scan is useful for different types of events. Another reason why these two events are chosen is that the events are known by LCB, BUAs, or me. This makes it easier to interpret the outcome of the scan and get an understanding of the situation of the event. If the events are not or are less known by us, the interpretation of the results could be more based on guesses than on understanding the event and being familiar with it.

6.2 The modal split and its impact on the environment

The modal split is determined before the event takes place. Most event organizations know from experience, or previous editions, what the modal split will look like. Last year's edition is usually used and updated for the coming year. Nevertheless, there are multiple factors that influence the modal split. As explained in the theoretical framework, Van Wee & Anne Annema (2014) categorized the factors:

- The needs and possibilities of the festival visitor
- The location of the event
- The resistance of the journey (time, effort, and costs)

Van Rijn & Van Damme (2015) and Green Events (2021) mention more variables that have an influence on the modal split of festivals. They say that the accessibility of the event and the time plays a huge part as well. Your event can take place in the city center, but if it takes place during the night and ends at five in the morning, no one is able to go home since no trains are running yet. This makes the event difficult to access or leave and can have an influence on the choice of modality.

The next step is to understand what the impact of the modalities is on the environment. CO2emissiefactoren (2023) publishes the emissions per modality in kg per km. Every year this list is updated with the most accurate information. This list is used to set up the first version of the sustainability scan. The list of the CO2 emissions per modality and the first draft of the sustainability scan can be found in Appendix 8.

6.3 The sustainability scan

During the research in the Discovering and Defining phase of the project, it became clear what the event sector is missing, and the objective of the scan is to fill this gap. Organizations that are actively working on reducing their CO2 emissions are DGTL Festival and MOJO (DGTL, 2022; Mojo Concerts BV, 2023). DGTL actively stimulates its visitors to think about the environment and its impact on it. They only offer vegan food options, use recycled plastic, energy, and water, and promote sustainable transportation. MOJO has recently published its plans to reduce all CO2 emissions related to transportation, together with its other plan to become CO2 neutral in 2030. It is unfortunate that both organizations were not able to talk to me about their strategy.

However, it became clear from desk research that the data online is not transparent. No event organization is keen on sharing data regarding their current situation. This makes it hard to see how well the measurements work. The objective of the sustainability scan is to be transparent to the event organizations and the event sector and show what the current CO2 emissions are. The next step is to give tips on how to reduce CO2 emissions. Below, the steps taken are justified; all versions of the sustainability scan can be found in Appendix 8 for clarification.

6.3.1 Sustainability scan V1 and V2

After determining the objective of the sustainability scan, the first version of the scan was created. The V1 was the first setup of the scan, just to present an idea to LCB of what it might look like in the future. Before creating the first version, multiple existing sustainability scans were collected and assessed to find out what has been done already and what is missing. Scans from *ecolibrum* (2021), *Future Festival Tools* (n.d.), *Greenhouse Gas Protocol* (2021), and *Myclimate* (n.d.) were analyzed. What was most striking, is that *Future Festival Tools* (n.d.) and *Myclimate* (n.d.) consist of a multiple-choice questionnaire with a lot of very detailed answers. Being too specific can be a bottleneck since it is harder for event organizers to recognize their own situation in the detailed sketches given by the questionnaire, and therefore event organizations do not know how to fill it in. *Ecolibrum* (2021) offers you the chance to calculate the CO2 emissions per trip and what it would cost to make up for the CO2 emissions. This of course gives insight into the degree of pollution of the journey but throwing money at the problem does not make it go away. The scan created by *Greenhouse Gas Protocol* (2021) is an Excel checklist in which you can fill in the CO2 emissions per category. The downside is that this checklist expects you to know the precise emissions already, it is more of a data collection sheet to create an overview. It became clear that the sustainability scans available online for the public do not qualify, and the scans used by MOJO and DGTL as mentioned above, are not shared with the public or the results shared are not transparent. With this in mind, the V1 version is created.

Together with Justin and Sanne (personal communication, 2023), more elements were added to the scan; with the two main elements the link with the CO2 emissions per modality and the distinction between the different public transportation modalities. In V1, the category of public transportation included the train, bus, metro, and tram. However, in V2 these were torn apart and every modality got its own spot in the scan with the corresponding CO2 emission. The reason why all modes of public transportation got separated was that we believed that this could give more insights into the current use of modalities for the event organization.

The general questions asked at the top of the scan were added after discussing them together with Justin and Sanne (personal communication, 2023). The idea was to ask these questions to find out if the event organization is aware of the impact of the modalities on the environment and if they are actively stimulating the visitors to choose a sustainable option. It was also the idea to rate the event organizations based on the distance between the event and the parking area, shuttle service, bike parking, and price for parking. That is why the grades are mentioned in the scan as well. These grades were not implemented yet but were written down as a reminder for me to not forget this.

6.3.2 Sustainability scan V3

When making the distinction between all modes of public transportation, it came to light that the trams and metros in The Netherlands are all driven by electricity and do not make use of gas or benzine, so there are no CO₂ emissions (CO₂emissiefactoren, 2023). The decision was made to remove the tram and metro from the scan since they do not add to the total CO₂ emissions. Another reason why these two modalities are taken out of the scan is that event organizations do not have insight into how many visitors arrive by tram or metro. The bus and train are more popular modalities and insights into these numbers are easier to get. This step can be found in V3 of the scan. In V3, the bus and train are combined as well. This is done since most event organizations do not know what percentage arrived by train or by public bus. To avoid making the scan too difficult or scaring the event organization with too detailed questions, the decision was made to combine bus and train. Otherwise, the same mistake would be made as the already existing scans, which are too vague or too detailed and cause confusion. Instead, a weighted average is used to calculate the emissions of the category of public transportation. The weighted average has been calculated as follows:

According to CO₂emissiefactoren (2023), the diesel train has an average emission of 0.068 kg CO₂ per passenger-km based on an occupancy rate of 26%. In the Netherlands, all NS trains run on green electricity, without CO₂ emissions (NS & Eneco, 2017). Autoriteit Consument & Markt (2019) has done research about the market share per train provider and based on the passenger-km traveled in 2018, the NS has a market share of 95% and other train providers have 5% of the market share. Half of the 5% are diesel trains (Arriva, n.d.), which leads to a weighted average for all trains in The Netherlands of **0,0017 kg CO₂ per passenger-km**.

According to CO₂emissiefactoren (2023), the diesel city bus has an average emission of 0.098 kg CO₂ per passenger-km. As of 2020, 80% of the city buses drive on green electricity, which means that only 20% of the buses drives on diesel (Brinck, 2022). The weighted average of the busses in The Netherlands is **0,0098 kg CO₂ kg per passenger-km**.

In order to come to the weighted average for buses and trains, the above-mentioned emissions must be combined. In the Netherlands, in 2021 the total traveled km by bus and train was 13.7 billion; 10.2 billion km by train and 3.5 billion km by bus (Centraal Bureau voor de Statistiek, 2022). The share of the train is 74% and the bus has a share of 26%. The weighted average for the bus and train combined is therefore **0,0019 kg CO₂ kg per passenger-km**.

The bicycle and scooter are also combined in the V3 version of the scan. Bicycles do not have emissions; however, scooters do. For this category, a weighted average is calculated as well. This has been done as follows:

According to CO₂emissiefactoren (2023), a scooter has an average emission of 0.113 kg CO₂ per passenger-km. There are 17.59 million inhabitants in The Netherlands in 2022

(Centraal Bureau voor de Statistiek, 2023) and 1.325.072 scooters in 2022 (Centraal Bureau voor de Statistiek, 2022). This means that 7,5% of the inhabitants own a scooter. Assuming that 7,5% of visitors come by scooters, the weighted average for scooters and bicycles is **0,0084 kg CO2 per passenger-km**.

For the private car, taxi, and K&R, a weighted average has been calculated as well:

The CO2 emissions overview of CO2emissiefactoren (2023) has a list of all emissions of any type of car; small, medium, large, hybrid, diesel, electrical, etc. Since it is hard, almost impossible, to know as the event organization which type of cars are arriving, an average of all emissions is taken and used to calculate the average emission of a car. The average CO2 emission for a car is **0,138 kg CO2 per vehicle-km**. To calculate the average emissions per passenger-km, the vehicle-km must be divided by the occupancy rate.

The occupancy rate for a car is on average 2,7. This average has been calculated by comparing multiple modal splits received from MOJO (personal communication, 2023), and previous school projects, and it has been verified during the brainstorming session (F. Hommes, 2023). The average CO2 emission for a car is **0,0509 kg CO2 per passenger-km**.

The occupancy rate for a taxi is on average 2,3. This average has been calculated by comparing multiple modal splits received from MOJO (personal communication, 2023), and previous school projects, and it has been verified during the brainstorming session (F. Hommes, 2023). The average CO2 emission for a taxi is **0,0598 kg CO2 per passenger-km**.

The occupancy rate for K&R is on average 2,2. This average has also been calculated by comparing multiple modal splits from MOJO (personal communication, 2023), and previous school projects, and it is verified during the brainstorming session (F. Hommes, 2023). The average CO2 emission for K&R is **0,0625 kg CO2 per passenger-km**.

The CO2 emissions for Mobility as a Service, in the scan these are the touring cars, is **0,014 kg CO2 per passenger-km**. This is based on an occupancy rate of 48 people per touring car (CO2emissiefactoren, 2023; Leestemaker et al, 2023). The CO2 emissions for the shuttle service are the same as the weighted average emissions of the public transportation bus. This is because the buses used for the shuttle service are the same buses as the public transportation bus. The average emission for the shuttle service is **0,0098 kg CO2 per passenger-km**.

6.3.3 Interview with Maarten van Rijn

On March 15, a short interview with Maarten van Rijn took place. During this interview, the V3 version of the scan was discussed to gather the first round of feedback from an expert. He explained that the foundation of the scan is very simple: what you need to know is the traveled distance and the modality to calculate the CO2 emissions and with that the impact on the environment. Van Rijn calls this the 'fun lane', which is related to the layer model explained in the theoretical framework. The funlane describes the route the visitor takes from the bed to the

beer, and back from the beer to the bed. Figure 7 is the schematic overview of the route of the visitor, according to Van Rijn.

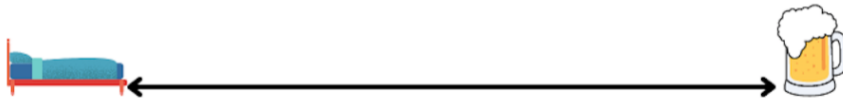


Figure 7 The "fun lane" by Van Rijn, personal communication (2023)

What is necessary for the scan, is to get insights into the whole journey of the visitor. It is important not to just look at the "last mile". The last mile is defined as the last kilometer the visitor travels to reach the event. What is done often, is that event organizations say that 50% of the visitors traveled via sustainable modalities. Most visitors walk the last part from the parking area to the entrance. In this case, the event organizations look at the last mile and state that most visitors arrived by foot, but they did not look further to where they came from, because then they would come to the conclusion that the visitors would have arrived by car instead of by foot. The reason why event organizations show the data from the last mile to the public is that it makes them look better (M. Van Rijn, personal communication, 2023). That is why this sustainability scan must focus on the complete route in order to get a transparent picture of the journey and the CO2 emissions that come with it.

Another aspect that Van Rijn mentioned during our conversation, was to not forget the airplane. The Netherlands is famous for its festivals and attracts many international visitors per year. The airplane has a huge impact on the environment, and therefore should not be forgotten according to Van Rijn (personal communication, 2023). Van Rijn also agreed that the scan must be easy to use for event organizations and have a structured look and feel.

Contributory, Van Rijn suggested doing an additional sample, to verify the data from Zicht op Data. As mentioned before, the first idea was to collect data from 10 festivals in Brabant. This idea was discussed during the interview with Van Rijn (2023), and his tip was to do an additional sample at those 10 events, or the ones that are manageable within the given timeframe, to verify the data received from Zicht op Data. This idea was discussed with LCB and at first, we decided that this was a good idea to gather extra data. Per festival, the sample size had to be a minimum of 377 people. This is based on a population of 20.000, an assurance level of 95%, and a margin of error of 5% (Alles Over Marktonderzoek, n.d.).

The idea was to ask 377 people per event where they come from and how they had traveled to the event. This would give an idea of the modal split, the traveled kilometers, and the corresponding CO2 emissions. However, after it was decided that only two festivals were going to be analyzed, 538 Koningsdag and Intents Festival, the idea of doing the sample got discarded; it would not be possible to gather a sample at Intents because it takes place after the deadline of this project. Hence, only gathering a sample from one festival would be inconvenient. This time

could be better spent on analyzing theories on how to influence the behavior of the visitors to choose a more sustainable modality. A full summary of the interview with Van Rijn can be found in Appendix 5.

6.3.4 Sustainability scan V4 and V5

The tips from Van Rijn were implemented into the sustainability scan; the airplane is added and the V4 version is created. The CO₂ emissions of the airplane were divided into three categories, 0-700 km, 700-2500 km, and 2500+ km. This is because the emissions differ per distance of the journey and per airplane (CO₂emissiefactoren, 2023). This idea was again discussed with LCB, and the conclusion was made that making the distinction between these three categories would be too detailed for the first pilot of the scan and could create confusion for the event organization. As the objective of the scan is to be easy to use, the emission of the airplane was defined as a standard Airbus-A320, the most common airplane within Europe (Luitwieler, 2020). The festivals in Brabant mostly attract national or European visitors, therefore the choice has been made to include the emissions of an Airbus-A320 for the pilot (Faber & Nelissen, 2008). In the future, this category could be expanded, depending on the demand of the sector (J. van de Pas & S. Kuipers, personal communication, 2023). In the V5 version, the airplane emission was brought back to only the Airbus-A320 model.

6.3.5 Brainstorming session March 29

On March 29th, the brainstorming session took place together with eight experts and professionals from the mobility industry. During the brainstorming session, the V5 version of the scan was shown. The objective of the brainstorming session was: “What variables do you keep in mind when deciding on the modal split?”. The goal was to validate the scan in order for it to be ready for the pilot measurement. They all came to the same conclusion; the variables of comfort and the ease of the journey determine the choice of modality.

“The last thing people think about is money. The ease of the journey is more important, if the journey is easy and comfortable, they will pay. ‘They’re going anyways’.” – Matthijs van Roekel, van Schaick (March 29, 2023)

Van Roekel explains that money does play a role in the decision-making process of the festival visitor, but he has seen from experience that comfort and ease are decisive. Besides that, the target audience of the festival is of relevance for the modal split.

“The number of visitors is important, but the target audience is of high importance in determining the modal split.” – Roy Hirs, Dutch Grand Prix (March 29, 2023)

Some people are more sensitive to pricing, and others refuse to travel by train and always take the car. Latin Village is an example of this, the target audience never travels by any other modality except their own car, no matter what the other options are (R. van Dijk, brainstorming session, 2023). When the modal split is finalized, the right measurements can be taken in order to

optimize the process of the journey of the festival visitor. In this process, comfort and ease are the key factors.

The second part of the brainstorming session was about validating the V5 version of the sustainability scan. In order to stimulate the experts, the scan was printed on A0 paper, and post-its were handed out. The group was divided into two smaller groups. Within these groups, the experts could write on the post-it what they think was missing, questions they had regarding the topics or anything else that might help in validating and finalizing the scan. A picture of the printed scans including all the feedback from the experts can be found in Appendix 6. The most important findings and feedback is mentioned below.

The most important feedback gathered from the brainstorming session is that the scan cannot be used to create a benchmark for similar kinds of festivals. As written before, the first idea was to categorize festivals and create an average to compare the festivals with. This cannot be done because there are too many variables the festivals are depending on, so they cannot be compared to each other. What can be done, according to experts, is to measure the festivals every year and compare them to those from the previous years (K. Toorenaar, brainstorming session, 2023). This way, progression or regression can be measured. The experts pointed out that some of the questions are more related to defining the willingness of festival visitors than to the actual measuring of CO2 emissions. The willingness of the festival visitor to choose a certain modality is something different than calculating the actual emissions; In order to make sure the scan is a baseline measurement per festival, the questions relating to the willingness were not relevant for the scan (F. Hommes, brainstorming session, 2023). Besides that, Van Rijn suggested pointing out certain variables within the scan for the event organization they can focus on. These variables should serve as handles for the organizations so they know what can be influenced to reduce CO2 emissions.

During the brainstorming session, it was also discussed how the result of the scan must be expressed in order for event organizations to understand it and be willing to work on it. All experts came to the conclusion that it does not matter how the results are expressed, kg or ton CO2, money, or trees, it matters what is done with the results. What must be avoided at all costs is to offer the possibility to compensate for the CO2 emissions by donating trees or money, because this does not solve the issue, it stimulates those who have money to continue working this way and “just” paying an extra fee (brainstorming session, 2023). Van Rijn and Vermolen (brainstorming session, 2023) suggested that every year, the festival organization must make sure the CO2 emissions are reduced by a certain percentage in order to get the permit. This is the only way to make organizations aware of the urgency of this topic.

So, it can be concluded from the expert session that there are many variables to take into account when designing the modal split and creating the mobility plan for an event. But there are only two variables to calculate the current impact of the modal split on the environment: the total traveled distance and the modality that was chosen. In the first versions of the scan, variables such as the distance to the train station, the availability of e-scooters, and the prices of parking tickets, were taken into account. However, after the brainstorming session, it was concluded that

these factors are more related to the willingness of festival visitors to choose a certain modality. The objective of the scan is to be transparent and give insight into the current CO2 emissions of the festival; factors determining the willingness of the festival visitor to give a second intention to the scan. To keep the scan easy to use, it should only focus on the current CO2 emissions; analyzing the willingness of the festival visitor is the next step in the process. The full transcript plus summary of the brainstorming session can be found in Appendix 6.

6.3.6 Sustainability scan V6

The feedback from the brainstorming session on March 29 is used to create the V6 version of the scan. Questions in the scan related to the willingness of the festival visitor have been removed, such as questions asking the distance between the entrance and the parking area, the price for a parking/shuttle ticket, and the number of available parking spots.

The scan now only focuses on calculating the CO2 emissions per modality. Since it was concluded during the brainstorming session (2023) that the only way of making organizations aware of the urgency of this matter, is to oblige them to reduce the emissions every year by a certain percentage. In the V6 version, all categories calculate the total CO2 emission, and in addition, the CO2 emissions per person in that category are added. The reason to add the total CO2 emission per person per category is to have a clear overview of which category is most polluting and to see in which category a lot can be gained. Having the emissions per person per category, and the average emissions per person in general makes it also easier to measure success in the future. The emission rate of Mobility as a Service and the shuttle service has changed as well. In the previous versions, the CO2 emissions per person per km were based on an occupancy rate of 48 for touring cars and 8,1 for shuttle buses (CO2emissiefactoren, 2023). For Mobility as a Service, the following calculation has been applied:

According to CO2emissiefactoren (2023), an average touring car has an emission of 0,0141 kg CO2 per passenger-km, based on an occupancy rate of 48. However, the most common occupancy rate for a standard touring car is 50 (MOJO, personal communication, 2023). Therefore, the emissions have to be adjusted to the right occupancy rate. First, the vehicle-km has been calculated: $0,0141 * 48 = 0,6768$ kg CO2. This must be divided by the actual occupancy rate: 50. The new emission rate for the touring car is **0,0135 kg CO2 per passenger-km**.

The same calculation is applied to the emission of the shuttle service:

Regular OV buses are used as shuttle buses (E. Vermolen, personal communication, 2023). It is not known what type of bus the shuttle bus is, therefore, the emission from CO2emissiefactoren (2023) of a standard bus is used: 0,089 kg CO2 per passenger-km. This average is based on an occupancy rate of 8,1 (CO2emissiefactoren, 2023; Leestemaker et al., 2023). The standard occupancy rate per shuttle bus is 80. First, the vehicle-km has been calculated: $0,0098 * 8,1 = 0,0793$ kg CO2. This must be divided by

the actual occupancy rate: 80. The new emission rate for the shuttle service is **0,0087 kg CO2 per passenger-km**.

For now, the touring car and shuttle service in the scan have a fixed occupancy rate. Of course, there are many different types of buses with different capacities. The pilot of the scan is meant to be easy to use, therefore, the standard busses are included in the scan. In the future, these categories can be expanded to all kinds of buses.

The last change is the division between electrical vehicles and gasoline vehicles. The distinction is made to get a more reliable outcome of the scan.

6.3.7 Last feedback LCB and the sustainability scan V7

On April 17, the last feedback is gathered from LCB regarding the scan and the last changes have been made. The V7 version of the scan is the final version. There are a few minor adjustments made with respect to the previous version. In the category “by foot” the questions related to the distance between the event and the closest bus/train station have been removed. These questions focus on the willingness of visitors, which is not the objective of the scan. These questions are relevant in the next stage, the influencing of the visitor part.

The scooter and bicycle are together in the scan. As written before, this choice was made since most event organizations do not know how many visitors arrive by scooter. Besides that, the data received from Zicht op Data does not offer insights into the use of scooters. They are able to make the distinction between a bicycle and a car, but not a scooter. Ruud Erhardt, CEO of Zicht op Data, says that this is because a slow scooter is just as fast as a fast bicycle (R. Erhardt, personal communication, 2023). Because a scooter is not a popular modality to use to travel to an event, and the distinction between a bicycle and scooter or car and scooter cannot be made with the bought data from Zicht op Data, it is decided that the scooter is eliminated from this category.

The category Mobility as a Service now only includes the touring car, but there are many more modalities that could fit within this category. The hard thing is that there is no fixed definition for this category, and most event organizations define it the way it fits them best (brainstorming session, 2023). A very common modality that could be included in this category is the shared e-scooter. The reason this modality is left out of the scan is that shared e-scooters, just as shared e-cars, etc., do not have any emissions and do not add anything to the results of the scan. The shared OV bicycle, which can be seen as a modality in this category, is already included in the bicycle category.

It might seem confusing why these electrical shared modalities are left out of the scan and the bicycle and foot are still included, even though both do not generate any emissions. The reason behind this decision is that by foot and by bicycle are two main categories included in the modal split and the STOMP theory. These two modalities are very common for visitors to choose from. In the future, the electrical shared modalities could be part of the scan, just like the metro and tram. Nonetheless, this first pilot of the scan must be easy to use and not create confusion for event organizations, so the decision is made to remove modalities that are not common to use.

The last change is that the squares that need to be filled in by the event organizers are grey now. The rest of the cells are locked so the formulas stay intact.

6.3.8 Conclusion

Within the whole process of creating the sustainability scan, the method of trial and error was central (Young, 2008). Every version of the scan can be seen as a new attempt, a new trial, in creating the scan. Every version of the scan was then reviewed in interviews, by colleagues from LCB, and during the brainstorming session, and the errors were found. In the end, it has led to the final scan, V7, which is used as a pilot when analyzing 538 Koningsdag and Intents Festival. A schematic overview of this process is shown in Figure 8.

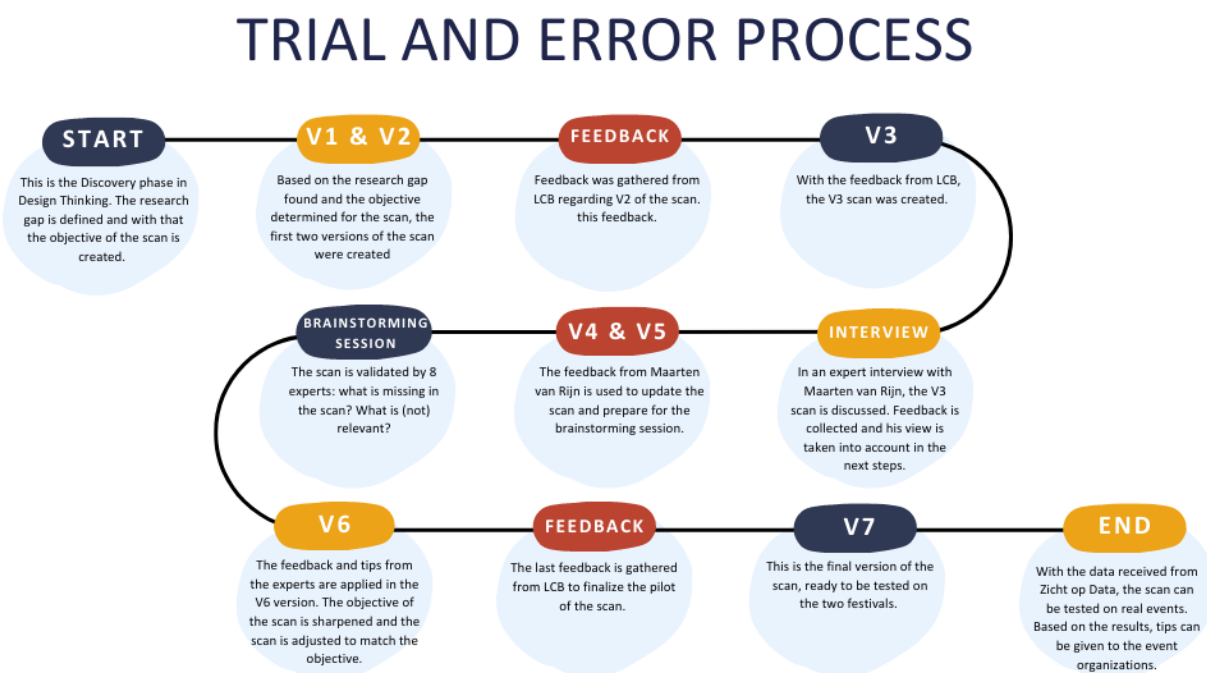


Figure 8 Trial and error process

6.4 Analyzing 538 Koningsdag and Intents Festival

This subchapter goes into depth about 538 Koningsdag 2022 and Intents Festival 2022. The data received from Zicht op Data was used to fill in the sustainability scan. This is the pilot of the sustainability scan on two real events. Based on the results of the scan, the current situation of both events is shown. The results of the survey are used to come to conclusions, possible recommendations, and pitfalls for both events. The choice to send out a survey was made in consultation with LCB and during the interview with Paul (personal communication, 2023). An online survey is chosen because it is easy to use, for both the participant and me. The survey helps to understand what the gross of the population thinks; the maximum duration they want to travel per modality. It is important to understand the motivation of the gross of the population

and not the specific opinion of one expert, because the measurements must apply to a huge population (Baarda, 2020).

The expert interview is described in subchapter 6.4.1. The results of the survey are explained in subchapter 6.4.2. Subchapter 6.4.3 analyzes 538 Koningsdag 2022 and subchapter 6.4.4 analyzes Intents Festival 2022.

6.4.1 Interview with Paul van de Coevering

On April 7, an online interview took place with Paul van de Coevering. He is a lecturer at the BUas and is specialized in Urban Mobility Planning and travel behavior. The objective of the interview was to gain insights into the travel behavior of festival visitors and their willingness to choose a certain modality. During the interview, Van De Coevering explained that it is possible to create an ideal modal split based on the origin of the visitors and the maximum duration people are, in general, willing to travel per modality. To find out more about the willingness, a survey was sent out later to gather the opinion regarding the maximum travel duration. This information is used to find out what the ideal situation could be for both 538 Koningsdag and Intents Festival. The total summary of the interview can be found in Appendix 7.

6.4.2 Results of the survey

The survey held was meant to get insights into the maximum duration festival visitors are willing to travel to the event per modality. Besides the maximum duration of the journey, the participants were asked to rank multiple modalities from “most favorable” to “least favorable” and to grade on a Likert scale from 1 – 7 the “Duration of the journey”, “Price of the journey”, “Comfort of the journey”, “Travel experience”, “Safety of the journey”, and “Reliability of the type of transportation”. These questions were meant to find out which variables festival organizations must focus on most to have as many visitors choose the most sustainable mode of transportation.

In the survey, a distinction was made between one-day events and weekend events. This was done because two events are analyzed in this project, 538 Koningsdag and Intents Festival. It is interesting to see if festival visitors have a different travel behavior for both types of events. Conclusions could be made based on the results of the survey to give tips and tricks to 538 Koningsdag and Intents Festival. This is useful information for event organizations since they can adjust their marketing strategy to reach the right people with the right advertisement.

The survey had 77 answers in total. After reviewing the answers and “cleaning” the data (removing those who did not fill in the survey completely or did not fill it in seriously), 67 responses remained, 21 are male and 46 are female, see Figure 9. They are mainly between 18 and 25 years old and visit on average 5 festivals a year. From this, it can be concluded that they are regular festival visitors who are familiar with travel procedures and know their preferences. These diagrams can be found in Appendix 9.

What is your gender?

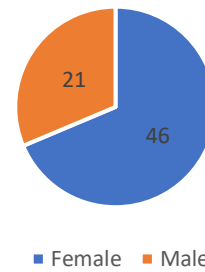


Figure 9 Gender division survey results

What is interesting is that, in general, is that for one-day festivals people prefer to travel by touring car or public transportation, besides walking and bicycling, see Table 2. The table shows the modalities the participants could choose between on the left, and how many times these modalities have chosen as a certain option at the top. The green marks the most chosen modality as choice 1 and so on. So, the most favorable mode of transport is “walking”, chosen 17 times as the first option.

Table 2 Ranking choice of modality for a one-day event

Modality	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5	Choice 6	Choice 7
Walking	17	10	13	5	7	7	8
Bicycle	14	18	11	6	7	9	3
Public transport	8	12	13	12	11	6	5
Touring car	5	4	11	20	13	10	4
Taxi	3	4	5	6	10	11	28
K&R	11	11	10	7	6	18	4
Car	9	8	4	11	13	6	15

Visitors are on average willing to travel about 60 minutes by touring car and public transportation. For festival organizations, this is important to know so they can arrange designated touring cars for those festival visitors to prevent them from taking the car. Please find these diagrams in Appendix 9.

The variables that matter most are the price and the reliability of the mode of transport, see Table 3. The third most important aspect of the journey is the duration. Since for one-day visitors, the maximum duration they are willing to travel by public transport and the touring car is about

one hour it is important to keep arrange fast and reliable transport for visitors to reduce the use of the private car.

Table 3 Influence of the variables - one-day event

Variable	Average point on a scale of Likert
Duration	5.0
Price	5.4
Comfort	5.0
Experience	4.0
Safety	4.8
Reliability	5.1

The survey pointed out that weekend festivals struggle more. It can be concluded that most visitors prefer to travel by car or get dropped off at the festival, as can be seen in Table 4. Their third choice is the touring car. What is interesting, is that weekend visitors are willing to travel just as long by car as by touring car, for about 85 minutes. Visitors are also willing to pay between 15€ and 20€ for car parking and touring car tickets. Event organizations must take this into account and organize designated touring cars from the biggest cities within an hour's radius of the event to reduce the number of private cars and get those visitors into the touring cars.

Table 4 Ranking choice of modality for a weekend event

Modality	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5	Choice 6	Choice 7
Walking	9	3	2	5	8	14	26
Bicycle	3	9	8	10	10	23	5
Public transport	7	12	14	15	12	4	4
Touring car	5	9	15	18	10	8	2
Taxi	1	2	10	11	18	8	16
K&R	12	19	9	5	6	10	5
Car	30	13	9	3	3	0	9

Besides the touring car as a third choice, public transportation is the fourth choice for weekend visitors. Again, the duration of the journey by public transport can be a maximum of 85 minutes, just as the car and the touring car. According to the results of the survey, price and the reliability are once again the most important variables, as can be seen in Table 5. The duration of the journey is less important. It would be smart for event organizations to take into account the price and reliability of the touring car and public transportation to decrease the use of the private car.

Table 5 Influence of the variables - weekend festival

Variable	Average point on a scale of Likert
<i>Duration</i>	4.7
<i>Price</i>	5.3
<i>Comfort</i>	5.1
<i>Experience</i>	4.3
<i>Safety</i>	4.8
<i>Reliability</i>	5.3

In the next subchapter, the maximum duration per modality is going to be compared to the origin of the festival visitors of both 538 Koningsdag and Intents Festival to create the start of the ideal modal split.

6.4.3 538 Koningsdag 2022

The data regarding the passenger movements toward 538 Koningsdag was received from Zicht op Data. This data was supposed to give insight into where the visitors were from (their origin) and their mode of transportation. Four areas were mapped out and sent to Zicht op Data:

- Breda Station
- The festival area
- The Kiss & Ride + Taxi
- The touring car

Based on the movement, and the cross-visits between these areas, it was supposed to become clear what the modal split was of the event. This information could have been used to complete the sustainability scan as a pilot on a real event. Unfortunately, there were some difficulties with receiving the data. The data arrived three weeks later than agreed, on April 26, and was incomplete. The data set received first gave insight into which municipalities the visitors were from instead of the postcode 4 level it was supposed to be. Knowing the origin in postcode 4 level gives a better understanding of the mode of transportation one may have chosen. However, the postcode 4 level data were not available since it cannot be measured that specifically as it turned out after receiving it. Another downside with the origin on the municipality level is that the numbers are based on GSM trackings found on the event day. By using certain algorithms, the data is made representative (R. Erhardt, personal communication, 2023), but that means that LCB did not receive the raw data. Requesting this data is an option but it would not be ready within the timeframe of this project. Therefore, the choice was made to compare the origin of the visitors to the maximum duration visitors are willing to travel from the survey. This way, it becomes visible which municipalities most people come from and what ideally their mode of transportation could be. For this, TravelTime (n.d.) is used to calculate the radius around the festival area.

In Figure 10, the maximum travel duration for the modalities bicycle, car, and public transportation are mapped around Chasséveld in Breda. The orange area marks everything within an 85-minute radius of the festival area by car. The pink area marks everything within an 85-minute radius by public transportation and the blue area marks everything within a 30-minute radius by bicycle. These distances are based on the results of the survey, which can be found in Appendix 9. The red pointers point to the municipalities which were most

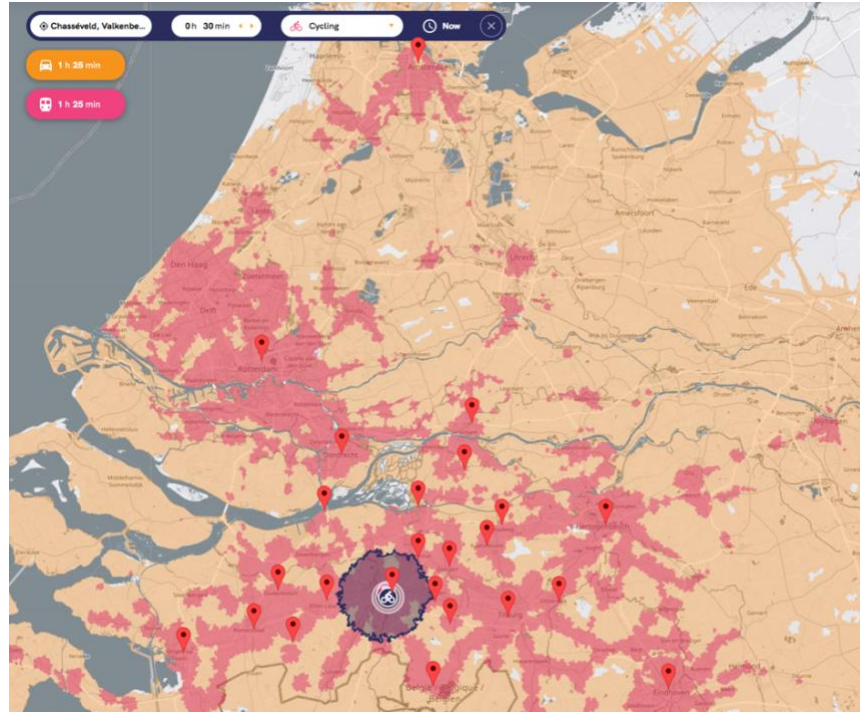


Figure 10 Radius maximum travel duration around Chasséveld plus the most present municipalities

represented at the event. This information is based on the report received from Zicht op Data about 538 Koningsdag. The full document can be found in Appendix 10. The touring car, taxi, and Kiss & Ride are not mentioned separately on the map, because they all drive the same routes and at the same speed as a car.

What is visible, is that everyone is from areas that are within the travel distance of public transportation. For 538 Koningsdag, this means that they must focus on these target audiences and make sure that the use of cars is relatively low. This can be done by making arrangements with public transportation companies to ensure enough trains are departing from the municipalities most visitors come from. It is important that those connections must be optimized since the use of public transportation between those cities is huge compared to other modalities. For visitors from Amsterdam, it could be that they come by car since it is further away, but it might be interesting to offer combination packages to them to stimulate them to take the train toward the event. It could be interesting to arrange designated coaches from bigger cities like Eindhoven, Rotterdam, or Amsterdam to avoid the use of private cars or Kiss & Ride. What is advisable, is to arrange a coach that stops at multiple cities or villages on the route since there are not that many visitors from these cities. If the coach has multiple stops to pick up people, it can most likely be fully occupied and the use of it is optimized.

Most visitors at 538 are from Breda itself or the surrounding villages, see Figure 11. As visible in Figure 10, the surrounding of Breda is within the radius by bicycle. For 538 Koningsdag, it is important to offer enough bicycle parking spots to ensure a safe parking area for everyone.

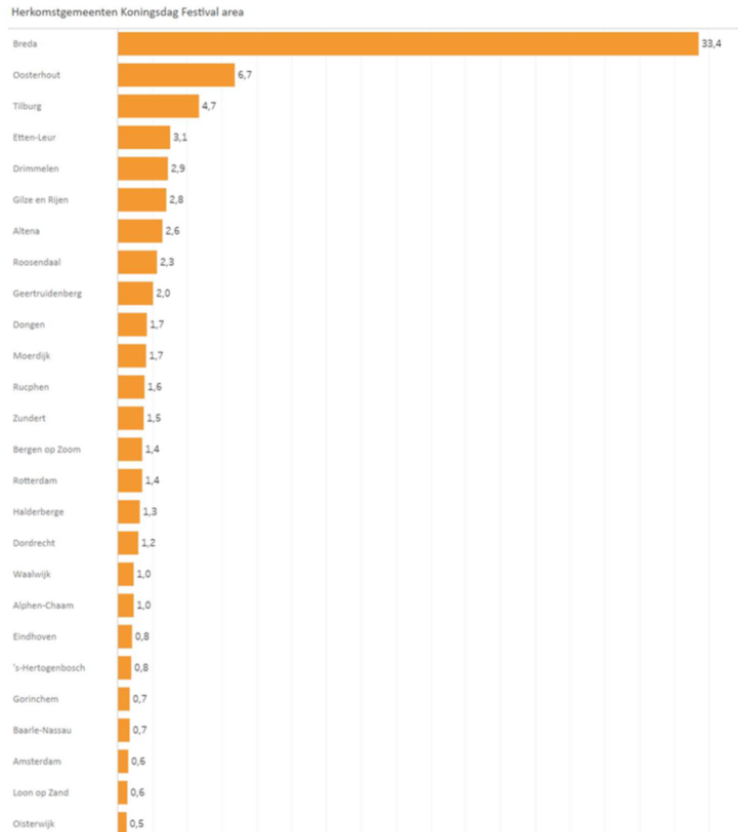


Figure 11 Origin 538 Koningsdag 2022

To conclude, based on the results of the survey and the origin of the visitors, 538 Koningsdag is organized at a great location since it is easy to reach by train, and their target audience is located in and around Breda. For 538 Koningsdag, this means that they could remove the parking facilities they had in the past years and fully focus on promoting sustainable travel. A pitfall could be that there are not enough bicycle parking spots available for the people from the neighborhood. Another pitfall is that the event attracts a younger target audience, who makes use of the Kiss & Ride facility. To prevent the use of Kiss & Ride, a discount can be given on train tickets or the parking facility of the Kiss & Ride must be located further away from the event than the train station. The price, reliability, and duration of the journey are the top three most important variables, according to the results of the survey. Relevant measurements can be taken to stimulate the use of sustainable modalities, keeping these variables in mind. Subchapter 6.5 goes further into detail about how to influence the behavior of the visitor.

6.4.4 Intents Festival 2022

For Intents Festival, the same approach is used as 538 Koningsdag. Here again, the data received from Zicht op Data made it hard to analyze the event the way it was supposed to. Intents Festival is a weekend festival, the mapped areas are:

- Station Oisterwijk
- The festival area
- The camping

- The weekend car parking
- The day car parking
- The Kiss & Ride
- The taxi stands
- The bicycle parking

For Intents Festival, the touring car parking is not identified since the exact location could not be found online. The decision was made to leave it out of the analysis instead of possibly analyzing the wrong area. Based on the movement in the above-mentioned areas, and the cross-visits between these areas, it was supposed to become clear what the modal split was of the event. Again, the data received is about the origin of the visitors per municipality and not on the postcode 4 level. Also, the raw data is not received, and could not be received on time. The choice was made again to compare the origin of the visitors to the maximum duration they are willing to travel per modality. This way, it becomes visible which municipalities most people come from and what ideally their mode of transportation could be. For this, TravelTime (n.d.) is again used to calculate the radius around the festival area.

It is possible to visit Intents Festival the whole weekend or to go for just one day. The parking area for the weekend visitors and the day visitors is different. However, these are located not too far from each other; it barely has an impact on the radius. Therefore, there is no distinction made between these two parking facilities when calculating the radius. It has also become clear from the data that the day parking isn't used that often. From the cross-visits, it became clear that only 2% was seen at the day parking and the festival terrain. Hence, it can be concluded that most visitors stayed at the camping or did not travel to the event by car for just one day. The radius used in this analysis is the radius from the weekend parking area.

In Figure 12, the maximum travel duration for the modalities bicycle, car, and public transportation are mapped around the festival area, weekend parking, and the train station Oisterwijk. The orange area marks everything within an 85-minute radius of weekend parking by car. The blue area marks everything within an 85-minute radius of the train station by public transportation, and the pink area marks everything within a 30-minute radius of the festival area by bicycle. These distances are based on the results of the survey, which can be found in Appendix 9. The touring car, taxi, and Kiss & Ride are not mentioned separately on the map, because they all drive the same routes and at the same speed as a car. The red pointers point to the municipalities which were most represented at the event. This information is based on the report received from Zicht op Data about Intents Festival. The full document can be found in Appendix 10.

What is interesting to see is that the target audience is mostly from around Oisterwijk and within North Brabant. These municipalities are all located within the radius of public transportation. Since it is a weekend festival, and almost a third of the visitors will stay at the camping (Response, 2022), it is important to keep in mind that the visitors will bring their belongings as well. Arranged transportation must be convenient enough so visitors can bring their camp materials. Comfort is one of the variables that weekend visitors see as important (brainstorming session, 2023; survey

results). A luggage service could be an option to stimulate those from the surrounding villages to come by bike (ecolibrium, 2020).

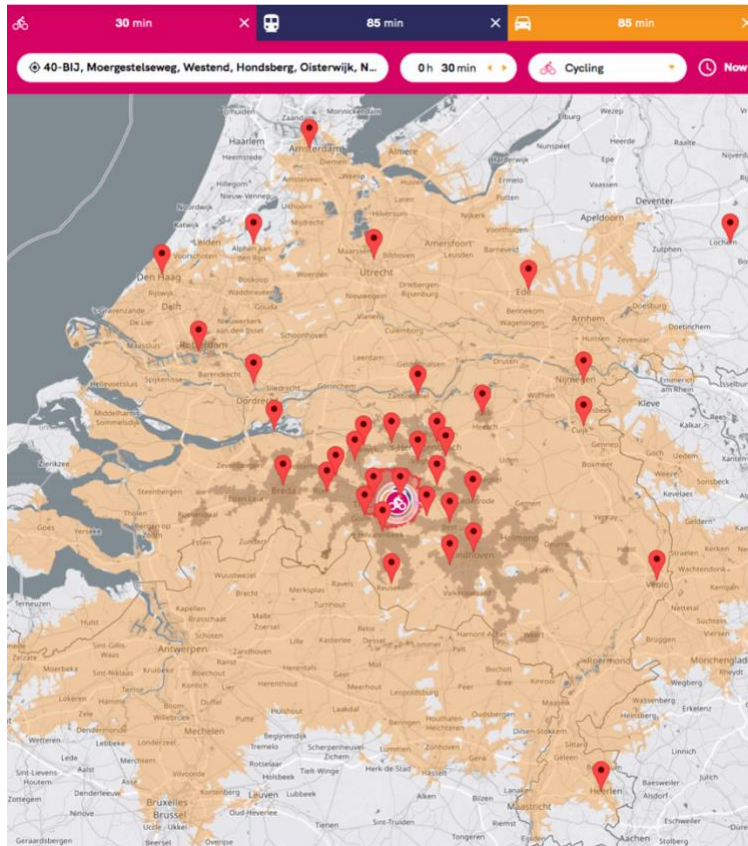


Figure 12 Radius maximum travel duration around Intents Festival per modality plus the most present municipalities

Another finding that is interesting for Intents Festival is to make use of designated coaches. It is possible to organize your own bus and inform the festival about this (Intents Festival, n.d.). However, since people can be lazy or forget about this option, it might be better for Intents Festival to offer this service themselves. As visible, there are visitors coming from far away and from big cities such as Amsterdam, Den Haag, Rotterdam, Venlo, and Heerlen. These cities could easily be combined in a designated touring car trip.

The cross-visits per day can be found in Figures 13, 14, and 15. To read the table, the first step is to look at the horizontal axis and then the vertical axis. E.g., 0.34% has first been seen at the bicycle parking and then at the camping. It is visible that on Friday when the camping opens, visitors have been seen at the bicycle parking and the camping. This does not apply to Saturday and Sunday, no one from the bicycle parking has been seen at the camping afterward. This means that a small number of visitors traveled to the festival with their camping equipment by bicycle on Friday. Another remarkable finding on Friday, no one is seen at the day parking and then at the festival area. Most visitors were seen at the weekend parking plus camping and then at the festival area. This means that there are barely any day visitors on Friday arriving by car and those who do stay at the camping. On Friday, the biggest cross-visits are between the bicycle parking,

Kiss & Ride, taxi stand, and the festival area. It can be concluded from this that the day visitors on Friday arrived by these modes of transportation.

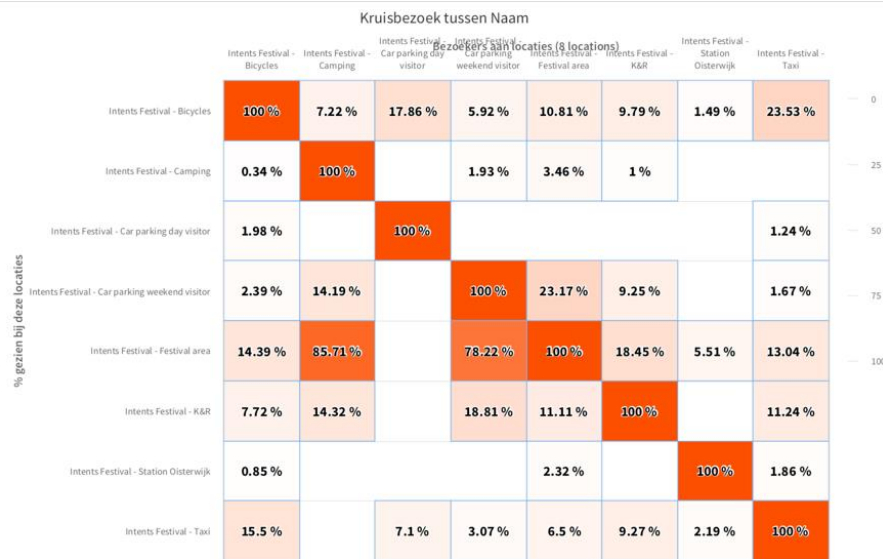


Figure 13 Cross-visits Friday Intents Festival

The train was used more often on Saturday, compared to Friday and Sunday. This is mostly because Saturday attracts the most day visitors. Saturday and Sunday do attract more day visitors than Friday in general. It is also striking that on both Saturday and Sunday, the cross-visits between the bicycles and the festival area are higher as well. It can be concluded from this that on both days, many visitors arrive by bike. The taxi and Kiss & Ride cross-visits are still high for both Saturday and Sunday, see Figures 14 and 15. As visible in Figure 16, the origin of the visitors, most of the visitors are from the surrounding municipalities which are within the radius of bicycling. Intents can use this information and maybe offer extra incentives to stimulate visitors to keep coming by bicycle and attract others to do the same as well.

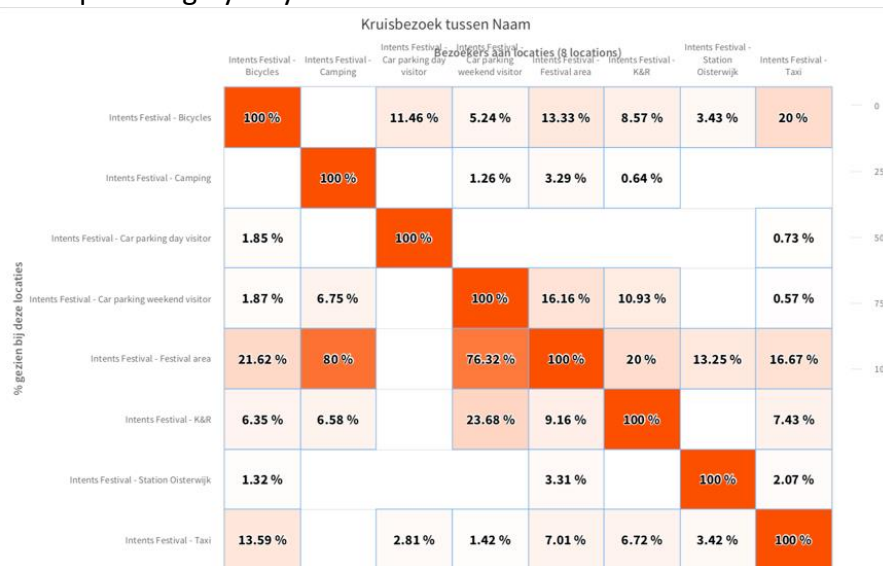


Figure 14 Cross-visits Saturday Intents Festival

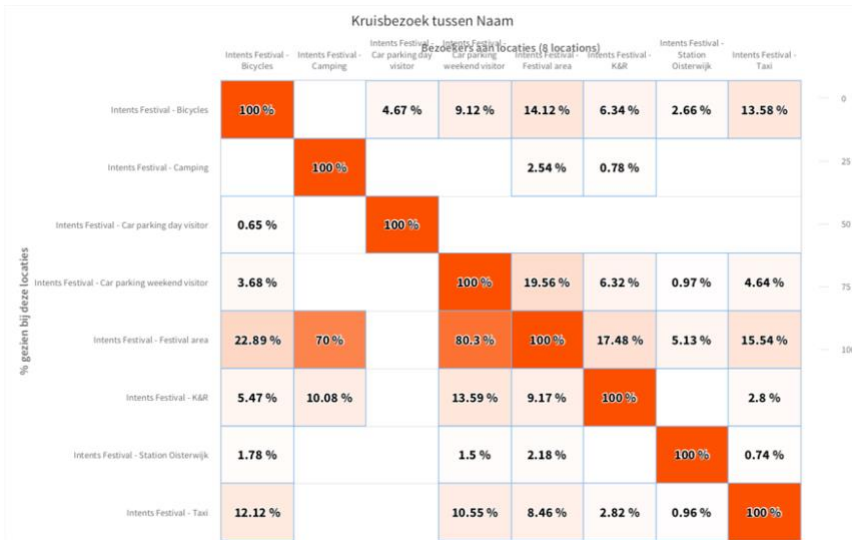


Figure 15 Cross-visits Sunday Intents Festival

To conclude for Intents Festival, based on the results of the survey and the origin of the visitors, the event isn't located at a very convenient spot. What is difficult for Intents Festival is that it takes place at a hard-to-reach location. That, as well as the fact that many people prefer to travel by car since they need to bring their camping materials, makes it difficult for the event to reduce CO2 emissions and stimulate visitors to take the train or bicycle. As a result of the survey, +85% say they are willing to travel by touring car/coach if one is available. The touring car also is their third choice of the modalities, as long as the price is not too high, and it offers comfort. For Intents Festival, this means that they must organize these touring cars themselves to show the visitors that this option is available, and it doesn't cost them extra time or money.

For Intents Festival, it is useful to know on which day most visitors will arrive by a certain modality. Compared to the maximum duration they are willing to travel, suitable measurements can be taken to stimulate sustainable transport. It is interesting for Intents to offer combination packages to those who travel by train, especially on Friday since no one takes the train then. To stimulate the use of the bicycle, the luggage service could be an option. Most visitors are from surrounding municipalities, see Figure 16, and are within bicycle distance of the event. Extra luggage services could make them decide to leave the car at home.

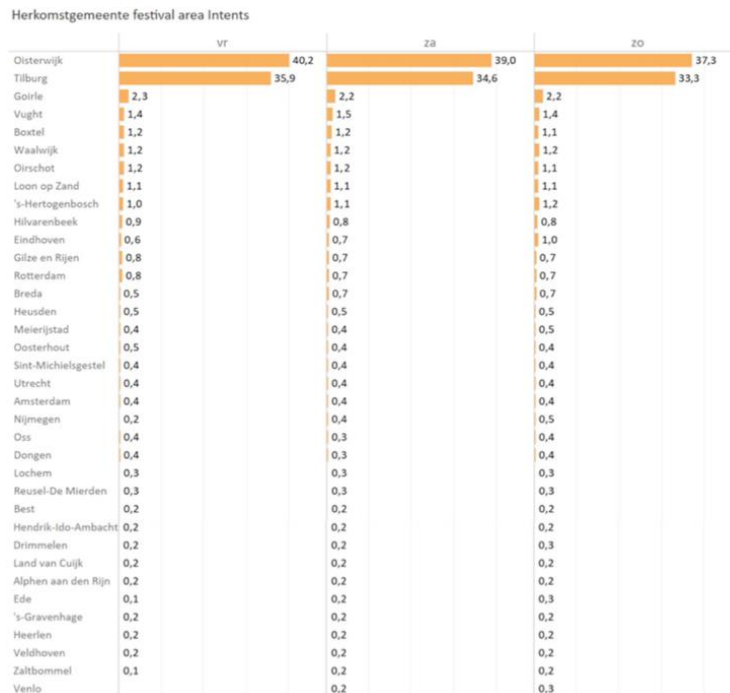


Figure 16 Origin Intents Festival 2022

The next subchapter goes further into detail about the “pains” seen in the sector related to mobility and the “gains” to solving the problems and influencing the behavior.

6.5 Influencing the behavior of the festival visitor

With the sustainability scan finished and the data received and analyzed from Zicht op Data, the last step is influencing the behavior of the festival visitor to choose a more sustainable modality. This part is crucial in the process, so far hardly any event organizations have mastered fully influencing the behavior of the visitors (Van Roekel, brainstorming session, 2023). In order to give meaning to the results of 538 Koningsdag and Intents Festival, tips are given on how to make the modal split more sustainable. The first subchapter, 6.5.1, shines a light on the “pains” experienced in the event sector. Organizations are already trying to be more sustainable, but not always with luck. Without understanding the pains, it is hard to create solutions. Subchapter 6.5.2 offers possible solutions on how to turn these “pains” into “gains” by looking at examples of events that worked out. Subchapter 6.5.3 concludes with tips for 538 Koningsdag and Intents Festival on how to make their mobility plan more sustainable.

6.5.1 Pains

During the brainstorming session on March 29, it was concluded that the variables “comfort and the ease of the journey” are the most important to festival visitors. But the pains experienced in the sector were also discussed. This subchapter sums up the most experienced pains in the sector by the experts and literature studies.

Usually, the shared modality options or **public transportation hubs aren’t located at the most convenient spots**. This makes them difficult to reach the visitors and therefore they are looking into other options to reach the event (ecolibrum, 2020). Other “pains” that came to light during the brainstorming session were that the **festival crowds are too individualistic and flexible**. Festival visitors buy many tickets for lots of events but only decide last minute which event to attend and they sell the remaining festival tickets. A reason for this is that there are **too many festivals** taking place every weekend. This leads to an increase in the ‘no-show’ numbers since visitors buy tickets for multiple events and decide last minute where to go. This also makes it difficult for event organizations to know what to expect.

“People buy a ticket because “they might want to go”. They don’t feel the obligation to go, it is a generation thing. They see if they feel like going, there are just too many options.”
– Kiliaan Toorenaar, Close App (March 29, 2023)

Besides that, there is just **not enough capacity on the roads** or around events to create parking places according to Hommes (brainstorming session, 2023). What is also difficult according to the experts, is that festival visitors have **less trust in public transportation** (M. van Roekel & W. Giessen, brainstorming session, 2023). Since the trust level in public transportation has significantly decreased, an increase is found in the number of Kiss & Ride drop-offs (M. van Roekel, brainstorming session, 2023). This development is important to keep in mind when trying to influence the behavior of the festival visitor.

Another problem is that the current **infrastructure for public transportation is not sufficient** enough for festivals taking place in rural areas. These locations are hard to reach and the journey takes longer. Public transportation usually stops early in these areas, it is **not aligned with the timetables of the event**, which makes it impossible to stay till the end of the event and catch your train home (ecolibrium, 2020).

The above-mentioned “pains” are all related to the pyramid of needs by Van Hagen & Van Hagen (2011). In Figure 17, the most frequently experienced pains are connected to the different layers of the pyramid. The pyramid must be read from the bottom to the top; safety and reliability must

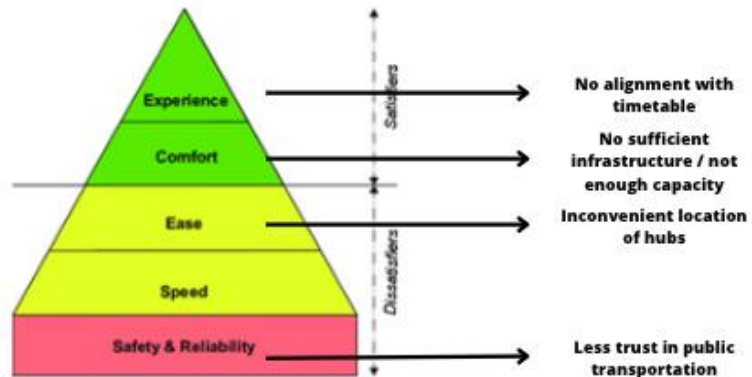


Figure 17 Pains related to the Pyramid of Customer needs (Van Hagen & Van Hagen, 2011)

first be established in order to go to the next level, speed, etc. The same goes for the pains; the trust in public transportation must first be restored in order to focus on the next pain: the inconvenient location. If the pain cannot be resolved, the other pains must be solved well enough to make up for the rest.

6.5.2 Gains

This subchapter provides possible solutions for the previously mentioned pains. These solutions are based on literature studies, examples from events, and the brainstorming session held on March 29.

The biggest pain in the sector is that there is less trust in public transportation by the festival visitor. This leads to an increase in the use of K&R or other modalities (M. van Roekel & W. Giessen, brainstorming session, 2023). Festival organizations can **give incentives to festival visitors** who travel by public transportation; for example, a fast-track entry for those arriving by train, or extra coins to buy beers (ecolibrium, 2020). Combination packages, or discounted public transportation tickets, are an incentive for visitors as well. Study shows that 42,7% would travel via public transportation if there is a discount on the tickets (Powerful Thinking, 2020).

A strategy to tackle the issue of the inconvenient location of the transportation hub is to **improve the first and last mile** of the journey. People will choose to take the train only if the first and last mile, the journey to the station and from the station to the event, is fast and convenient (European Environment Agency, 2020). A solution is to offer discounted shared vehicles, such as GO Sharing or Felyx scooters to reach the train station. These shared vehicles are not available in most small villages. If this is the case, a **shared touring car or coach** can be used to travel to the event. This coach passes multiple smaller villages where visitors can get on the coach and travel

straight to the event. Festivals such as Shambala Festival and Boomtown have successfully decreased their carbon footprint by 10% by implementing more designated coaches traveling to the festival (Powerful Thinking, 2020). It can also be concluded from the results of the survey that about 85% of the visitors are willing to travel by touring car if there is one available.

Another pain that was found is the insufficient infrastructure of public transportation, especially for events taking place in rural areas (ecolibrum, 2020). Events are hard to reach due to the inconvenient time schedules of trains or shuttle services, the travel time is usually much longer when taking public transportation instead of driving by your own car. And according to the results of the survey, the reason visitors do not want to travel by public transport or bicycle is because of the hassle of bringing your own equipment. To tackle this problem, SNNTG Festival in Hanover has offered **free bikes** from the closest public transportation hub and a **free luggage shuttle** for those staying at the camping to encourage visitors to leave their cars at home (Powerful Thinking, 2020). Another solution is to **offer pre-setup tents** so visitors would not need to carry too much and be able to come by train then (ecolibrum, 2020).

To deal with capacity issues, **first and last-mile improvement** can be applied as well. It was concluded during the brainstorming session that there is not enough capacity around events to use as a parking area. Hirs (brainstorming session, 2023) has said that there is plenty of capacity left in the trains, and this should be used by event organizations. To incentivize visitors to take the train, the first and last mile should be optimized to make this option more attractive. Another solution is to offer **incentives for cars to be fully occupied** (Powerful Thinking, 2020; ecolibrum, 2020). This way, fewer parking spots need to be arranged. Another incentive can be to offer **free parking for electric cars and provide electric car charging** (brainstorming session, 2023).

Besides these possibilities, it is always key for event organizations to **create awareness amongst the visitors** about the impact of their journey on the environment; it is most likely that more visitors will then choose a more sustainable modality. **Extra services** must be offered as well to make sure the timetables of the event are aligned with the public transportation departing times.

The above-mentioned solutions can be linked to the STOMP principles (CROW, 2021), see Figure 18. The STOMP principles are an easy and useful tool to evaluate your modal split and focus on the most sustainable travel options first.

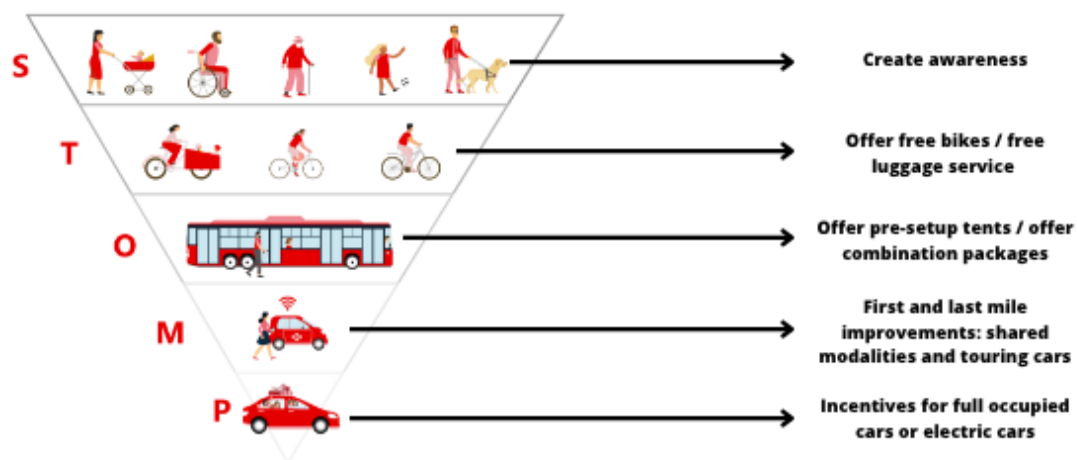


Figure 18 Gains related to the STOMP principles (CROW, 2021)

The STOMP principles also help prioritize the solutions. In this case, it is necessary to already start creating awareness regarding visitors' travel choices. The next step would be to offer free bikes to oversee the last mile and also offer a free luggage service with it. As seen in the results of the survey held, festival visitors do want to travel by bicycle if possible, but only without camping gear. The free luggage service will stimulate them to still come by bicycle. Another possibility is to offer pre-setup tents and offer combination tickets for public transportation and the festival itself. This way visitors are stimulated to come by bicycle and public transport. To improve the use of Mobility as a Service, the first and last mile must be improved. Lastly, there can be incentives for those who arrive with a fully occupied car or electric car.

7. Conclusion

Improving sustainable mobility options and reducing CO2 emissions is an ongoing process, but there is still a lot to learn. With the current tools available, the first steps can be made, but there is still a lot to gain. The sustainability scan developed in this project is the first step to being transparent and offers insight into which modalities are the most polluting, but it also offers the possibility to measure success or failure per event. The scan has the potential to be the start of a sustainable future.

The problem statement as formulated at the start is *“How can we reduce CO2 emissions from passenger traffic to and from an event?”*. The answer to this question is straightforward, after the insights gained from this research: event organizations must use the sustainability scan every year to measure their CO2 emissions in general and per modality. Based on the result of the scan, and the most polluting modalities, fitting measurements must be taken, keeping the STOMP principles in mind here. Even though the answer is straightforward, the process is quite difficult. It is not easy to influence the behavior of festival visitors and steer them toward your vision. Nevertheless, the CO2 emissions can be reduced by applying the sustainability scan to your event, understanding the travel behavior and wishes of your target audience, and implementing the right measurements. These steps are visualized in Figure 19 and are summarized in the Sustainability scan manual, created as an end product for LCB.

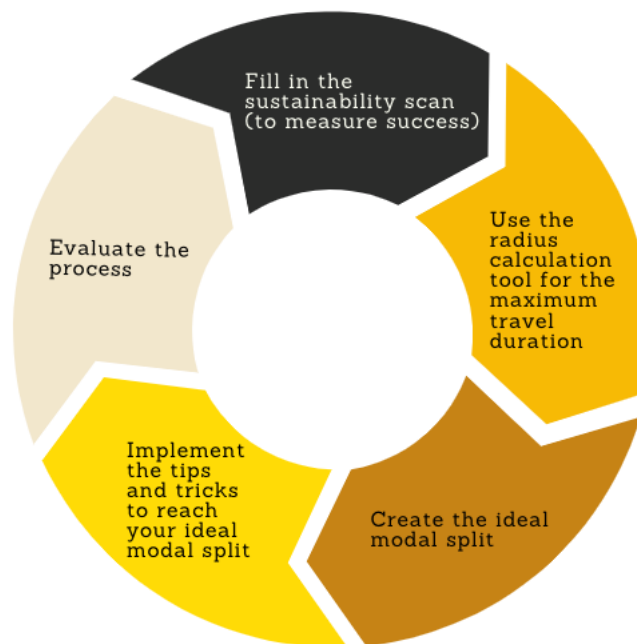


Figure 19 Visualization of the sustainable mobility process

The Sustainability scan manual is a small booklet with a step-by-step overview on how to use the scan. It has a clear and structured approach and explains how to read the results. It also provides the tips and tricks that came to light during the research and summarizes them for future use for event organizations.

8. Limitations

There are a few limitations to this research. First of all, the scan is not complete yet. There are many other modalities that could be included in the scan to get the greater picture. As mentioned by Vermolen (personal communication, 2023) there are many different types of busses that can be used as shuttle services or touring cars. This scan uses the most common bus, but in the future, it is better to include multiple types of buses to make the scan more accurate. It was not feasible within the given timeframe to include other modalities since that information is not publicly available. Another reason why the other modalities are left out of the scan is that this is only the pilot version. It is better to first focus on creating the right foundation for the future and then add more factors to it. That is why the scan as well only focuses on CO2 emissions and no other polluters; it is better to have a great foundation for the future on which others can build.

What is also not included in the scan is if festival visitors stay in the city of the event after it is over, e.g., book a hotel close to the event or stay with friends who live close. Some festival visitors travel back by a different modality than they came with. This is hard to distinguish from the data received from Zicht op Data. This of course influences the CO2 emissions. In the future, if festival organizations will use this tool themselves, they have more insights into the travel behavior of the visitors and they can take this aspect into account.

The maximum duration visitors are willing to travel per modality is based on the results of the survey. However, the survey has got 67 useful responses. It must be kept in mind that this is not representative of the whole events sector. More research must be done in the future to confirm this data.

The data received from Zicht op Data has a few limitations as well. The data was supposed to show the movements to and from the event and make the distinction between walking, bicycle, and car. Certain areas were marked and given to Zicht op Data, they calculated the movements within these areas and the cross-visits between those areas. Based on the movement in these areas, and the cross-visits between these areas, it was supposed to become clear what the modal split was of the event. This information could have been used to complete the sustainability scan as a pilot on a real event. As written before, there were some difficulties with receiving the data. The data arrived three weeks later than agreed and it was incomplete. The data received at first gave insight into which municipalities the visitors were from instead of the postcode 4 level it was supposed to be. Knowing the origin in postcode 4 level gives a better understanding of the mode of transportation one may have chosen. However, the postcode 4 level data are not available since it cannot be measured that specifically as it turned out after receiving it. Another downside with the origin on the municipality level is that the numbers are based on GSM trackings found on the event day. By using certain algorithms, the data is made representative (R. Erhardt, personal communication, 2023), but that means that LCB did not receive the raw data. Requesting this data is an option but it would not be ready within the timeframe of this project. LCB does know now what to expect of the data and what it will look like. For future research, this must be kept in mind and used. Next time, the data must be requested in a different form to be useful immediately.

9. Reflection

At the start of the graduation project, I had no idea how to start and what to expect. The subject was chosen in consultation with LCB, and after doing a bit of desk research, I had no idea what to expect. Sustainability is a very broad and popular topic, which makes it easy to find information about it, but hard to select the right approach. The four months went by very fast and I believe I managed to combine different research techniques to come to this end product. There were a few setbacks that held up the process a bit; most of them were related to the data analysis being more difficult than expected at the beginning, as written in the previous chapter Limitations.

The data we wanted to have was impossible to get from the event organizations themselves. In the beginning, we wanted to gather data regarding the origin of the visitors and the modes of transportation from as many events as possible to test the scan. After reaching out to about six events, without getting a response, and reaching out to a few mobility companies as well to receive modal splits, it became clear that festival organizations do not want to share this information. During the brainstorming session with the experts and internal meetings, we concluded that the reason these organizations do not want to share their data is that they do not want to be part of a pilot scan because the results are most likely that they are not sustainable, and they do not want this information to reach the public. This vision was confirmed by the experts who work closely with festival organizations. Therefore, Zicht op Data was brought into the process so we could find out the movements and modes of transportation another way.

I was in contact with Ruud, CEO of Zicht op Data, and together with my colleagues from LCB we had multiple meetings to discuss the data we need and what our goal was with that data. Ruud had experience in working with festivals and we believed that this was the right way to get insight into the movements we needed. The data received was the right data, but it did not give me the insights I needed, because the data was altered by algorithms already. The conclusions I was looking for were hard to make. However, after consultation with a colleague, we found a way to still use the data and come to interesting insights, for both LCB and the festivals. More could have been done with the data, but unfortunately, that wasn't possible within the timeframe of this project. This is a learning point for the next person who will continue this research.

I learned from this situation to have a critical perspective and I improved my analytical skills. At first the data looked like it was useful, but after digging into it, it turned out to miss some crucial information that was necessary to come to conclusions. By having a critical perspective, mistakes in the conclusion were prevented. My analytical skills were tested since the data received was spread out over multiple documents and Excel files. Data analysis was never my strongest point, but I believe that this project has taught me to dive deeper into the material and find connections between them. This skill is one I need in the future if I want to stay in the mobility sector to get a better understanding of how to optimize mobility and how to make it more sustainable.

Besides the small setback with the data, there was one thing that I am proud of myself, the brainstorming session on March 29. For this session, the introduction was done by LCB, and the second part of the session was held by me. To LCB, the session was meant to start a collective

with the experts to regularly meet and discuss sustainable mobility in the events sector. To me, the objective was to share the scan thus far, collect feedback, learn more about the current mobility sector, and network with the experts. During the second part of the brainstorming session, I did a small case study as an icebreaker to start the conversation, and I shared the scan with them.

During the brainstorming session, the experts look critically at my work so far. This was kind of scary, and they had many tips ready for me on what to include in the scan and what to take out. I was kind of shocked at first since I thought that they didn't agree with what I did. They asked a lot of questions, and really tried to help me improve the scan. They also challenged me to think further, about what might happen once the scan is done and ready to be used in the field. This made me decide that the scan must be repeated year after year to measure success, and therefore, the scan can become a standard tool for events to use in the future.

The brainstorming session has taught me to question experts and start a discussion about the topic. It taught me to go out of my comfort zone. I was quite nervous at the beginning of the session; eight experts were in front of me being critical about my work. I was afraid that what I had done was not sufficient enough and that I wouldn't be able to communicate the reasoning behind my work well. However, the experts were impressed by the work and gave good tips to make the scan even better. In my turn, I asked them the right questions that helped me to further develop the scan. I can say that my professional communication and attitude has improved and that I learned how to deal with critical feedback, but also to have a critical view on their opinion. I think these skills must be mastered in order to become a professional in the sector.

One more skill I learned is time management. I am proud of my time management because I followed my tight schedule, and I was able to finish the project a week before the deadline. From the start, I was fully focused on finishing on time, and I managed to do so. Even though there were a few setbacks, this didn't stop me. As well as the many experts and external parties involved in the project; this didn't lead to a delay in the progress. I know that I am now ready to work in the field and I know for sure that the event sector is the sector I want to work in.

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