Road and Transportation Research Association
Working Group: Traffic Planning

FGSV

EVC

Recommendations on Traffic and Crowd Management for Events

Requirements, Standards and Options for Action for Consideration in the Planning, Approval Processes and Putting on of Events

Edition: 2022 | Translation 2024

R 2

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Preliminary note:

The "Recommendations on Traffic and Crowd Management for Events. Requirements, Standards and Options for Action for Consideration in the Planning, Approval Processes and Putting on Events" (EVC), edition 2022, were developed by the working party "Notes on Traffic Development at Large-Scale Events" in the working committee "Survey and Forecast of Traffic" (head: Univ.-Prof. Dr. Tobias Kuhnimhof, Aachen). In addition to the members of the working party, the following people were also involved: Bernd Belka, Bergheim; Günter Cranz, Karlsruhe; Thomas Hußmann, Düsseldorf; Dr. Angelika Kneidl, Munich; Dr. Dirk Serwill, Aachen and Prof. Dr. Armin Seyfried, Jülich and Wuppertal.

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1 Preface

The Road and Transportation Research Association (FGSV) divides the publications produced by the various committees into four categories with varying levels of importance. A distinction is made between the categories R 1, R 2, W 1 and W 2. The categorisation can be found on the next to the last cover page of this publication.

These regulations (R 2) "Recommendations on Traffic and Crowd Management for Events. Requirements, Standards and Options for Action for Consideration in the Planning, Approval Processes and Putting on Events" (EVC), edition 2022, are an R 2 publication of the FGSV. These recommendations contain both standards and rules ("do/do not") and recommendations (should/should not) that are commonly found in R 2 regulations. They also include requirements and specifications ("must/must not") typical for R 1 regulations and options for action ("can/could") that are common in knowledge documents. Requirements result from safety-relevant and functional basic specifications as well as from the implementation of the legal framework. Standards and rules are derived from documented and verifiable findings and ensure appropriate quality requirements. Recommendations reflect experiences that apply to most cases.

Options for action are only appropriate in certain cases as indicated. Experience shows that R 2 publications, just like R 1 publications of the FGSV, are also evaluated and used as recognised standards of good engineering practice or as state-of-the-art techniques in the planning, approval and operation of (traffic) facilities, especially in cases of dispute. It is recommended not to deviate from requirements and specifications, except when absolutely essential, and only to deviate from standards and rules for valid reasons and to justify any deviations in writing – ideally within the safety concept for an event.

The FGSV recommends using the "Recommendations on Traffic and Crowd Management for Events" (EVC), edition 2022, for all planning and approval processes concerning the traffic and crowd flows to and from events. Additionally, it recommends employing these recommendations for the management and assessment of crowd movements during events.

In future, the FGSV plans to regularly update these recommendations through a dedicated working committee with several working parties. Additionally, it aims to address specific topics related to traffic and crowd management for events in greater depth through separate publications. Updates can be found on the FGSV website, on the FGSV publishing house website and in the FGSV newsletter.

These recommendations contain numerous references to other FGSV regulations. They and their contents are updated on a regular basis, with the new date of publication is shown. The "Recommendations on Traffic and Crowd Management for Events" (EVC) cites references with the publication year valid at the editorial deadline. When implementing these recommendations, always refer to the edition of the references valid at the time of implementation.

2 Introduction

2.1 Purpose

For the purposes of these recommendations, "traffic and crowd management for events" is defined as follows:

Traffic and crowd management incorporates planning, approving and operating the facilities and services designed to efficiently manage:

- crowd flows and flows of traffic,
- arrivals and departures at public areas,
- crowd movements and prevent overcrowding in public areas at an event and
- operations in normal situations and in the event of incidents or

hazards.

These recommendations are intended for planning and approval processes and the associated administrative procedures leading up to and during an event, including arrivals and departures, thereby preparing for the safest, most efficient and most compatible management of the volume of traffic and people possible.

The main focus is on traffic and crowd management, both as a responsibility of the event organiser and as a public duty. The recommendations represent recognised standards of good engineering practice and state-of-the-art techniques for traffic and crowd management at events. They encompass the tasks of planning, managing and supervising people's arrival, departure and circulation while attending the event.

Towns, cities, municipalities, entire regions and the private event sector hold events of varying scale to improve their public image, promote their location, or as a lucrative commercial endeavour, often attracting an international audience. An "event" embodies a sense of (positive) emotionality and frequently creates a culture of high expectations. The expectations relate to the overall experience, including travelling to and from the event: pedestrian routes, strolling, lingering, dancing, standing or sitting in public areas; such, the overall experience should be seen as a single event, that also includes attendees travelling to and from it.

The following are the main criteria that can contribute to the successful management of the traffic and crowd flows at events and are taken into consideration in these recommendations:

Safety
In the past, we have witnessed safety-related incidents involving personal injury at events both in Germany and around the world. The main aim of these recommendations is to avoid these incidents at events.

Public safety and order
Events necessitate complex organisation and often entail significant interaction in the public sphere. Consequently, events frequently involve a profound intertwining of private and public responsibilities. The traffic needs of event organisers and the maintenance of public safety and order must always be considered when preparing and putting on events.

Quality of traffic and convenience

When designing facilities and evaluating the flow of traffic, in addition to safety-related aspects, the quality of traffic flow on the way to and from the event and within a venue significantly influences the overall perception of attendees. Therefore, the objective of these recommendations is to facilitate the efficient, convenient and easily understandable management of the volume of traffic and people at events.

Environmental compatibility and safeguarding the interests of the general public
Traffic management and meeting the traffic needs of participants should not unduly compromise the services for the general public in the provision of essential services, environmental quality, opportunities for economic activity or the concerns of local residents and the community at large.

The objective of these recommendations is to promote eco-mobility in traffic management and to minimise inconvenience to the general public in host communities and regions.

These recommendations are therefore aimed at everyone involved in planning, approving and operating facilities and transport services for traffic and crowd flows at events. They are, in particular:

- event organisers,
- operators of event sites and areas,
- authorities for approving public events (in particular building, regulatory and traffic authorities as well as road construction and maintenance authorities),
- public safety authorities and organisations (BOS),
- traffic management,
- traffic planners employed by event organisers and local authorities or commissioned planning offices,
- organisations responsible for public transport and transport service providers,
- hazard prevention agencies (specialist authorities and emergency response organisations),
- tourism and hospitality institutions,
- event agencies along with their technical planners and safety advisers.

Traffic and crowd management at events has not yet been adequately addressed in laws, regulations and standards. German-speaking countries primarily regulate emergency management at events and risks outside of normal operations. As the inaugural instalment in a planned series of FGSV regulations and knowledge documents regarding traffic and crowd management for events, these recommendations seek to address some of these deficiencies.

The contents of these recommendations are based on verified research findings, evaluations and experiences during previous events. Key learnings from the tragic occurrences at the 2010 Love Parade in Duisburg, Germany, have also been integrated.

The COVID-19 pandemic, which commenced in 2020, and its impact on events did not prompt the publication of these recommendations. Rather, these recommendations are based on scenarios where traffic and crowd density may become high.

2.2 Contents of the Recommendations on Traffic and Crowd Management for Events (EVC)

2.2.1 Traffic and crowd management

The analysis is based on the route people take to and from the event location. This "customer journey" (Figure 1) is also a central element of the event experience from the perspective of attendees. The components of traffic and crowd management are therefore also a central element of the Recommendations on Traffic and Crowd Management for Events (EVC).

The recommendations also cover strategies for managing the gathering and movement of people in public areas and the possible evacuation of an event site in case of an emergency.

2.2.2 Traffic facilities

These recommendations relate to facilities and services for travelling to and from an event as well as public areas. These are:

- road traffic facilities, squares and paths,
- facilities for standing motorised traffic,
- public transport services as well as coach and taxi services that facilitate arrival and departure either as part of the public transport system or through special traffic arrangements,
- bicycle traffic infrastructure and bike racks,
- pedestrian traffic facilities such as walkways for pedestrian routes, including tunnels, entrances and steps leading to and from the public areas of an event,
- entrances and security search systems such as doors, gates, separating elements and security search points,

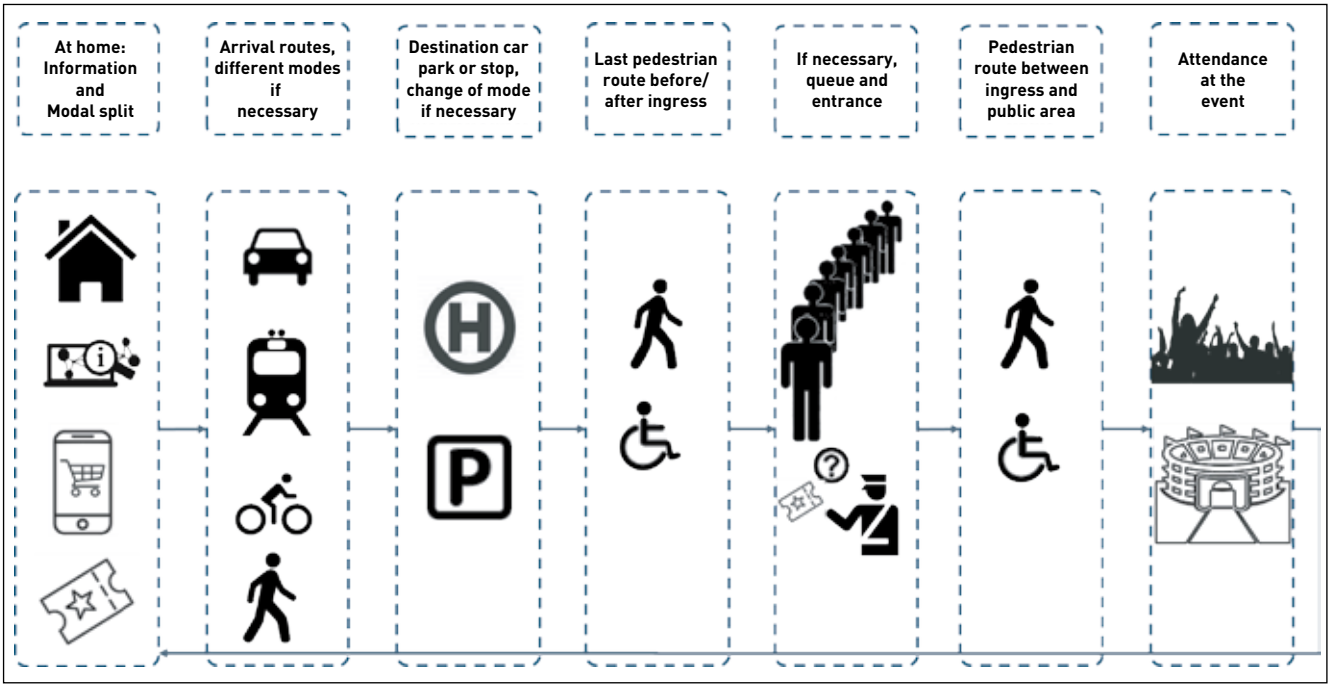

Figure 1: Arrival and departure routes as part of a "customer journey"

including pre-entry queuing systems or areas for throng development,
- public areas that are used as central event areas by standing or moving people, such as rooms and halls or outdoor areas with seats and standing areas, dance floors, paths between exhibition and entertainment facilities or paths between market stalls,
- facilities and services used to control and manage arrivals and departures, such as information services, signposting systems, traffic control centres and steward services,
- facilities and services to ensure the orderly gathering and movement of people in public areas, such as public order and security services or barriers,
- exits along pedestrian exit routes, and
- emergency exits to ensure safe evacuation in case of an emergency.

In general, traffic facilities should be designed with full accessibility in mind. Relevant information can be found in the "Notes on Accessible Traffic Facilities" (H BVA) of the FGSV.

2.2.3 Individual topics covered

The recommendations cover the following individual topics that are relevant when planning, approving and putting on events:
- legal basis for traffic and crowd management for events (Section 3),
- determining, estimating and influencing the traffic and crowd flows at events (Section 4) for the various traffic modes,
- managing moving and standing motorised traffic, its signposting and traffic management, providing and organising facilities for standing traffic and special traffic (logistics, delivery traffic, emergency services) (Section 5),
- providing and organising public transport and any shuttle services as well as managing coach and taxi services (Section 6),
- managing bicycle traffic and providing bike racks (Section 7),
- planning the management of crowd flows on pedestrian routes to and from public areas and managing the gathering and movement of people in public areas (Section 8),
- monitoring, assessing and controlling crowds of people during an event (Section 9),
- managing disruptions and hazardous incidents (Section 10).

Finally, the annexes contain checklists and practical examples to facilitate the application of the "Recommendations on Traffic and Crowd Management for Events" (EVC) in daily practice.

2.2.4 Criteria for incorporating individual topics

The individual topics to be incorporated depend on the requirements of the specific case under consideration. Not all sections need to be fully addressed for every event. A key consideration when addressing individual sections or steps is ensuring safety on arrival, departure and within the public areas of an event, in particular:
- traffic safety on the routes on arrival and departure with the various traffic modes,
- avoiding delays on arrival or departure and at entrances is crucial to prevent people from missing out on the expected experience and to minimise the risk of hazardous situations caused by a crowd surge,
- preventing the uncontrolled movement of people along pedestrian routes between security search points and public areas at events with unassigned seating (people pushing forward in a crowd to get the best seats on a "first come, first served" basis),
- minimising high crowd densities in individual clusters of people,
- ensuring orderly site evacuation in the event of hazardous incidents, and
- ensuring orderly exiting.

These recommendations, therefore, also intensively address these safety-relevant factors. Many accidents within crowded environments could have been largely prevented through proper planning and the advance preparation of contingency measures in the event of deviations from the original plan. However, planning a safe event cannot rely solely on focussing on quantitative factors, references to applicable laws and regulations or dismissing the potential for unforeseen hazards. Rather, it is important to examine and evaluate all stages of the event with regard to the appropriateness of the measures being taken. These recommendations are intended to close these gaps and provide assistance where there is no quantitative basis for assessment.

2.3 Area of application and differentiation from other tasks when preparing and putting on an event

The recommendations can be applied to various event types and locations, such as town and village shows, country fairs, markets, outdoor events and events held in buildings, halls and stadiums. Implementation of the recommendations is recommended for large-scale events as well as smaller ones and sporting events such as runs or cycle races.

Prior to an event, the various stakeholders, especially the relevant authorities, must agree on which aspects of traffic and crowd management need to be addressed. However, detailed consideration in accordance with these recommendations is likely to be necessary if one or more of the following criteria apply:

- an event is to be held at a venue for the first time or the event plan of a recurring event should be or must be changed,
- the safe capacity of the facilities and services is no longer adequate for the expected traffic and crowd flows. This can relate to:
  - motor vehicle, cycling and pedestrian facilities,
  - facilities for standing traffic, or
  - public transport facilities and services,
- if a high crowd density is expected on certain sections of pedestrian routes, including waiting zones in front of security search systems or in public areas,
- if the event is expected to significantly impede the functionality or safety of the heavily utilised connecting and access points of the traffic network,
- if – regardless of the number of people expected – groups of people pose or are exposed to an increased risk potential when travelling to and from the event and/or when moving around or staying in the public areas compared to other events,
- if there are complex pedestrian-traffic movements on site, in particular two-way traffic or cross flows on routes or in areas with high crowd flows,
- if significant interdependencies exist between developments in the public traffic area and occupancy or traffic in public areas,
- if noticeable disruptions to local residents and/or the general public are expected as a result of event traffic,
- if public safety and order might be impaired,
- if a number of authorities are responsible for various aspects of the event or responsibilities are unclear,
- if there are general doubts about the feasibility of the event,
- if there is a high ratio of young people, young adults, older people or people with limited mobility,
- if overlapping with other events (e.g. event areas and halls or stadiums in close proximity) is to be expected, or
- if an additional increase in the volume of people in the vicinity of the event is to be expected, e.g. on high streets on popular shopping days.

Traffic and crowd management are interdependent of other tasks required for preparing and putting on the event, including creating a safety plan (see Figure 2). The boundaries and connections between the individual tasks are not always clearly defined according to state-of-the-art techniques and must be clearly defined at the start of event planning.

When planning and putting on events, it is imperative to maintain a clear assignment of tasks among stakeholders, ensuring they are adequately fulfilled in the interest of prudent organisation of the event operation. Notable gaps in the consideration of individual aspects and sub-areas of the event site, including the entire journey to and from the public areas, can cause hazards for persons travelling to and from and/or attending the event and must be avoided.

Safety-relevant parts of the traffic plan can be incorporated into the safety plan of an event, but they may also be influenced by requirements and basic parameters from other sub-plans (e.g. fire safety or stewarding plan). Such requirements and basic parameters are, for example:

- locations, dates and times,
- processes,
- expected participants,
- usable and used installations and areas,

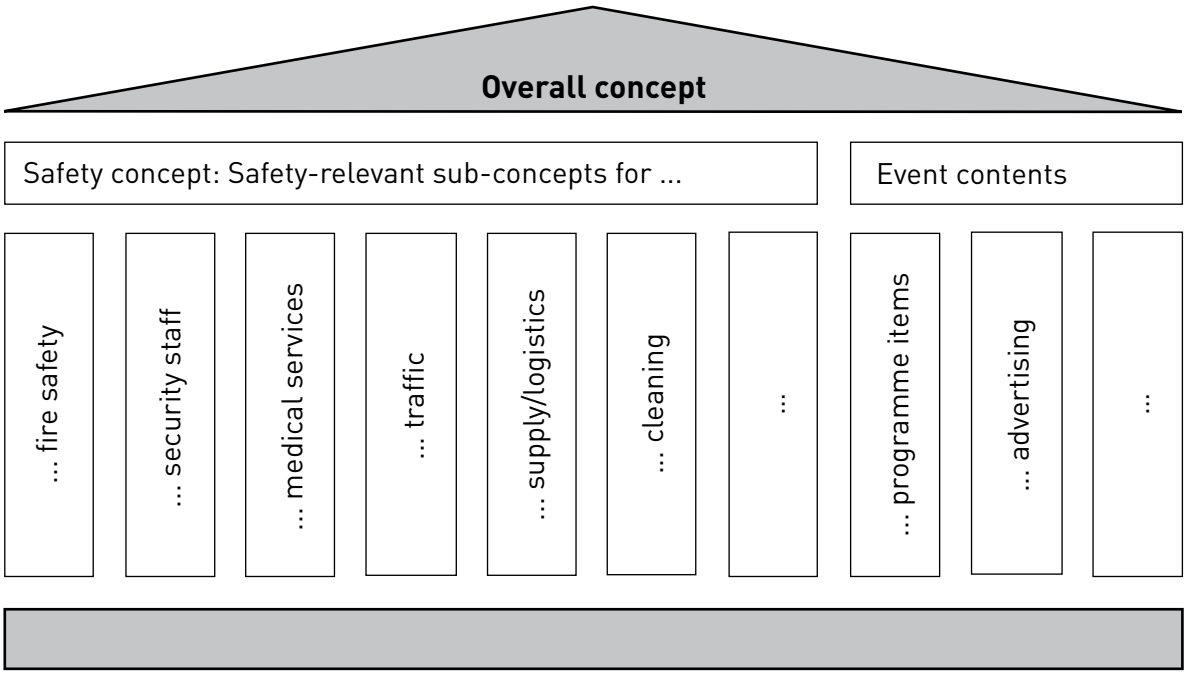

Figure 2: Overview of tasks and sub-plans when preparing and putting on a large-scale event

- infrastructure for access, maintenance, supply and disposal,
- organisation,
- responsible contacts,
- conditions of use and operation and the definition of safety objectives, and
- legally relevant basic principles, planning and approval process.

These aspects are dealt with in detail in the following sections.

The safety plan is a binding summary of all the necessary and reasonable protective measures agreed upon by all the parties involved. After determining the safety objectives, it takes into account the recognised and assessed risks. The aim of the safety plan is to ensure safe event operation during all phases of the event within the scope of the accepted risks.

Depending on the type of event, legal requirements must be considered when preparing and planning the safety plan. Further details are regulated by state laws, such as security and order laws, as well as in ordinances of the federal states, some of which are based on the German Model Ordinance on Places of Assembly (MVStättVO). Technical recommendations for preparing a safety plan also exist. The literature references in these recommendations list publications that can be consulted when preparing a safety plan. Safety-relevant aspects of traffic and crowd management that can be incorporated into the safety plan are dealt with in detail in these recommendations.

3 Legal basis for traffic and crowd management for events

3.1 Introduction

The legal basis is of great importance when planning and putting on an event: It regulates the duties, responsibility and liability of the event organiser and all the other institutions involved. Private law applies between the event organiser and the economic stakeholders (participants, service providers, etc.), while the provisions of public law apply between the event organiser and the relevant federal state and local authorities. Labour protection law and criminal law also play a role in determining obligations.

3.2 General duty of safety

The most important principle when preparing and putting on an event is to ensure that the event is conducted safely to offset the likely effect of the accepted risks. This includes – with varying areas of competence and responsibility where applicable – not only the processes but also in particular arrivals and departures by all means of transport, the pedestrian routes to and from the public areas as well as the movement of people in public areas and the required infrastructure.

Operators and event organisers as well as the other parties involved must, therefore, ensure that the event is conducted safely – and as smoothly as possible – to offset the likely effect of the accepted risks.

In addition, it is legally required that local authorities check event plans to ensure that it can take place in the designated public or private space in accordance with relevant laws – even if unfavourable conditions should arise.

The following explanations concerning the legal bases and recommendations for organising the event focus on the vital aspect of traffic and crowd management when preparing and putting on an event. Reference is made to the law relevant to the places of assembly or event venues where corresponding interactions arise. The presentation should, therefore, not be regarded as being exhaustive.

3.3 Relevant laws and regulations in the context of traffic and crowd management of an event

3.3.1 Regulations under private law

From a private law perspective, the requirements set out in the German Civil Code (BGB) are decisive with regard to (ancillary) performance obligations and possible liability. Furthermore, the legal institutions of organisational and legal duties to maintain traffic safety developed by the highest courts are of significance.

In the context of an existing contractual obligation, Section 241 (2) of the German Civil Code (BGB) extends the event organiser's performance obligations to include points relevant to safety and traffic planning. The event organiser must take into account the rights, legal interests and interests of the beneficiary when performing their principal obligations. This also includes proper event organisation and, therefore, in particular:

- organised arrival and departure,
- sufficient quality of traffic overall and an adequate infrastructure for the expected number of attendees,
- qualified event, safety, traffic and crowd management, and
- organisation of technical and supply aspects.

If the event organiser enters into contractual agreements with participants (usually through the sale of admission tickets), the principal obligations are usually the content of the event and the corresponding counter value of the monetary payments made by the participants. However, even if no contract is concluded between the event organiser and participants due to the design of the event (e.g. an open air town show or street festival), the law of torts and the principles developed from it regarding the legal duty to maintain traffic safety stipulate that the person who creates or maintains a hazard source has a duty to take the necessary and reasonable precautions to prevent any harm to others. The non-exhaustive catalogue of measures and obligations set out in Section 241 (2) of the German Civil Code (BGB) can also be deduced from this premise.

In addition, there are possible claims for damages under the law of torts if culpably protected legal interests of third parties are violated (e.g. from Section 823 (I) or Section 823 (2) of the German Civil Code (BGB) in connection with the breach of a so-called conservation act) and the resulting obligation to do what is necessary and reasonable to avoid liability.

Under civil law, responsibility and liability do not end at the boundary of a property. For instance, if there is no defined boundary of a property (e.g. at town shows) or at the

boundary of the defined event location. In this respect, the depth of the contractual agreement and the actual sphere of competence and responsibility of the event organiser are relevant. It is recommended that the event organiser extends their area of responsibility beyond the entrances/exits to include adjacent areas of arrival and departure, for example pre-entry dwell areas or queuing systems, pedestrian routes, available parking facilities, train stations and stops. The participants are the event organiser's attendees and the event organiser must, therefore, regularly ensure that arrivals and departures can be managed in an orderly and largely safe manner.

3.3.2 Regulations under public law

Under public law, the role of event organiser and/or operator of event facilities brings with it a wide range of responsibilities and obligations. These regulations also authorise the initially responsible regulatory, building and road traffic authorities to intervene.

On the one hand, the procedural regulations under public law regulate the responsibilities and the possible administrative procedures. In local terms, they are based on the location and any restrictions placed on the event location and, in legal terms, on the extent of the regulation. On the other hand, when putting on an event and utilising facilities there may be a duty to obtain a permit and/or conditions imposed by the competent authority. Events during which roads are used for more than "normal traffic" within the meaning of the German Road Traffic Regulations (StVO) or during which roads are used beyond public use require a relevant permit, e.g. in accordance with Section 29 (2) of the German Road Traffic Regulations (StVO) or the German Traffic Law (StrG). In addition, if there is a sufficiently specific risk situation for public safety and order, or the justified assumption that such a situation would arise if the event continues unchanged, relevant official requirements and conditions may be imposed. They are intended, among other things, to prevent hazards to public safety and to ensure public order and safety and to maintain a smooth flow of road traffic.

Some federal states have introduced regulative laws for the approval of events (Bavaria under the State Criminal Law and Ordinance Act (LStVG), Hamburg under Section 31 of the Safety and Order Law (SOG), Rhineland-Palatinate under Section 26 of the Police and Public Order Law (POG)) or are in the process of doing so (e.g. the State of Berlin).

If places of assembly are operated and used, the respective federal state-specific application or implementation of the German Model Ordinance on Places of Assembly (MVStättVO) plays a role, while the federal state-specific building law comes into play for the use of other structural facilities.

The relevant legal bases for such regulations are in particular:

- state building law and building regulations with provisions on traffic safety, traffic routes, escape and emergency routes and access for police, fire and emergency services in connection with the use of structural facilities as a place of assembly or as an event site (state law in-line with laws on safety and order, state building regulations, special building regulations, Ordinance on Places of Assembly, standards),
- police law with provisions for maintaining safety and order (police and public order laws of the federal states and ordinances based thereon),
- road traffic regulations and laws with the same purpose, supplemented by the requirement to maintain access and ensure the safety and a smooth flow of road traffic. This applies in particular to the regulations on implementing traffic engineering measures (German Traffic Law (StrG), German State Roads Act (LStrG), General Administrative Regulation for German Road Traffic Regulations (VwV-StVO), German Ordinance on the Construction and Operation of Street Railways (BOStrab)). For events in public areas, Section 29 of the German Road Traffic Regulations (StVO) [excessive road use] and Section 44 of the German Road Traffic Regulations (StVO) [subject matter jurisdiction], Section 8 of the German Federal Trunk Road Act (FStrG) as well as the corresponding road and highway laws of the federal states and Section 14 of the German Act on Assemblies and Processions (VersammlG) form the legal basis for corresponding requirements and conditions,
- trade law with provisions on the safe operation of markets and exhibitions and
- regulations on fire safety and the provision of assistance by fire-fighters and public rescue services (e.g. fire and rescue services acts).

In most cases, suitable, necessary and appropriate requirements and conditions can be stipulated at the discretion of the competent authority in the respective factual context. Event organisers and operators may – subject to proportionality – also be obliged to take measures beyond the actual event area.

Measures relating to road traffic are usually not possible without the consent of the road construction and maintenance authorities, the public safety and order authorities and the traffic authorities. With a few exceptions, the police (Section 36 of the German Road Traffic Regulations (StVO)) are responsible for controlling traffic.

A special feature from a legal point of view is that different competences, responsibilities and requirements for corresponding orders arise for various event areas, and making claims against the event organiser may not always be justified. It is therefore necessary to clarify or define the responsibilities within the legal system at an early stage. Based on this, cohesive plans can be drawn up with the aim of achieving a safe event by offsetting the likely effect of the accepted risks.

With regard to traffic and crowd management measures, it should be noted that operators and event organisers can only act in public traffic areas if they have been granted corresponding rights, e.g. a corresponding special use permit. In all other cases, the tasks would need to be carried

out by the public administration and its emergency services in accordance with the need-to-know principle.

3.3.3 Labour Protection Law regulations

The provisions of the Labour Protection Law are likely to be relevant in the realm of traffic and crowd management, particularly concerning work within road spaces and, when applicable, for work on other facilities frequented by individuals travelling to and from the venue, as well as those present at the event. This concerns, for example, the manner of execution, the safety equipment and the nature of the personal protective equipment of the persons deployed at the site.

3.3.4 Criminally relevant provisions; administrative offences

Section 315b of the German Criminal Code (StGB) criminalises dangerous interference with road traffic. This applies to unlawful structural alterations and, in particular, to the unjustified interference with the safety of road traffic by private traffic management staff on public roads.

In the context of administrative offences, violations of the aforesaid provisions as well as orders, conditions and ancillary provisions based on them are punishable. Failure to comply with the requirement for proper operational management and organisation can also constitute a public order offence under Section 130 of the German Act on Administrative Offences (OWiG).

If personal injury occurs, legal action and criminal proceedings may follow. In planning and approval processes, it must be borne in mind that in the event of safety deficits that are determined to be the direct cause of injury or damage, representatives of the organiser and the authorities may be held responsible. The benchmark is the diligent, meticulous and expert work of professionals who could and should have identified safety deficiencies. In this respect, planners and approval bodies bear a great deal of responsibility. It is important to note that in many instances, those in charge serve as guarantors and the failure to act can be construed as the realisation of a criminal offence.

3.3.5 Technical regulations

Technical regulations specify the organisational and legal duty to maintain traffic safety and must be taken into account both with regard to the operation and set-up of the actual event locations and to traffic and crowd management.

For event traffic, the regulations of the FGSV must essentially be taken into account. The following sections on traffic and crowd management contain references to relevant regulations.

3.4 Relevant duties to obtain permits for traffic and crowd management

Whether permits must be obtained or issued for an event when preparing traffic and crowd management depends on:

- the type and scope of the event,
- the premises being used,
- the areas and facilities involved,
- the area of application of the respective legal bases,
- the circumstances that are subject to an approval obligation, i.e. a duty to obtain a permit, and
- the applicable state and/or municipal regulations.

Event organisers and authorities should, therefore, coordinate and clarify at an early stage which aspects of traffic and crowd management have duties to obtain permits and which requirements must be met to obtain the respective permits.

When using structural facilities as event areas, this may be the case according to state-specific law, such as building law, which is partly based on the German Model Ordinance on Places of Assembly (MVStättVO). This model ordinance is adopted by the Conference of Building Ministers and serves in part as the basis for implementation in specific state law. Each federal state decides to what extent the state regulation follows the model and adopts regulations in the respective state building regulations or special building regulations. Duties to obtain permits may also be regulated in state-specific laws for the protection of public safety and order.

According to the German Model Ordinance on Places of Assembly (MVStättVO), adopted in 2005 and amended in 2014, the model regulations contained therein apply, for example, to places of assembly with assembly rooms that can accommodate more than 200 people, to outdoor places of assembly with stage areas and grandstands that are not temporary structures and can accommodate more than 1,000 people in total, and to sports stadiums and outdoor sports facilities with grandstands that are not temporary structures and can accommodate more than 5,000 people in total.

Regulation of the areas of application and of duties to obtain permits may vary from one federal state to the next. For example, according to the state laws of Hamburg and Rhineland-Palatinate and the police regulations in these federal states, a public event requires a permit from the competent authority if more than 5,000 or 10,000 people are expected at the same time or if, based on general experience or the findings of expert bodies, there is reason to assume an increased risk potential for life and limb of the event participants, in particular taking into account the scale and type of event, the location or nature of the event location and possible conflicts among the event participants or with third parties.

The German Model Ordinance on Places of Assembly (MVStättVO) and the relevant regulatory authorities (Sec-

tion 31 of the Safety and Order Law (SOG) in Hamburg, Section 26 of the Police and Public Order Law (POG) in Rhineland-Palatinate) contain a number of model regulations that are relevant to the planning and organising of events and facilities for the traffic and crowd flows.

This applies, in particular, to the need to:

- establish a safety plan,
- establish a team of stewards under the direction of an appointed stewarding manager,
- determine the minimum number of stewards according to the number of attendees and the degree of risk (if necessary, present in the plan),
- set up a first-aid service, determine the number of first-aid staff and notify the authority responsible for first-aid and rescue services if more than 5,000 people are expected to attend the event,
- determine operational safety measures and general and special safety announcements,
- design emergency routes,
- comply with regulations pertaining to stairways, doors and gates, fencing and entrances, seating, corridors and steps, barriers and protective devices, safety lighting, etc.

It must be noted that the effective area in the safety plan must be seen as extending beyond the boundaries of the property or the event area. In addition to the entrances/exits, it also includes adjacent areas for arrivals and departures as well as car parks or stops. The safety plan for the place of assembly and thus also for the planning and operation of the traffic area must be coordinated with the authorities responsible for safety and order, in particular the police, fire and rescue services.

As an event-related element of the safety plan, a risk or hazard assessment must be carried out as specifically as possible. The risk or hazard assessment, as an event-related element of the safety plan, must contain the following relevant information in particular:

- public areas (seats, standing areas, dance floors, paths between stalls, etc.),
- expected number of people,
- volume of people travelling to and from the event, differentiated by time and place,
- expected audience profile (e.g. quiet, lively, young, old, degree of willingness to accept and comply with the rules of behaviour and consideration of factors that may affect this willingness),
- possible crowd pressure situations (especially at entrances/exits as well as in public areas), narrow sections, bottleneck situations or funnel effects,
- evaluation of the location, number and width of emergency exits and course of emergency routes, narrow sections along emergency routes,
- consideration of route risks (natural hazards, disruptions in the infrastructure being used, failure risks, etc.),
- access risks for both participants and the emergency services, and
- organisational and communication risks, extending to both cross-organisational collaboration and external communication with participants and the affected public.

It must be ensured that public law regulations are observed and that all decisions, such as the number of security search points and law enforcement staff required at these points, are based on criminal and police law requirements and are made independently of economic considerations. In addition, measures and strategies must be defined on how to act in the event of an incident.

Regardless of the scope of the state-specific laws or ordinances, the planning and organisation of facilities may have a duty to obtain a permit and/or conditions for people arriving, departing and attending. Duties to obtain permits may result from the areas of environmental law, nature and green space protection law (meadows and green spaces), preventive fire safety, the German Federal Immission Control Act (BImSchG), commercial law (especially markets), explosives law, road traffic law, local law in matters of self-administration and hospitality law. For example, traffic and crowd management may be part of the necessary considerations regarding noise protection, nature conservation, environmental protection and sustainability, and may also be subject to an environmental impact assessment which may result in additional requirements that need to be met.

If the event is held in a public area, some federal states impose notification or the duty to obtain a permit from a regulatory perspective, as the use of areas dedicated under public law generally involves use beyond the scope of public use. This use is authorised by a special use permit or a road traffic law order. In addition, the following measures concerning moving and standing traffic also require approval:

- excessive use of public traffic areas (e.g. for pedestrian routes, for the installation of safety equipment, as an event area, etc.),
- construction and operation of car parks and, where applicable, any parking facilities,
- installation of traffic signs in accordance with the German Road Traffic Regulations (StVO), but also of signage for traffic control,
- installation and operation as well as the securing of technical facilities, such as for traffic control or for the separation of different types of traffic (access restrictions),
- any form of traffic control, wherein the regulatory competence of the police according to Section 36 of the German Road Traffic Regulations (StVO) must be observed.

In accordance with road traffic laws, these measures require approval or an order from the relevant competent authority following an application or at the authority's own discretion.

Events where use of the road for normal traffic has to be restricted because of the number of participants [...] require a special permit (Section 29 German Road Traffic Regulations (StVO)). Roads within the aforesaid meaning include all public areas as well as private properties on which actual public traffic is permitted. Traffic includes not only motor vehicles but also pedestrian traffic.

The relevant road traffic authority is responsible for issuing the permit. Which road traffic authority is responsible in each individual case depends on the laws of each federal state. The permit has a bundling effect and includes at least the required special use permit under road law.

Typically, events within the meaning of these regulations will necessitate traffic control or other measures under road traffic law. They can address both the event participants and other traffic affected by the event.

The German Road Traffic Regulations (StVO) are the authoritative legal entity for all control, restriction or prohibition measures imposed on moving traffic in public areas or on private properties with actual public traffic.

The General Administrative Regulation for German Road Traffic Regulations (VwV-StVO) provides the road traffic authorities with regulatory discretion. Section 29 (2) of the General Administrative Regulation for German Road Traffic Regulations (VwV-StVO) provides the road traffic authorities with detailed requirements for carrying out approval processes.

In addition, the General Administrative Regulation for German Road Traffic Regulations (VwV-StVO) refers to numerous transport gazette announcements and regulations that may be relevant for traffic law orders in connection with events (e.g. "Guidelines for Diversion Signage" (RUB) [FGSV) 2021], "Guidelines for Directional Signage on Highways Other than Motorways" (RWB) [FGSV 2000]). These regulations are primarily aimed at the road traffic authorities. However, especially for larger events, knowledge and consideration of these regulations by the applicant will speed up the procedure considerably, in particular by avoiding queries.

The road construction and maintenance authority is obliged to procure, install, maintain, operate, illuminate and remove the traffic signs and traffic installations; otherwise the owner of the road is obliged to do so (Section 45 (5) of the German Road Traffic Regulations (StVO)).

The costs associated with procuring, installing, maintaining, operating and removing the official traffic signs and traffic installations as well as the other traffic signs and traffic installations approved by the German Federal Ministry for Transport and Digital Infrastructure shall be borne by the agency responsible for road construction and maintenance [...]. If there is no road construction and maintenance authority, the owner of the road is obliged to bear the costs. [...] Notwithstanding the above [...], the costs shall be borne by the organisers of [...] events for the corresponding official or approved signs (Section 5b German Road Traffic Act (StVG)).

The order may require the consent of an affected road construction and maintenance authority or other administrative bodies responsible for managing the area.

In addition, irrespective of the scope of the state-specific laws and ordinances, conditions can be imposed for reasons of hazard prevention, which in turn formulate the obligation to draw up safety plans and thus directly or indirectly the implementation of measures for the planning and operation of facilities for traffic and crowd flows.

Requirements are based on the safety objectives that need to be specified for each individual event. In general, traffic and crowd management should ensure that:

- planning and putting on an event, as well as approving the planning and operation of facilities for people travelling to and from the event and those in attendance comply with the legal requirements and regulations,
- cross-organisational collaboration is ensured, responsibilities are clarified and there is legal certainty for those responsible,
- the safety of those involved can be guaranteed within the framework of the risks accepted by the legal system,
- basic services to the local population as well as public safety and order are not negatively impacted by the event traffic,
- participants reach their destination safely and within a reasonable time,
- all participants are only restricted in their freedom of movement within the accepted limits and can get themselves to safety in the time required,
- the traffic infrastructure, transport services and traffic management are sufficient to meet demand during normal operation,
- sufficient resources are available to deal with incidents and emergencies,
- participants are not exposed to any unacceptable additional risks when participating at their own responsibility,
- the local population is not exposed to any unacceptable additional risks.

The event organiser must ensure strict adherence to the specifications of the permits, the conditions and requirements, and, if applicable, to the provisions outlined in the safety plan.

If a safety plan has been prepared, the stipulations made therein must be agreed with the responsible authorities, in particular the police, fire and emergency services. In terms of traffic and crowd management, the parties involved should be extended accordingly to include traffic authorities, the road construction and maintenance authorities and the institutions and operators of public transport.

3.5 Recommendations for dealing with legal bases within the context of traffic and crowd management at an event

In addition to regulations under public law, event organisers and operators should take into account the fact that they are obliged under private law to protect the rights of third parties. The event organiser is subject to duties of care, traffic safety and organisation, while the authorities are responsible for ensuring public safety and order and the safety and normal traffic flow. This means that there are identical interests in most areas, thereby necessitating that the measures taken, following cross-organisational collaboration and the definition of responsibilities and interfaces between authorities and event organisers, align with the shared objectives.

Just like the event organiser, the authorities should deal intensively with the event activities that have been applied for or become known, including arrivals and departures and all routes as well as the public areas. For example, it is the responsibility of the event organiser to configure, plan and provide parking areas, pedestrian routes, entrances/exits, security search systems, adequate barriers and effective stewarding in a professional and proficient manner. Authorities should check these designs, plans and provisions in advance of the event, possibly enabling the involvement of external experts, and to closely monitor them on the day of the event.

It should be noted that the regulations for preparing and putting on an event are not at present fully standardised throughout Germany and that varying requirements and procedures must be taken into account and applied in individual federal states and municipalities. Event organisers should contact the relevant authorities at an early stage to coordinate the necessary procedures and contents. Furthermore, the latest decisions must be taken into account when applying the law.

3.6 Recommendations for the organisation of planning and approval procedures with traffic and crowd management contents

3.6.1 Responsibilities

Responsibilities for individual aspects of event preparation can be derived from the legal bases. As part of the event preparation, complete, clear and mutually agreed regulations must be established for all aspects of specific responsibilities and competences during the planning process, for any approval components, for checks and approvals and for putting on the event.

Within the context of traffic and crowd management, the "concept" of the legal duty to maintain traffic safety must be observed. "Anyone who opens or maintains a traffic route for people on land belonging to them or under their control [must] ensure traffic safety, and anyone who creates or allows a hazard situation to exist [must] take precautions that are necessary and reasonable to avert the resulting dangers to third parties" (cf. Henkel, 2011). This legal duty to maintain traffic safety relates not only to technical but also to organisational or staff measures and is, therefore, not limited to the property (e.g. judgement of the German Federal Court of Justice (BGH) dated 3 June 2008, case no. VI ZR 223/07, NJW 2008, 3775 para. 9 with furtherreferences).

According to the established case law of the German Federal Court of Justice (BGH), the person with a legal duty to maintain traffic safety is:

- whoever creates or maintains a hazard source (a hazard source in the context of traffic and crowd management could be, e.g., a shuttle bus service, an exit from a temporary car park, a narrow section in the entrance system or an emergency exit that is too narrow), or
- whoever is in control of something that could be hazardous for third parties (e.g. the installation of traffic signs or signposts), or
- whoever exposes hazardous objects to general traffic or incorporates them into traffic situations (e.g. event-related traffic installations, barriers, etc.).

The event organiser, therefore, has a legal duty to maintain traffic safety regardless of their legal form, professional status or business intentions. The event organiser is, therefore, responsible for planning and controlling the arrival and departure of people to and from the public areas as well as those in attendance in the public areas of the event based on a legal duty to maintain traffic safety. Nevertheless, the event organiser is generally not solely responsible for planning and implementing traffic and crowd management of an event. Depending on the scale and type of the event as well as the legal requirements of the event and the responsibilities to be defined, parts of the responsibility may be transferred to other parties involved. In addition, there may be other original responsibilities, such as those of the authorising bodies for the approval and control of facilities, the transport authority for public transport or the road administration or the municipal administration, including the traffic authority for road traffic. In this respect, it should be clarified and bindingly determined before an event which additional parties, besides the event organiser, are responsible for which individual tasks for planning, approving, controlling and operating facilities and services for people travelling to and from the public areas and for attendees in the public areas of an event.

In addition to the responsibility of the event organiser and unless otherwise specified, the following responsibilities shall apply to individual aspects of traffic and crowd management of an event:

- responsibility of the regulatory agency, i.e. usually the public order office, including the traffic authority of the local authority, for issuing conditions, for example regarding the number of law enforcement staff to be deployed in safety-relevant areas, as well as for individual hazard prevention tasks, for example with regard to the

designation of no parking zones and keeping emergency routes clear of parking offenders,

- responsibility of the building authority, i.e. usually the building authority of the local authority, for the control or approval and monitoring of the structural facilities for people arriving and departing as well as those in attendance, for example for the fence elements and barriers to be used and erected in safety-relevant areas,
- responsibility of the planning authority and here in particular the traffic planning department, i.e. usually the traffic department in charge of checking and approving traffic management of the local authority, e.g. for checking the number of parking bays and parking spaces to be provided, maintained and available, entrances/exits, security search systems or widths of narrow sections on the pedestrian routes and public areas,
- responsibility of the traffic authority and/or the public transport authority for checking the safe use of public traffic areas and demanding adherence to regulations,
- responsibility of the authorities and transport operators for the management of public transport,
- responsibility of the federal police for individual hazard prevention tasks in rail traffic and at railway property, such as inside train stations,
- responsibility of the state police to avert threats to public safety and order and to prevent and prosecute criminal offences,
- responsibility of the fire service to inspect fire safety precautions, such as inspecting and testing facilities for safe evacuation, as well as for non-police hazard prevention during the event,
- responsibility of the rescue and medical services for emergencies and urgent incidents.

In the case of events that may have an impact on nature and the environment due to their noise emissions, for example, the responsible environmental protection departments should also be involved.

When starting to plan an event, both the event organiser and the authorities should each appoint a coordinating body, or even better a coordinating person, to bring about agreements, clarify the question of individual responsibilities and coordinate planning, approving and putting on the event. Coordination then also includes traffic and crowd management, wherein the technical and traffic-related tasks should be assigned to people with expertise and experience in implementing and controlling traffic and crowd flows. From the event organiser's perspective, the coordinator will usually have the role of an event manager.

3.6.2 Procedure

When starting to plan traffic and crowd management, the event organiser should clarify with the authorities which institutions need to be involved, which documents need to be prepared and which permits and/or orders need to be obtained or issued. The first authority to be contacted is usually the public order offices of the municipalities.

The number of parties involved should be limited as much as possible to facilitate coordination with short communication channels, wherein all the institutions concerned should always be involved. This also applies to stakeholders who do not have any planning tasks but who will later play key operational roles. In addition to the responsible parties mentioned in Section 2.5.1, the following other parties may also be involved:

- traffic information service providers,
- public relations or marketing officers,
- representatives of relevant associations (e.g. automobile/cycling clubs),
- representatives of local residents,
- other parties affected by the event traffic and/or road closures (e.g. business owners, social service providers, suppliers),
- those responsible for commercial and catering matters, and
- political decision-makers.

A stakeholder analysis can be useful at the start of the traffic and crowd management planning process to identify the group of relevant stakeholders. During the planning and approval process, the group of relevant stakeholders should be reviewed and expanded or reduced as required. It is advisable to create and maintain a list of all those involved along with their contact details.

Once the group of responsible parties and other stakeholders has been established, the expectations and goals they have for managing the traffic and crowd flows should be determined. For example, political decision-makers might expect the town to successfully present itself as a host municipality with efficient and attractive traffic facilities without impacting commuter or normal traffic and without having to set aside any of the municipal budget to cover costs for transport measures. In return, the event organiser could expect the political decision-makers to support the preparations and ensure that short-term consultations and quick decisions are possible. The likelihood of discord in the event of conflicting expectations should be analysed, and possible strategies and measures to overcome the potential for conflict should be identified.

The procedures and working methods for preparing for traffic and crowd management should be defined together with all the parties involved. In the case of extensive measures for preparing and putting on an event, it is advisable to prepare rules of procedure, a reporting system, for example with the installation and maintenance of an Internet-based information platform and quality management, including an evaluation of managing the traffic and crowd flow during the event and a review of experiences after the event.

Specifications can be documented in the minutes of meetings. Milestones with interim reports can be agreed in order to communicate work statuses and recognise critical time lines. The minutes should be agreed with all the participants and made available to them as an agreed basis.

It must be noted that the planning process for traffic and crowd management can be very time consuming. A consensus is often required, which demands a certain planning lead time. For extensive measures, at least 12 to 24 months should be estimated in order to adequately prepare for managing the traffic and crowd flows. Experience has shown that it makes scheduling easier for everyone involved if the frequency of meetings is fixed from the start, i.e. if the meeting dates are agreed months in advance. Extensive planning sub-concepts and/or the use of new technical systems should be planned well in advance, especially as test stages may need to be scheduled.

It is usually advisable to set up a "traffic and crowd management" working group. In the case of extensive measures, separate working groups for private transport, public transport, pedestrian traffic and emergency planning may also be appropriate. It is then the task of coordination to ensure an appropriate exchange of information. It is recommended that strict scheduling and clearly formulated tasks are used to ensure a speedy process and that a responsible coordination centre is created and staffed with a "care-taking role" that ensures that those responsible are involved in good time, that initiates the necessary clarifications and documents the specifications accordingly and that monitors and evaluates their implementation.

At the end of the event, it is recommended that all the results achieved are documented and that existing documents and evaluations are archived so that they can be retrieved at a later date.

3.7 System-inherent risks

In the German legal system, different legal bases and, as a result, different official responsibilities apply to different arrival and departure routes. These are also regulated differently in some cases in the federal states. If the decisions of individual stakeholders are not integrated, there is a danger that isolated, contradictory decisions will result in unnecessary risks.

In the interest of a holistic conceptualisation for the organisation of planning, approval and administrative processes, a holistic approach that meets the requirements of integrated traffic and crowd management should therefore also be taken when applying the law.

Despite varying responsibilities stemming from different legal bases and the specific applications of the law, along with the influence of state or location-specific specifications, all the involved parties must remain focused on the overarching objectives.

4 Volume of traffic and people

4.1 Initial conceptual design

To begin with, a relevant basic assessment of the event must be made. The following should be recorded:

- the event location and the nature of the event
- the expected number of people,
- the expected volume of traffic and people, differentiated in terms of space and time,
- the stakeholders involved in traffic and crowd management and the relevant interfaces,
- assessments of the safety situation and – if already available – information on planned safety measures for managing the volume of traffic and people,
- the given conditions for accessibility to the event location,
- expectations regarding the weather and the resulting requirements for putting on the event, including arrival and departure,
- experience from previous comparable events, and
- other basic parameters at the time of the event, e.g. due to construction sites or overlaps with other events.

Annex A contains a checklist that can be used for basic evaluation. Annex B contains questions that may be helpful for the further processing of relevant topics on the basis of these principles and which are dealt with in more detail below.

4.2 Forecasting the number of people arriving, departing and attending the event in time intervals

A forecast of the expected number of people is to be prepared on the basis of the determined bases. In a first step, this forecast should refer to the total number of people expected, regardless of the expected modal split.

In addition to the total number of people expected, their arrival, departure and attendance are relevant for managing the volume of traffic and people. It is necessary to forecast the time intervals in which a certain number of

- people arriving ($q_{t,\ arriving}$),
- people departing ($q_{t,\ departing}$),
- people attending ($q_{t,\ attending}$, (sum of people arriving minus people departing in previous time intervals)[1)]

are expected. Table 1 contains an exemplary estimate of people arriving, departing and attending.

The duration of the time intervals t for which a forecast is prepared is based on:

- the scale and type of event,
- the course of the event,
- the distribution of attractions at an event and the distribution of the associated public areas,
- the duration and distribution of arrival and departure times, and
- the intervals of public transport services during on-peak periods or adjustment to the capacities of the entrances/exits of the event.

1) For events with several attractions or several separable public areas and corresponding route relationships, the analysis must be carried out section by section.

Table 1: Sample estimate of people arriving at, departing from and attending a sporting event

Time	$q_{30,\ arriving}$ People arriving in the time interval via the entrances	$q_{30,\ departing}$ People departing in the time interval via the exits	$q_{30,\ attending}$ People present at the end of the time interval in the public areas
1 pm - 1.30 pm	5,000	0	5,000
1.31 pm - 2 pm	5,000	0	10,000
2.01 pm - 2.30 pm	10,000	0	20,000
2.31 pm - 3 pm	25,000	0	35,000
3.01 pm - 3.30 pm	10,000	0	45,000
3.31 pm - 4 pm	5,000	0	50,000
4.01 pm - 4.30 pm	0	0	50,000
4.31 pm - 5 pm	0	0	50,000
5.01 pm - 5.30 pm	0	5,000	45,000
5.30 pm - 6 pm	0	35,000	10,000
6.01 pm - 6.30 pm	0	10,000	0

The common time intervals “t” are 60, 30 and 15 minutes. Road traffic facilities are designed and reviewed based on peak hours, while pedestrian facilities are based on the 2-minute interval with the highest traffic load. For large, long-lasting events, such as one-day events with multiple timed attractions, forecasts of people arriving, departing and attending are typically based on hourly values. For events with just one attraction and shorter stages of arrival and departure, forecasts in a 30 or 15-minute interval range are appropriate.

Taking into account the expected length of stay, load curves should be created that reflect the expected time distribution of people arriving, departing and attending.

Annex C contains examples of load curves that were determined as part of the evaluations for events.

In the case of admission-free events (especially "free outdoor events"), the expected number of people should be differentiated according to groups of people who are seriously interested in the event and stay for a longer period of time and onlookers who only stay for a shorter time.

If data from previous or comparable events is available or surveys can be used to determine data, it should be taken into account for planning purposes.

The number of people arriving, departing and attending during the highest demand periods is a decisive factor for managing the volume of traffic and people. Depending on the type of event and the facility under consideration, the highest demand

- in a 1-hour period (q_{60}),
- in a 15-minute interval (q_{15}) and/or
- in a 1-minute interval, derived from the 2-minute interval with the highest traffic load (q_2)

is relevant at the respective facilities and must be estimated accordingly. The following sections, which deal with the individual arrival and departure routes and the public areas, will discuss this issue in more detail.

The possible number of attendees during individual time periods depends on:

- the capacity of the public areas,
- the options for safe evacuation, and
- the possible number of people on the relevant routes per time unit.

If entrance tickets are sold or access rights assigned in advance, the maximum number of people present at the same time can be estimated based on the number of entrance tickets sold or access rights assigned, plus any possible "onlookers". It is generally recommended that entrance tickets be issued in advance to avoid the congestion associated with conducting transactions on site, e.g. through the use of QR codes, to avoid overloading. If entrance tickets are not issued, the number of people expected will depend on various factors such as the day of the week, weather conditions and special individual or partial events. In such cases, the number of people should be estimated as a realistic maximum expectation.

For various types of events, empirical values from previous years are available as guide values (see Annex C). The event location, the amount of awareness of the event and its accessibility using individual transport sub-systems have a major impact on the catchment area of the event and thus on the number of people attending.

The type of event and the audience profile have a major impact on the load curve of people travelling to and from the event and the people attending in public areas. For example, admission periods of up to 90 minutes are generally accepted for concert events. If the majority of people expected to attend are season ticket holders, a shorter arrival time interval should, nevertheless, be used as a basis for calculating.

For events with a defined beginning and end, for example concerts or sporting events, the total number of people travelling to the event is usually distributed over a longer period of time, while high volumes of traffic generally occur in short periods of time during departure from the event. Nevertheless, in addition to the departure, the arrival also requires independent consideration, as the "fear of missing out" can lead to safety-critical situations, especially on pedestrian routes of the journey ("last mile").

Forecasting the number of people arriving, departing and attending in various time intervals can be an iterative process. If the capacities of individual options, routes or areas are insufficient, changes to the event concept, such as offering entertainment before and after the main event, can also be considered in order to extend the duration of arrivals and departures and thus reduce the peak volume. It may also be possible to extend the arrival and departure period, e.g. by making early arrival and late departure more worthwhile by providing good catering and entertainment at the event location. In such cases, the forecast demand must be adjusted during the planning phase.

It is important to note that the forecast must be prepared at an early stage in order to ensure sufficient lead time for planning and for any adjustments and approval processes.

4.3 Forecasting and influencing the modal split of people arriving and departing

In addition to the number of people arriving, departing and attending, the distribution to various transport modes is decisive for managing the traffic and crowd flows. It is, therefore, necessary to estimate the ratio of people travelling to and from the event by means of the individual transport modes available. The modal distribution or modal split depends on the type of event, accessibility by the individual means of transport, accessibility on foot and attendee characteristics such as age, disability, gender or social status. For example, at events predominantly attended by young people, you can expect to have a high ratio of drop-off and pick-up traffic, while at events close to the city centre with a mixed audience, you can expect to have a high ratio of cyclists, pedestrian traffic and public transport users.

Empirical values on the modal split are available from previous years for various event modes. If the modal split is difficult to estimate, it is advisable to draw up scenarios that assume different ratios.

The mode of transport chosen by people travelling to and from an event has a major impact on its environmental friendliness and compatibility with the surroundings: For example, a high motorised individual traffic ratio is usually accompanied by the highest level of emissions, and motorised individual traffic also generates the highest parking facility demands. The traffic and mobility management of an event must therefore be designed in such a way as to ensure the lowest possible motorised individual traffic ratio for people travelling to and from the event. However, people with disabilities travelling by motorised individual traffic who have an EU parking card for people with disabilities must be considered separately. Influence is exerted in the run-up to the event via various communication channels, such as newspapers, local radio and social media, through the sale of combined tickets for ticketed events and through the assignment of access rights and/or reservations.

Public transportation services (characterised by convenient and accessible connections, frequent schedules, affordability and supplementary event/night buses, potentially combined with parking facilities at start stops) should be designed to attract the adoption of eco-friendly modes of transportation. This includes enhancing cycling and pedestrian infrastructures to make these options more attractive. Experience has shown that great effects can be achieved if restrictive measures for motorised individual traffic are implemented in parallel with good eco-mobility offerings that have already been well communicated in advance. These include, in particular, parking fees that are significantly higher than the cost of travelling by public transport, as well as deliberately limiting the amount of parking facilities in conjunction with consistent parking facility surveillance.

For people travelling by motorised individual traffic, suitable information should be provided in advance, in particular about the (remaining) available parking options and the recommended route (see Section 4.1.3). In addition, information should be provided on arrival and departure as well as during the event via social media, local radio and/or by announcements at train stations and stops and through variable message signs. To a lesser extent, information about already full car parks in the vicinity of the event can also be used to encourage people to switch to eco-mobility options while travelling to the event.

Responsibilities for the creation, provision and distribution of information content should be clarified in advance of the event. A detailed timetable should be drawn up for the provision of information, wherein contradictory or outdated information should be avoided. The use of a standardised logo or layout can improve the distribution of information to the event.

The choice of the appropriate way to communicate information depends on the issue and the target group concerned. A list of possible information content and a distribution to target groups in conjunction with possible communication media is summarised in Table 2. Since the devastating 2021 floods in Germany, cell broadcasting systems have also come back into focus. The extent to which these can also be used at events in the future is currently not foreseeable.

Further information, in particular on influencing the modal split, can be found in the "Recommendations for the Implementation of Mobility Management" (EAM) [FGSV 2018a)].

Table 2: Overview of possible information contents for various target groups via possible communication media

Question/topic	Target groups	Internet/ social media	Leaflets/flyers	Event programme	Posters/notices	Press	Radio	On-site announcements	Signposting and parking guidance systems
Target group-specific parking bay and parking space allocation	People prior to and on arrival, car park operators, traffic marshals, stewards, VIPs, representatives and organisations of people with disabilities, coach operators	X	X	X		X	X		X
Parking concept for available parking facilities	Car park operators, traffic marshals	X	X					X	X
Traffic management plan/ arrival and departure information	People prior to and on arrival and departure	X	X	X		X	X		X
Stops/driveways for vehicles	People prior to and on arrival and departure, shuttle and limousine service, organisations of people with disabilities	X	X	X		X			
Public transport (special) timetables	People prior to and on arrival and departure	X	X	X	X	X	X	X	
Degree of accessibility of public transport, shuttle services and pedestrian routes	Representatives and organisations of people with disabilities	X		X		X			
Shuttle transport plan	People prior to and on arrival and departure, shuttle service operators	X	X	X	X	X	X	X	
Cycle route plan	People prior to and on arrival	X	X	X		X			
Bike racks	People prior to and on arrival	X	X	X	X	X			
Bike+Ride	People prior to and on arrival	X	X	X	X	X			
Accessibility on foot	People prior to and on arrival, stewards, taxi services, public transport staff	X	X	X	X	X		X	
Pedestrian routes, entrances/exits, security search systems, public areas	People prior to and on arrivals and departures, stewards	X	X	X	X	X		X	
Taxi service concept	People prior to and on arrival, Taxi services	X	X	X	X	X			
Additional use of public areas	Logistics companies, set-up and dismantling, local residents	X	X			X	X		
Protection of local residents	Local residents	X	X			X	X		
Information on supply options and luggage storage	People prior to and on arrival	X	X	X	X	X	X	X	

4.4 Demand of normal traffic

Knowledge of the normal traffic situation without an event is an essential basis for preparing traffic and crowd management of an event. Relevant for consideration are those facilities along arrival and departure routes where, in the sum of normal and event traffic, potentially high capacity utilisation or even overloading could occur during individual periods.

If no information or only incomplete information on normal traffic is available, traffic surveys must be carried out. Demand data for motorised individual traffic, standing traffic and public transport are generally relevant for preparing the management of the volume of traffic and people. If cycling and/or pedestrian facilities that are already heavily used in normal traffic are also to be utilised, demand data for these facilities is also relevant.

The methods and options for gathering demand data can be found in the "Recommendations for Traffic Surveys" (EVE) [FGSV 2012a)].

To provide sufficient capacity for arrivals and departures, strategies for influencing normal traffic in areas and times of arrival and departure are suitable. By informing the population properly and at an early stage about the expected and anticipated event-related traffic demand, it is possible to significantly reduce the demand for normal traffic. For example, local residents can move their shopping trips to other times, commuters can adjust their working hours or choose other means of transport if they are made aware at an early stage that congestion is to be expected on certain routes at certain times. Irrespective of this, local residents should be informed about expected restrictions. As a rule, this group of people are more likely to be disadvantaged by events. Early information can contribute to greater acceptance of the event and of the negative impacts of the event traffic.

Public area closures, especially, can disrupt the access of local residents to essential care, delivery and courier services. Therefore, providing early information enables adequate adjustments to mitigate these impacts.

In the case of extensive but rather minor restrictions e.g. changes to traffic routing, information can be provided through the media. In the case of more serious restrictions, like closing off residential roads, it is advisable to communicate directly with residents through personal letters or direct outreach. In principle, informing local residents about various restrictions can increase the acceptance of events. Information should be passed on as early as possible so that this group can adjust to changes, but only far enough in advance of the event so that the date is not forgotten. Two to three weeks before the event is recommended as a suitable time period.

4.5 Estimating and presenting demand as a basis for planning

As a basis for planning, the expected demand for event and normal traffic must be determined in total and presented in such a way that the demand peaks at all relevant facilities for the management of the volume of traffic and people are covered. As a rule, the presentation includes the expected:

- cross-section-related volumes of traffic on route sections for motorised traffic,
- volume of motorised traffic at junctions,
- volume of traffic entering and exiting available parking facilities,
- capacity utilisation of available parking facilities, taking into account parking bays for disabled people with parking authorisation,
- volume of traffic of public transport vehicles travelling to and from public transport stops,
- volume of people on pedestrian routes and in particular at entrances/exits, at security search systems and in narrow sections, and
- volume of people in public areas.

If high utilisation of the bicycle traffic infrastructure is expected in individual cases, the expected flow of bicycle traffic at crossings and junctions relevant to the analysis and the expected utilisation of bike racks must also be presented.

If an analysis of the immediate area around the event site is sufficient, the expected volumes of traffic can generally it is determined that "manually" transferred to the immediately adjacent traffic network and used as a basis for planning. As soon as a larger network section with numerous facilities and mutual interactions is to be considered, the use of a macroscopic and/or microscopic traffic model may be necessary.

5 Moving and standing motorised traffic

5.1 Moving motorised traffic

5.1.1 Testing, planning and implementing measures in the road network

Based on the planning principles outlined in Section 3, a comprehensive list of measures for managing both moving and standing traffic is derived and subsequently implemented (Figure 3).

The main objective of traffic management for moving traffic and parking facility management is to ensure that sufficient capacity is available at junctions, on route sections and in parking facilities. If necessary, (usually temporary) measures such as targeted routing of event traffic, the creation of additional capacity in the road network (for example through one-way regulations) or the creation of additional available parking facilities (for example through the use of company car parks or brownfield sites) must be prepared and implemented.

The following steps are to be carried out for this purpose:

- Step 1: Determining arrival/departure routes and the distribution of people travelling to and from the event on these routes,
- Step 2: Checking performance,
- Step 3: Creating and implementing a catalogue of measures.

Step 1: Determining arrival/departure routes

The first step is to analyse the accessibility of the town/event site. Outside urban areas, these access routes can be motorways and rural roads and, in the case of events

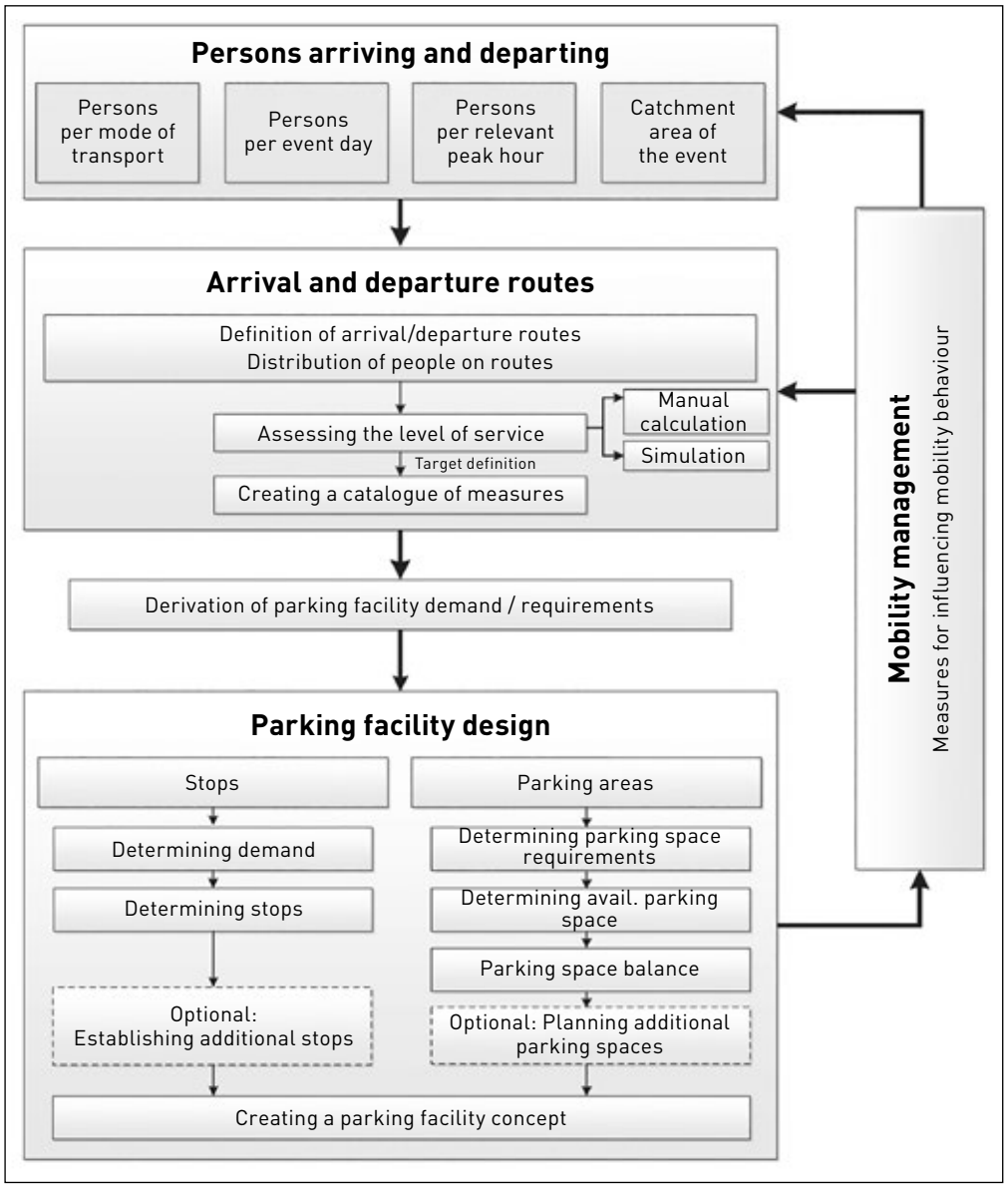

Figure 3: Procedure for drawing up a catalogue of traffic management measures for moving and standing motorised traffic

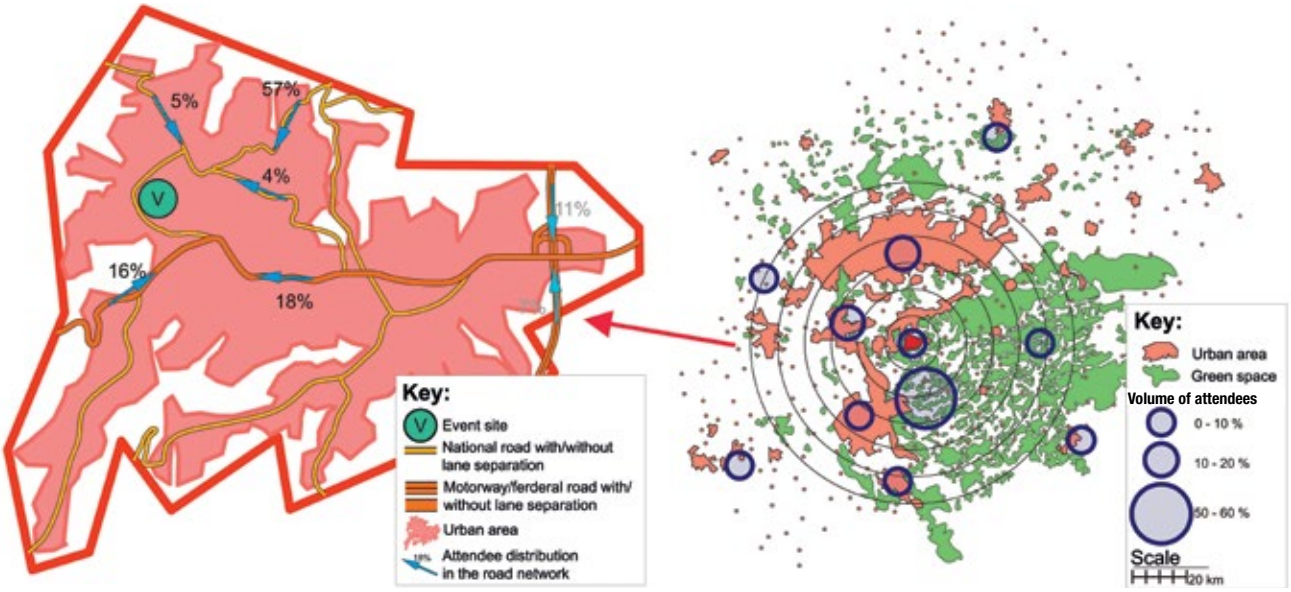

Figure 4: Distribution of incoming traffic on arrival routes (source: BaSiGo 2015)

within a municipality, local main roads and residential roads.

An estimate must then be made of how the people travelling to and from the event are distributed along arrival and departure routes. The distribution of local residents in the assumed catchment area can help here (example: Figure 4).

The routes can be influenced by extensive signposting if necessary, but they depend, in particular, on:

- the location of the event (entrances, exits, distribution in public areas), and
- the spatial distribution of available parking facilities.

Consideration of the routes taken by people travelling to the event is required to check the efficiency and sensible placement of signage.

Step 2: Designing traffic facilities, checking capacities and the quality of traffic flow

To ensure hassle-free arrival, it should be checked whether the roads intended for arrival and departure can accommodate the event traffic in addition to the expected normal traffic or whether unacceptable congestion is to be expected. In particular, this should also include:

- overlapping events taking place at the same time or the simultaneous arrival or departure of traffic for various events,
- route sections that need to be kept clear as emergency routes, and
- closures due to the type of event (e.g. a marathon) or the public areas affected (e.g. wide areas of the town centre).

If overlapping occurs, it should be noted that the peak periods of normal traffic are generally not at the same times as the peak periods of an event. The highest volumes of traffic in the sum of expected event and normal traffic are decisive.

The objective is to ensure that everyone travelling to the event can reach the public areas in time for the anticipated commencement of the planned experience. As a rule, congestion in moving traffic or loss times before clearing standing traffic can be accepted to the extent that this objective can still be achieved. Departing passengers should also not have to put up with unreasonably long waiting times, as this can also lead to safety-relevant manoeuvres on departure. If these objectives are not guaranteed with the existing transport installations and traffic regulations, measures must be developed to ensure them.

Performance calculations and verifications of the quality of traffic using manual calculations in accordance with the "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015] can provide an indication of how to check these objectives. For complex conditions and interactions between the individual arrival and departure routes, traffic simulation models and in particular micro-models should be used.

Annex D explains the principles on which manual calculations and simulations are based and which principles are relevant when considering capacity, the achievable relevant volumes of traffic and the speeds to be used as a basis.

When applying the manual calculation methods presented in the "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015], proof of the quality level of traffic flow (QSV) D is generally provided for the design interval considered to be decisive, i.e. the volume of traffic in the peak hour in the most frequently used hourly interval of the expected event and normal traffic period. As the capacities

of the traffic facilities are defined as the limit between the quality level of traffic flow (QSV) E and F in accordance with the "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015], there are generally still possibilities to compensate for fluctuations in the volume of traffic with high peak traffic of a short duration, which can lead to congestion, in the hourly interval.

Waiting and loss times due to congestion increase progressively with increasing volumes of traffic close to capacity, i.e. particularly in situations that are to be assessed with the quality level of traffic flow (QSV) E according to the "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015], and are also subject to significant random fluctuations (unstable traffic flow). The standard requirement outlined in the quality of traffic flow (QSV) D should prioritise avoiding volumes traffic nearing capacity, thereby preventing overloading. This entails steering clear of volumes of traffic surpassing capacity, as assessed by the quality of traffic flow (QSV) F according to the "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015]. Exceeding capacity can lead to tailbacks and waiting times of such magnitude that they become difficult to calculate, significantly impacting journey safety due to a heightened motivation to reach the destination along the "last mile" ("fear of missing out") and affecting travel comfort to and from the destination.

Only in exceptional cases, i.e. departures following the conclusion of an event or during pronounced peak traffic occurring at 15-minute intervals, traffic facilities may be designed for moving motorised traffic as part of the traffic management strategy utilising the quality of traffic flow (QSV) E (capacity limit) through manual calculation.

In such instances, occasional longer periods of congestion can be tolerated, as they can be mitigated in subsequent 15-minute intervals. This ensures attendees can travel home after an event without the "fear of missing out". Nevertheless, care must be taken to ensure that the expected waiting and loss times on departure, which generally involve higher but shorter peak traffic compared to arrival, are not unreasonably high.

In the case of a pronounced peak volume of traffic in 15-minute intervals (q_{15}), which are above the usual third of an hourly peak volume of traffic, proof of the quality of traffic flow (QSV) E can be provided as an alternative to proof of the quality of traffic flow (QSV) D when using the manual calculation method, even in arrival traffic, if

- the load of the most frequently used 15-minute interval (q_{15}) is extrapolated by a factor of 4 to an hourly volume of traffic (q_{60}) as the design volume of traffic,
- a buffer to be determined in each individual case is planned so that the design volume of traffic does not reach the capacity (limit between E and F), and
- there are sufficient time resources, taking into account the time required for the "last mile" to reach the seats and/or standing areas or the spectator zones and the start of the event.

If simulation models are used, they should primarily serve to determine and evaluate the time required to manage the volume of traffic travelling to and from the event. Taking into account the time required to cover the pedestrian routes to the public areas, all those travelling to the event should be able to reach the public areas at a time when the expected experience begins. As a rule, it will make sense to include all arrival and departure routes in simulation models in an area close to the public areas – to be determined on a case-by-case basis (see Figure 5 for an example). This allows both moving traffic and pedestrian traffic performance deficits to be identified and the effects of measures to be checked.

Simulations can help to identify areas of congestion and enable parameter studies on the basis of which alterna-

Figure 5: Example of a micro-simulation of arrival at and departure from the public areas of an event
(source: ptv AG)

tive traffic routes can be analysed. In particular, the joint processing and time-synchronised display of the capacity utilisation of footpaths and carriageways make it possible to intuitively identify where both modes of transport may interfere with each other or where there is potential to resolve bottlenecks through the re-distribution of the available space. While the animations of the simulation results are visually appealing, it is important to recognise that these simulations are only as accurate as the models and assumptions upon which they are based (Guidelines for Microscopic Evacuation Analyses (RiMEA 2016)). Assumptions made during simulation setup and uncertainties concerning input parameters – ranging from demand fluctuations to the parameterisation of driving and walking behaviour – should be documented and considered during the interpretation phase.

Step 3: Creating a catalogue of measures

If the aforesaid objectives cannot be achieved with the existing transport services, measures must be developed, tested and selected and then coordinated with all the relevant stakeholders prior to implementation. The measures for planning and putting on an event should be documented and overall operation evaluated, thereby facilitating the continuous refinement and enhancement of future events.

Suitable measures for controlling or influencing moving motorised traffic can be, for example:

- traffic control through event signposting (if several events overlap: differentiated signposting),
- utilising suitable signal programmes,
- one-way traffic regulations,
- modifying lane assignments at junctions (e.g. additional slip lanes),
- temporally and spatially limited closure of sections of roads or squares,
- relocation or staggered release of available parking facilities, and
- setting up a shuttle transport service.

The closure of roads and squares may also be carried out in connection with fan separation measures or the establishment of buffer zones and must be coordinated with the security authorities.

If it is to be expected that a large number of attendees will miss the start of the expected event, it must be considered whether or not to delay the start of the event accordingly.

The assessment of the quality of traffic and subsequent formulation of relevant measures, the planning of parking areas and the definition of directional signage are all interlinked and iterative processes integral to developing a catalogue of measures. If, for example, it turns out at the beginning that the quality of traffic at a junction is insufficient, a change in the allocation of the parking area and a corresponding design of the directional signage can lead to changed traffic loads on the arrival routes and thus also to changed results in the verification of the quality of traffic of the corresponding junction.

Before, during and after the event and on arrival and departure periods, volumes of traffic and lengths of tailbacks should be recorded and monitored, at least at those traffic facilities where high utilisation rates are expected. If unexpectedly long waiting and/or loss times occur – for example due to unforeseeable events such as accidents or breakdowns – which jeopardise the achievement of the aforesaid objectives, suitable measures must be taken in response. These can be temporary traffic management measures to control or influence moving motorised traffic, such as providing additional lanes on arrival routes and/or for entering parking areas. If it turns out that a significant number of people travelling to the event are likely to miss the start of the expected experience, consideration should be given as to whether or not the start of the event should be delayed.

Information on surveying traffic can be found in the Recommendations for Traffic Surveys (EVE) [FGSV 2012a].

5.1.2 Signposting

Directional signage provides orientation for people travelling to and from the public areas. In addition, it may be necessary to set up temporary signposting for traffic travelling to and from the immediate vicinity and for through traffic in the event of diversions.

The signage should maintain consistency to ensure drivers and pedestrians know which routes they should and should not use.

Static, dynamic or manual signposts should be provided where orientation – for example when turning, turning off and crossing motorised traffic or pedestrian traffic – needs to be supported. The extent to which existing signposting and parking guidance systems can or must be used, switched off or concealed needs to be checked. If closures are planned, diversion signage should, if necessary, be set up.

The following regulations, in particular, can be used for signposting:

- "Guidelines for the Installation of Non-Official Signposts for Trade Fairs, Exhibitions, Sporting Events and Similar Temporary Large-Scale Events" [FGSV 2010],
- "Fact Sheet for Directional Signage for Bicycle Traffic" [FGSV 1998],
- "Directives for Route-Indicating Signage Away from Motorways" [FGSV 2000].

The installation of signs constitutes special usage with a duty to obtain a permit. If this is ordered within the framework of Section 45 (1) Sentence 2 (5) of the German Road Traffic Regulations (StVO) (with signage in accordance with the German Road Traffic Regulations (StVO), it does not constitute special usage, but agreement must still be reached with the road construction and maintenance authority. If the signage does not comply with the German Road Traffic Regulations (StVO), a special use permit may be required in accordance with German Traffic Law (StrG) (e.g. Sections 13, 16 StrG BW), depending on the relevant

federal state. This is the responsibility of the road construction and maintenance authority.

In general, it should be noted that signposting on motorways is only used in exceptional cases and only if it is urgently required for the traffic plan. In front of junctions, signposting are generally installed before the first official signpost as an advanced sign (in urban areas at least 50 m, out of town at least 100 m in advance). Repeated signposts must be installed at suitable locations to indicate or confirm the "correct" route to drivers. Obstructions must be avoided to ensure signs are easy to see from a distance.

In general, when designing signs, it should be noted that the lettering and background must be of a visually contrasting colour and the lettering must be large enough to be easily understood from a distance and at speed by the type of traffic being addressed (motor vehicles/cyclists/pedestrians), even in the dark. Signposts should have a maximum of three lines of text (first line: event location, second/third line: name), and signs for cyclists and pedestrians should include information on the remaining distance.

For larger or recurring events, it makes sense to use modern traffic management and safety technology (see Section 5.3.3). This includes the use of LED displays that stand out clearly from the existing signs. Furthermore, traffic information boards can provide an early warning of traffic disruptions caused by the event.

Signs should only be installed or in operation for as long as they are required for the event. Consent to install temporary signs should be obtained from the land or property owner in good time.

In the run-up to the event, signposting should be publicised and compliance with them promoted to prevent drivers following satellite navigation systems, which do not necessarily take temporary diversions into account.

5.1.3 Traffic control

Traffic management should be prepared and implemented to direct and control traffic and crowd flows. The different responsibilities generally require a cross-organisational structure. Interaction with the event and security organisation, with the relevant agencies and authorities and with the public transport authorities must be defined and implemented.

To coordinate the tasks involved in traffic management and to record and monitor the volume of traffic, it is advisable to set up a control centre that monitors and controls all arrival and departure routes.

The control centre should take on the tasks of presenting the situation and coordinating control and management measures, including information and communication with people arriving and departing and with all the institutions involved, such as the police, fire and medical services. It is also advisable to document events and decisions.

Depending on the risk situation and volume of tasks, liaison officers from the institutions involved should be sent to the control centre. Depending on the event, the control centre can be staffed as follows:

- head of the control centre, who is also the contact for event management,
- staff who present and document the overall situation,
- staff who coordinate various measures, including information and communication,
- police liaison officer, possibly from both the federal and the state police forces,
- fire and rescue service liaison officer,
- medical service liaison officer,
- public order office/traffic authority liaison officer and, if necessary, road administration liaison officer,
- public transport liaison officer, and
- shuttle service liaison officer, if necessary.

Traffic control and management can be divided into various sections according to the specific requirements, which are assigned to the individual arrival and departure routes. Such sections can be, for example, the large-scale road network with motorways and rural roads, the local road network with inner-city streets, including cycling and pedestrian facilities, public transport, possibly divided into long-distance and local transport and rail and bus transport, the pedestrian routes between the train station/stop/available parking facilities and public areas ("last mile") and the public areas in the core area of the event. Crowd management for the pedestrian routes and public areas is discussed in more detail in Sections 8 and 9.

The control centre monitors the traffic flow and responds to relevant disruptions. It coordinates traffic control to predefined destinations (e.g. facilities for standing traffic) in consultation with other institutions, such as the police. If relevant disruptions occur, measures should be coordinated and implemented in order to reduce congestion and speed up processes.

The deployment of law enforcement and security staff is generally indispensable in the context of traffic control, but they do not generally have any sovereign powers.

For events with an increased volume of people before and/or after the end of the event, it may be prudent to adjust light signal system controls or deploy skilled traffic control staff to flexibly manage conflict areas in parking facilities or on the road network, releasing individual flows for longer phases as needed. To this end, contact should be made with the responsible authorities in advance of the event and the further procedure agreed with them. It may also make sense to use mobile light signalling technology. Sufficient lead time must be ensured.

It is advisable to communicate traffic control measures to people travelling to and from the event as part of the planning prior to the event. In particular, information on arrival and departure via flyers, event website, social networks, local radio, etc.; dedicated event apps and traffic reporting services offer the opportunity to issue traffic recommendations, which can also be done at short notice. The option of using scrolling signs on passenger information systems

at local public transport stops to draw attention to disruptions or closures of stops and transfer recommendations should be utilised. Communication options on the arrival and departure routes and in public areas should be identified in advance, and it should then be checked whether it, is possible and sensible to use them. If no adequate communication options are available, they should be created in advance.

Sections 8 and 9 contain further information on communication between the institutions involved and with the people travelling to and from the event and in public areas.

5.2 Safety management for the road infrastructure

Road safety when driving, cycling or walking to and from the event depends on the risk of accidents, which can vary depending on the junction, the route section and the traffic infrastructure, and can be above average on individual routes of the journey to and from the event.

Event organisers and the responsible authorities, including the local police, have the opportunity to be proactive and use their knowledge of accident situations along key routes to and from the event to assist road safety for people travelling to and from the event. Particularly in the case of recurring events at an event location, it makes sense to identify accident-prone traffic locations and take measures to minimise the overall risk. These can be, for example, structural measures (usually in the care of the public works authority) or traffic regulation measures (usually in the care of the regulatory agency) or safety measures (usually in the care of the police or the event organiser). The prerequisites for this are in place – accidents are systematically analysed and standardised and effective instruments for proactive and reactive road safety work are available.

The web-based and freely available Accident Atlas is a publicly accessible source of information. Information on all accidents involving personal injury registered by the police is available online for all to see (see Figure 6 for an example). Individual characteristics, such as the involvement of cyclists or pedestrians, can be filtered and analysed separately. If accidents occur more frequently in the vicinity of event locations, it is likely that the local conditions and safety deficits observed there are a cause of the accident.

Event organisers, authorities and the police should aim to take preventative action and work together to create basic parameters in which errors are not punished, and accidents cannot happen in the first place; and to take reactive action where certain types of accidents occur frequently in a given time, and in a given area.

The instruments that can be used in coordination with the competent authorities, which utilise police accident recording data in addition to publicly available sources, are in particular:

- investigation and elimination of accident clusters by means of local accident investigations and safety analyses of road networks, and
- inspection of the applicable road network by means of safety audits of existing roads, route inspections and traffic inspections.

The individual procedures were first described in Articles 3 to 6 of Directive 2008/96/EC of the European Parliament and of the Council of 19 November 2008 on road infrastructure safety management (European Union 1998-2006) and have been transposed into national law in the European Member States. The EU directive was updated in October 2019 (Directive (EU) 2019/1936).

If there are concerns about road safety on arrival and departure routes and/or if there are frequent accidents in specific areas, it is advisable to use these instruments in consultation with the competent authorities and, if necessary, to call in external expertise. This can be the accident commission members of the respective municipality or certified safety auditors. The Federal Highway Research Institute (BASt) maintains a list of certified auditors who can assist in the identification of safety deficits and the selection of suitable measures.

Further details on the applicable instruments can be found in the "Leaflet on Local Accident Investigations in Accident Commissions" (M Uko) [FGSV 2012b], the "Recommendations for Safety Analysis of Road Networks" (ESN) [FGSV 2003] and the "Guidelines for the Safety Audit of Roads" (RSAS) [FGSV 2019].

5.3 Parking facility management

5.3.1 Designing the available parking facilities

The design of the available parking facilities for events is generally carried out in five planning steps.

Step 1: Determining the parking facility demand

The number of parking bays or parking spaces required is determined by the number of people expected, the location and the availability of public transport (see [FGSV) 2005]) or is based on the expected traffic and crowd flows (see Section 4).

The following parameters are required to determine parking facility demands (see Section 4):

- forecast number of people arriving and expected length of stay,
- forecast or target share of motorised transport in the modal split,
- occupancy rate and turnover rate of motor vehicles.

Orientation values can also be found in Annex C. In principle, the aim should be to maximise the share of eco-mobility in the modal split.

In addition to the parking areas for people travelling to the event, the following areas should generally be planned:

- special parking areas for people with limited mobility, VIPs, employees, media representatives,
- stop zones/parking areas for coaches (possibly also for motorhomes, motorcycles),

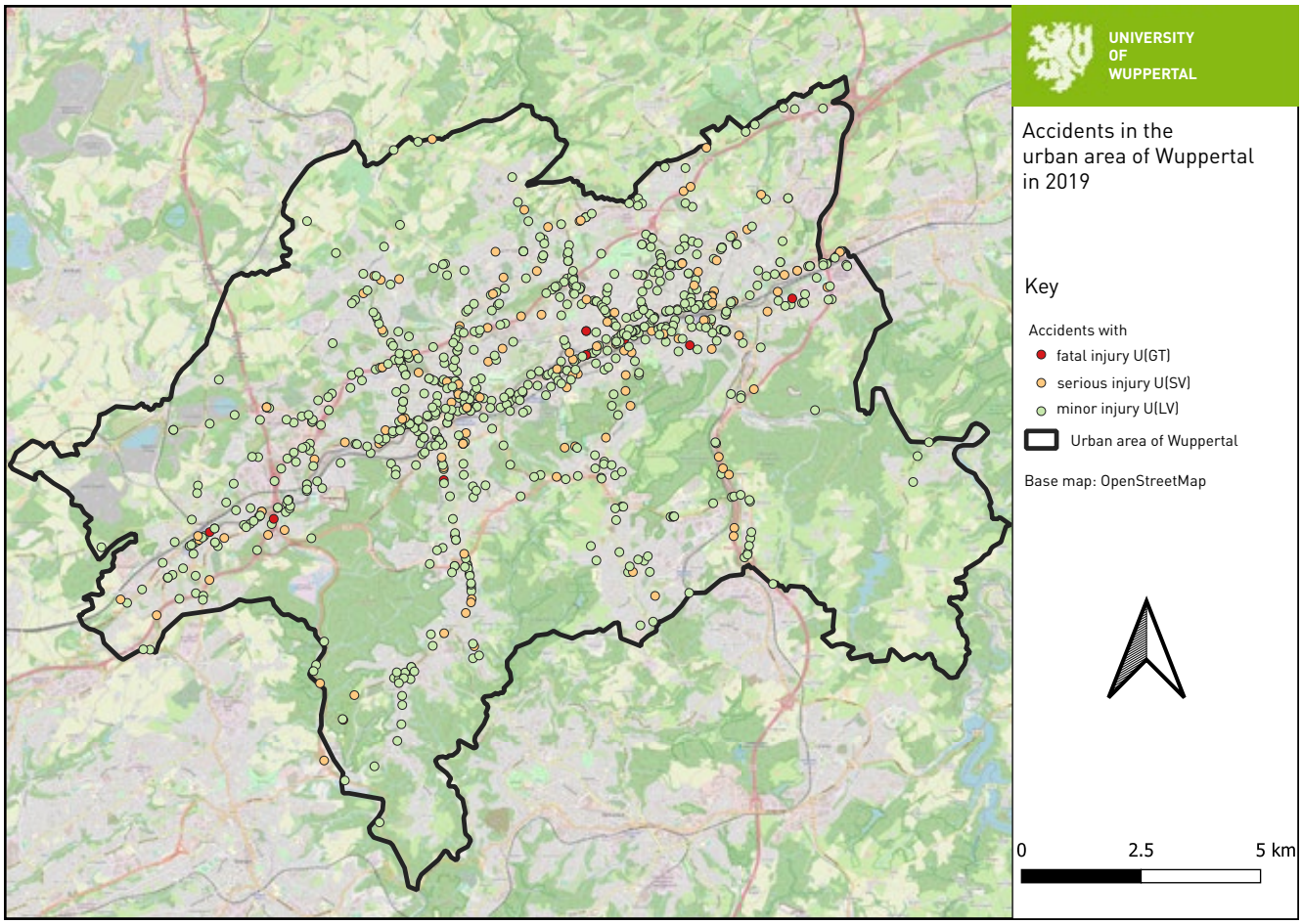

Figure 6: Example of a map of all accidents with personal injury in one year from the Accident Atlas as the information source (https://unfallatlas.statistikportal.de/)

- stop zones for the shuttle service, and
- stop zones for taxis and pick-up and drop-off traffic,
- stop zones/parking areas for public safety authorities and organisations.

Stop zones for pick-up and drop-off traffic should be provided especially at events where a high ratio of young people are expected. If a high number of people are expected to be picked up by car, a plan should be created for how the people being picked up and the people picking them up can find each other. It should be noted in particular that mobile phone networks are often operating at full capacity during events. A decentralised distribution of the pick-up zones (e.g. according to the various arrival routes) has proven to be practicable.

The following calculations can be used to determine the number of parking bays required:

- forecast number of people (with motor vehicles) = forecast people · motorised individual traffic ratio
- arriving motor vehicles = forecast number of people (with motor vehicles)/motor vehicle occupancy rate
- required parking bays = arriving motor vehicles/turnover rate, or
- required parking bays = arriving motor vehicles · ratio of maximum number of persons in attendance

For example, with a forecast 10,000 attendees in one day, a 55% motorised individual traffic ratio, an average occupancy rate of 2.8 persons per motor vehicle and a motor vehicle turnover rate of 3 (or a maximum attendance limit of 34%), 660 parking bays or parking spaces would be needed to accommodate event traffic throughout the day.

Depending on the load curve or timing distribution of people arriving, departing and attending, the parking facility demand may vary in individual time periods.

Step 2: Determining the existing and available parking facility

The first step is to check which parking facilities are available and can be used in the vicinity of the event site. This may include municipal car parks as well as private car parks/multi-storey car parks belonging to retail outlets and commercial offices or companies, for example.

For the available parking facilities, the total number of, available parking bays or parking spaces should be determined taking into account any occupancy by normal traffic and estimating how many parking bays are available for event traffic during the relevant time periods.

If precise information on the number of parking bays in an area is not available, the values in Table 3 can be used to roughly determine the number of existing parking bays.

Requirements, recommendations and information on the arrangement of parking bays or parking spaces and the associated lanes can be found in the "Recommendations for Standing Traffic Facilities" (EAR) [FGSV) 2005]. More detailed information on the dimensions and turning curves of design vehicles can be found in the "Guidelines for Design Vehicles and Minimum Turning Curves for Testing the Trafficability of Traffic Areas" (RBSV) [FGSV 2020a].

Step 3: Parking area balance

The comparison of the parking facility demand determined in step 1 and the available parking area determined in step 2 provides the number of – usually temporary – new parking bays that need to be created.

Step 4: Expanding or reducing the available parking facilities

If the existing parking facility capacities are deemed insufficient, further options for parking areas for event traffic must be sought. Brownfield sites or fields could also be considered for parking event traffic. However, with regard to parking bays for disabled people with parking authorisation, care should generally be taken to ensure that the, ground is only slightly sloping, suitable for wheelchairs with very few irregularities, and not slippery.

In addition, people travelling to the event can be influenced in their choice of means of transport via various media, thus changing the modal split. Deliberately reducing the available parking facilities and communicating this fact can also be part of traffic management.

Table 4 provides guidelines for space requirements in unmarked parking areas, including lanes, for planning the final available parking facilities

Figure 7 shows a sketch of various types of parking layouts. When selecting a parking layout, the position of the entrances/exits may have to be taken into account.

When parking in longitudinal or transverse rows, a distinction can be made between parallel, angle and perpendicular parking. The advantages and disadvantages of these parking layouts and the respective dimensions are shown in Table 5.

According to the dimensions in Table 5, 4 - 5 parking bays or parking spaces (including the lane) can be achieved per 100 m^2 depending on the angle and width of the lane.

The "Recommendations for Standing Traffic Facilities" (EAR) [FGSV) 2005] contain further information on the space requirements for marked parking areas. By way of comparison, Table 6 shows examples of the evaluated space requirements of parking layouts in parking areas at selected events. Values for marked parking areas should be corrected downwards for unmarked areas in parking rows, as existing areas can rarely be optimally utilised and often leave residual spaces that cannot be used for parking. If separators, such as a curb at the edge of the road, are available, the information from the "Recommendations for Standing Traffic Facilities" (EAR) can be used and, if necessary, corrected slightly upwards, as drivers do not reverse into spaces (space required for the length of a parking bay when reversing is 5.70 m) as the parking row is filled from behind with smaller distances between vehicles (evaluated average length of a parking bay in one surveyed case was 5.20 m).

Further details can be found in the "Recommendations for Standing Traffic Facilities" (EAR) [FGSV) 2005].

Step 5: Determining parking facility management

The goal of parking facility management is to fill available parking facilities according to expected traffic demand and evaluations of the flow of moving traffic, thereby minimising the need for drivers to search for parking spaces. Parking facility management can include:

- parking management,
- allocation of certain parking areas for specific purposes and groups of people,
- staggering the release and filling of certain parking areas,
- parking guidance system, and

Table 3: Space requirement for different types of parking layout

Type of parking layout	Space requirement
Perpendicular parking at the roadside	2.50 m per parking bay/parking space 3.50 m per parking bay/parking space for disabled people with parking authorisation
Parallel parking at roadside	With markings: Length 5.70 m per parking bay/parking space, width 2.15 m (taking into account the design vehicle "passenger vehicle" according to the "Guidelines for Design Vehicles and Minimum Turning Curves for Testing the Trafficability of Traffic Areas" (RBSV) [FGSV 2020a]) Without markings: Length 5.30 m per parking bay/parking space, width 2.15 m (taking into account the design vehicle "passenger vehicle" according to the "Guidelines for Design Vehicles and Minimum Turning Curves for Testing the Trafficability of Traffic Areas" (RBSV) [FGSV 2020a])
Angled parking bays at roadside	Depending on the angle e.g. with a 45 degree parking angle: 3.54 m per parking bay/parking space + 3.54 m back offset
Car park, including lane	20 - 30 m^2/car parking bay/parking space

Table 4: Advantages and disadvantages as well as space requirements of parking layouts for parking facilities [IVM 2007]

Parking layout of unmarked parking areas	Advantages	Disadvantages	Space requirements, including lane
Illegal parking (generally not recommended)	no staff required	– no controlled/organised parking – parked vehicles and blocked lanes are to be expected – disabled people with parking authorisation cannot park safely	≥ 40 m²/car parking bay/ parking space
Parallel or perpendicular parking	– no trapped parking – individual departure possible – re-filling possible	– higher staff demands – increased need for temporary closure measures (e.g. barrier tape)	20-30 m²/car parking bay/ parking space
Block/convoy layout (only recommended in exceptional cases)	– less staff required – decreased need for temporary closure measures (e.g. barrier tape)	– trapped parking – individual departure not possible	15-20 m²/car parking bay/ parking space
Coach parking bay			120-150 m²/coach parking bay

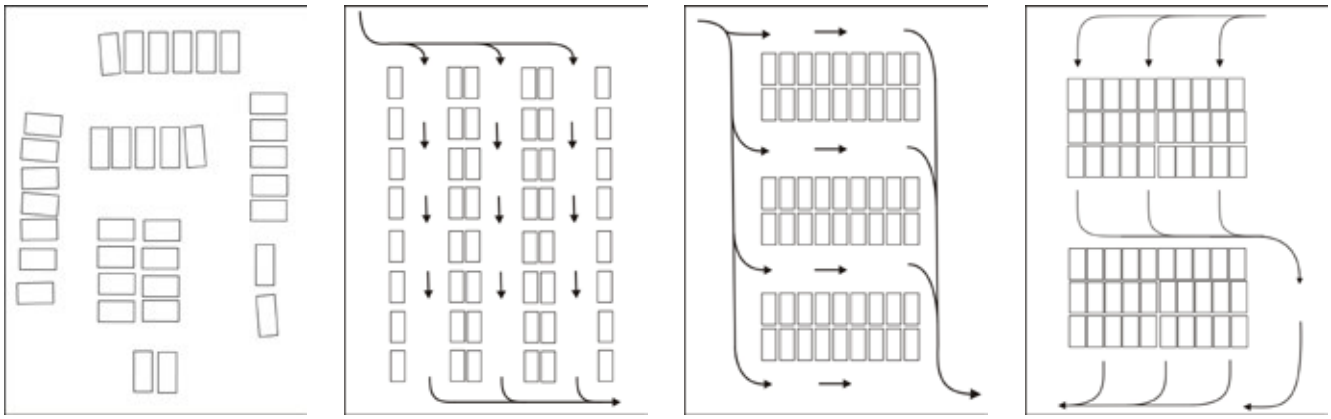

Figure 7: Illegal parking, parallel parking bays, perpendicular parking bays, block parking (from left to right) (source: BaSiGo 2015)

Table 5: Advantages and disadvantages of parking layouts

Parking layout in rows	Advantages	Disadvantages	Dimensions
Parallel parking	– quick (initial) parking possible – "relatively" simple parking of vehicles	– high space requirements due to larger number of lanes – arrangement of parking bays/parking spaces for disabled people with parking authorisation may be problematic due to the access route	Width of the parking lane ~ 2.15 m (taking into account the design vehicle "passenger vehicle" according to the "Guidelines for Design Vehicles and Minimum Turning Curves for Testing the Trafficability of Traffic Areas" (RBSV) [FGSV 2020a]); length per passenger vehicle ~ 6 m
Angled parking	– quick parking (even with lane-based approach) – significantly narrower lanes possible when operated in one direction	– difficult to align vehicles evenly – danger of "wandering" rows and narrow lanes	Depth of the parking lane ~ 5 m Width per passenger vehicle ~ 2.50 m - 3.50 m
Perpendicular parking	– "relatively" simple parking of vehicles – good space utilisation – easy re-occupation	delays in parking possible with lane-related approach	Depth of the parking lane ~ 5 m Width per passenger vehicle ~ 2.50 m Width per parking bay/parking space for disabled people with parking authorisation 3.50 m

Table 6: Ranges for space requirements for parking bays depending on the source (FGSV 2005; BaSiGo 2015)

	Basis	Parking bays per 100 m² (including lanes)
Parallel parking	EAR (Tables F-1, F-2, classification B_e)	4.0
	"Hessentag"	3.5 to 4.1
Perpendicular parking	EAR (Tables F-1, F-2, classification B_Z)	5.0
	"Lüntenbeck castle" Christmas market	2.9
	"Annakirmes" fun fair Düren	3.0
	Open air event "WDR 2 für eine Stadt", Remscheid	3.7
		parking bays per 100 metres
Roadside parking, parallel	EAR	17.5
	Open air event WDR 2 für eine Stadt, Remscheid	19.2

- installations for managing and controlling the transition between moving and standing traffic.

If parking management is planned, it is usually achieved through the collection of payments by hand, ticket machines or check-in/check-out systems at entrances/exits.

For certain purposes and for certain groups of people, it is usually necessary to reserve individual parking areas. As a rule, special parking prioritisation can and must be used to reserve or keep clear parking areas for:

- people with limited mobility (disabled people with parking authorisation),
- medical and rescue services, fire service and police,
- media representatives, artists and VIPs,
- staff, security operatives, stewards,
- delivery traffic,
- coach traffic,
- taxi services and drop-off/pick-up traffic, and
- shuttle service if necessary.

Depending on the location of the individual parking areas, traffic management for moving traffic, and the deployment of staff for controlling and managing parking operations as part of parking management, it may be necessary to stagger the release or filling of individual parking areas.

A parking guidance system serves to provide orientation, to stagger the filling of individual parking areas and to avoid having to search for parking.

Appropriate check in and control in the transition between moving traffic and standing traffic is intended to avoid long waiting and loss times when travelling to and from the parking facility.

Individual aspects of parking facility management are discussed in more detail in the following sections.

5.3.2 Entrances and exits to and from parking areas, including check in and control

Parking areas with free entrance/exit generally fall into either a managed or an unmanaged category. If existing public parking areas are used by event traffic, they are usually managed with ticket machines. In private event parking areas without controlled entrance/exit, members of staff can collect parking fees from drivers near to their selected parking bay upon arrival. In the case of large parking areas, traffic marshals should be used to ensure the safe, efficient movement and parking of vehicles. The cashiers move through the parking area as it fills up. In addition, for large parking areas, marshals should be used to speed up the vehicle allocation to the parking area and minimise disruptions to the flow of traffic arriving at the parking area.

For large parking areas, well signposted and efficient traffic routes are essential for vehicles entering and exiting the parking area. Traffic routes should ensure that the parking bays close to where people need to go when they leave their vehicles, are filled first followed by ones further away from their destination. This avoids unnecessary searching for parking spaces and helps keep pedestrians segregated from moving vehicles in parking areas. The layout of parking rows and lanes depends on the desired number of parking bays or parking spaces and the flow of traffic determined by the location of the entrance/exit and the demands for one-way or two-way traffic in the lanes. Lanes and parking rows should be segregated by means of physical barriers (e.g. "barrier tape") as a filling aid, or by applying markings. Parking guidance systems or signpostings that clearly indicate parking areas and lanes tell drivers about the routes they should use when entering the parking area. The exits and the routes back to the public road network should also be clearly indicated with route-indicating signage wherever necessary.

Efforts should be made to minimise waiting and loss times when filling and emptying parking areas. Furthermore, efforts should be made to minimise tailbacks on public roads caused by vehicles entering (filling) the parking area. When emptying the parking area, traffic control measures and/or members of staff should be used to ensure that the parking area empties quickly and that vehicles are able to pull away safely into the moving traffic. At longer events with a higher turnover rate, the layout of the parking areas must ensure that empty parking bays are re-utilised swiftly. Continuous monitoring of the situation in large parking areas with on-site staff and/or camera surveil-

lance is recommended to be able to respond quickly and adequately in the event of disruptions to the traffic flow.

For controlled entrance/exit, check-in systems or alternatively a collection of payments by hand at the entrance should be used. A flat-rate automatic pay system at the entrance is possible if entrance is regulated by a control terminal. The control terminal handles flat-rate parking fee payments via cash, credit card, debit card, or authorisation card, issues parking tickets and automatically opens the barrier for entering the parking area. There are then no checks when exiting the parking area. Placing control and payment processes at the exit is impractical, as it leads to long waiting times when everyone leaves the parking area at the same time after short events with a defined end time.

If public parking facilities are used, automatic entrance/exit control terminals are in operation in many cases. For event areas with recurring events, it may also be a good idea to set up automatic entrance/exit control systems. The individual system components, such as entrance control terminals that issue a ticket at the push of a button, automatic pay stations for payment of the parking fee and exit control terminals equipped with a reading slot or for the insertion of parking chips, as well as control media, e.g. parking chips, magnetic strip tickets or barcode tickets, are described in more detail in the "Recommendations for Standing Traffic Facilities" (EAR) [FGSV 2005].

Event search points, frequently used at events, must be strategically positioned and designed to suit their function, while considering the traffic impact on the surrounding road network. Criteria for designing check-in systems include the capacities, entrance/exit times, waiting and loss times and the lengths of queues in front of the check-in devices. If full capacity utilisation, i.e. complete occupancy of the parking areas, is to be expected, timely action is required using route-indicating signage and/or parking guidance systems to direct drivers to other available parking facilities.

The capacity is determined by the maximum traffic load that can be checked in by a check-in system under the specific conditions of the system used at the entrances or exits (see also Annex D).

This maximum number of vehicles to be checked in is only reached if there is a constant traffic jam in front of the check-in devices. However, if check-in systems are designed near to the capacity limit and vehicles are thus constantly queuing in front the check-in devices, long waiting times and significant lengths of queues are expected. This occurs because the check-in time for each vehicle, due to individual actions or errors when approaching and operating the control terminal, often exceeds system capacity and varies greatly, causing some high and above-average check-in times that have a major impact on the lengths of queues and waiting or loss times. Therefore, the capacity of a check-in system must be configured in such a way that the capacity utilisation achieved with the expected traffic load still leads to acceptable waiting times and lengths of queues. In this context, it must be noted that waiting times for entrance or exit increase progressively with higher traffic loads. Thus, when designing at the capacity limit, it is almost certain that an at least 30-vehicle tailback will occur at least once over the design hour, resulting in an average waiting time of over 10 minutes for drivers at the end of the queue before entering.

Traffic loads near capacity should thus be avoided – overloading, i.e. traffic loads above capacity, must be avoided at all costs, at least on arrival and entrance, as the resulting waiting times and lengths of queues can no longer be calculated, are almost impossible to reduce and have a considerable impact on safety during arrival due to an increased motivation to reach the destination on the "last mile" ("fear of missing out") and on comfort on arrival and departure.

The guide values listed in Table 7 can be used to determine check-in times and capacities at check-in systems and devices, provided the equipment and layout are suitable (e.g. good accessibility, straight-line location and not in a curve) and the control terminals function properly. The queues to be expected with 85% certainty at least once over the design hour are also given for the expected traffic loads. User errors within the usual parameters are taken into account.

There is currently no corresponding information available for a management system in which parking fees are collected by members of staff and people leaving their cars pay close to the selected parking bay. Similarly, no information is currently available on the operating times of ticket machines and pay stations.

The design must ensure that there is a sufficiently dimensioned congestion zone in front of the entrance control terminals, outside public roads. The check-in system must positioned far enough within the parking area to prevent the expected lengths of queues from negatively interfering with pedestrian and vehicle traffic on public roads. The average vehicle length, including an average distance between two vehicles, should be set at a gross distance of 6 m.

For events of longer duration with a high turnover rate, the design of the facilities and the traffic routing in front of the exits should prevent queues at the exits from blocking entrances and ensure smooth flows of traffic within the actual facility. For car parks with multi-lane check out, each lane should have a sufficiently dimensioned congestion zone to prevent drivers obstructing each other in front of the check-out system.

The "Recommendations for Standing Traffic Facilities" (EAR) [FGSV 2005)] contain further descriptions and information on check-out systems and the design of entrances/exits. The "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015] describes procedures for the design of check-in and check-out installations.

5.3.3 Parking guidance systems

Parking guidance systems aim to direct drivers to available parking areas continuously, even without knowledge of the route or navigation. If the parking facility comprises several parking areas in various locations, large announce-

ment boards should clearly indicate the entire parking facility, using simplified representations aligned with the respective direction of travel. A separate parking guidance signposting system should stand out from the rest of the signs as an additional signposting system, wherein its size and the scale and type of the font must correspond to the general signposting.

Displays of a parking guidance system should be set up where drivers make decisions about which routes they should and should not use. For longer routes with junctions or crossroads, the "straight ahead" display should be repeated as often as possible in the direction of travel. If changes of direction are necessary, respective displays must be installed.

Static parking guidance systems only indicate the location of parking areas. They can be used for events if a good spatial distribution, equal attractiveness and no overloading of the individual parking areas are expected.

Dynamic parking guidance systems with variable displays depending on the situation, which can also include manually operated signs in addition to automated systems, should be used if the connected parking areas are in high demand or utilised in a staggered manner and/or if overloading of individual parking areas is expected.

If parking guidance systems are available, they can possibly be used for the event. It must be clarified in advance to what extent they can be used, whether parts of the system need to be switched off and whether individual displays need to be covered.

It must be noted that the route guidance provided by navigation systems to event sites may not correspond with the guidance provided by parking guidance systems. In addition, the route guidance provided by navigation systems is not suitable for the staggered filling of parking areas. The dynamic modification of destinations entered into vehicle navigation systems during the journey by third parties, such as the event organiser, is currently not widespread, but developments in this direction are under way. However, to direct navigation system users to available parking facilities, it is advisable to communicate in advance that navigation devices (without compatible functionality for dynamic destination adjustment) must be switched off once the parking guidance system has started. If necessary, special addresses should be announced to ensure access to the parking guidance system. At critical decision points, it should be checked whether stewards and/or physical barriers need to be deployed.

Signposts should be placed in the parking areas to ensure correct guidance to the adjoining pedestrian routes. The routing to the parking bays or parking spaces for disabled people with parking authorisation should be communicated in advance via various media (see Table 2 in Section 4.3). Whether the integration of these parking options into the parking guidance system is necessary must be decided on a case-by-case basis (see Section 5.4).

Further recommendations for parking guidance systems can be found in the "Recommendations for Standing Traffic Facilities" (EAR) [FGSV 2005)].

5.4 Special traffic and special parking prioritisations

Special traffic (e.g. police, medical and rescue services, VIPs, delivery traffic, arriving exhibitors, staff, disabled people with parking authorisation) may require special consideration. It must be checked and agreed whether special areas for moving and standing traffic, special signposting and/or the provision of separate roads, lanes and areas are required for this type of traffic.

It should also be noted that existing parking facilities are sometimes no longer available to the general public as a result of events. If special target groups are affected (e.g. disabled parking spaces), it must be checked whether these can be relocated. It is advisable to inform the target groups concerned.

5.5 Delivery traffic and traffic of public safety authorities and organisations (BOS)

Depending on the scale of the event, determining the event location for open air events presents event organisers with problems in terms of securing delivery traffic and the use of logistics areas. For events in permanent installations that are approved as places of assembly, these issues are usually dealt with as part of the planning permission process. In the case of temporary places of assembly, transport connections and the use of areas for logistics must be applied for and approved as part of the event permit. This may involve excessive use of roads or special usage of public areas. The use and extent of a public area may change depending on the event and also during the course of an event. For example, at large festivals, open air events and other large-scale events, even over several days. The following aspects concerning delivery traffic and the use of logistics areas must be taken into account when organising an event, from the planning phase right through to putting on the event and overseeing post-event activities:

Identifying suitable traffic areas for deliveries and defining delivery routes

Depending on the type of event, different types of transport must be taken into account. In addition to light traffic (passenger vehicles, delivery vans, bicycle and pedestrian traffic) which existing traffic routes can easily accommodate, there may also be high-volume traffic that requires separate consideration and planning.

Suitable access to the event area must be checked for all traffic and guaranteed for the required periods of time. It must be communicated who receives which access authorisation.

Table 7: Capacities and expected lengths of queues at entrances/exits (according to [FGSV 2005; FGSV 2015])

Control medium	Entrance		
	Check-in time [s]		Capacity [passenger vehicle/h]
	Single vehicles	Follow-up vehicles	
Credit/debit cards	24.40	21.60	160
Prepaid/customer cards	16.40	16.70	210
Collection of payments by hand	17.80	14.90	240
Chip card tickets	10.90	10.40	340
Magnetic strip/barcode tickets/ chip coins	13.30	12.30	290
Magnetic strip tickets (side strip)	13.30	12.30	290

Control medium	Expected length of queue [passenger vehicles] in front of entrance with expected traffic load [passenger vehicles/h]							
	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]
Credit/debit cards	30	160	20	155	10	125	5	70
Prepaid/customer cards	30	210	20	180	10	150	5	100
Collection of payments by hand	30	240	20	215	10	170	5	110
Chip card tickets	30	340	20	305	10	260	5	160
Magnetic strip/barcode tickets/ chip coins	30	290	20	260	10	210	5	130
Magnetic strip tickets (side strip)	30	290	20	260	10	210	5	130

Control medium	Exit		
	Check-out time [s]		Capacity [passenger vehicles/h]
	Single vehicles	Follow-up vehicles	
Credit/debit cards	19.50	16.50	210
Prepaid/customer cards	24.90	22.00	160
Chip card tickets	11.10	9.90	360
Magnetic strip/barcode tickets/ chip coins	11.60	10.60	340
Magnetic strip tickets (side strip)	15.20	14.00	250

Control medium	Expected length of queue [passenger vehicles] in front of exit with expected traffic load [passenger vehicles/h]							
	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]	Length of queue [passenger vehicles]	Traffic load [passenger vehicles/h]
Credit/debit cards	30	210	20	190	10	155	5	80
Prepaid/customer cards	30	160	20	150	10	120	5	60
Chip card tickets	30	360	20	320	10	275	5	150
Magnetic strip/barcode tickets/ chip coins	30	340	20	310	10	260	5	140
Magnetic strip tickets (side strip)	30	250	20	240	10	175	5	80

Special utilisation areas may need to be designated for parking the vehicles of members of staff involved in event setup or for temporary material storage.

In the case of temporary assembly areas, it may be necessary to create and maintain special areas for logistics. For example, it may be necessary to provide a green area, meadow or other usable areas that have to be specially prepared to withstand the strain of logistics and setup.

It is recommended to initiate proceedings for the preservation of evidence, especially for temporary paths and public areas or green areas. The transport of large components or parts with unusual dimensions for an event is particularly challenging. If they are outside the permitted legal dimensions, Section 29 (3) of the German Road Traffic Regulations (StVO) refers to them as large and heavy-load transport. Not all traffic facilities on a planned route are suitable for such transports. This applies in particular to bridges and underground structures. In the case of prescribed approval procedures for large and heavy-load transport, the road construction and maintenance authority is asked for a statement as part of the route inspection.

With regard to the suitability of the public areas to be used, coordination with the responsible road construction and maintenance authority or the land owner will be required in advance.

Depending on the design of the road, the road construction and maintenance classes of the planned delivery routes must also be considered. It is recommended that both the authorising body and the event organiser carry out or arrange for the preservation of evidence before and immediately after the event. This can eliminate or clarify liability issues in the event of damage to traffic routes.

Pre-arranged routes and delivery routes then pose no unexpected risks when putting on the event.

Logistics areas, temporary storage or staging areas

An orderly event schedule may demand assembly areas or staging areas for deliveries. Temporary storage areas are also conceivable, depending on the event. Logistics management should be provided for the appropriate coordination of journeys to prevent overloading or obstruction of the local road traffic network.

The logistics areas may also be required for the storage of transport packaging, containers and vehicles or trailers. The areas are used as temporary storage for larger quantities of consumables or utility materials.

Signposting access and exit routes for delivery traffic at an event

Depending on the requirements of the authorising body, the design of the signage must be based on the "Guidelines for Directional Signage on Highways Other than Motorways" (RWB) [FGSV 2000] and Section 39 ff of the German Road Regulations (StVO).

It is recommended that signage for deliveries and logistics at large-scale events is installed on the central traffic route network in good time. Logistics routes should not be selected according to the shortest possible route, but rather according to the least disruptive route for the usual traffic flow.

Delivery traffic during the event period

Delivery traffic that is necessary for putting on the event should take place outside the event's operating hours. Only essential transportation operations for event organisation should occur during, shortly before and after the event. This may include, for example, VIP shuttle transport services, the arrival of artists or performers, the transport of consumables or equipment that cannot be stored on site or the cleaning and disposal of toilet facilities.

The provision of goods and merchandise required for the event should take place prior to the start of the event and, in the case of events lasting several days, generally during the non-event phase.

During temporary events, the disposal of refuse and waste water/sewage should ideally occur outside event times to minimise odour and noise pollution. Replacing containers and collection bins is always preferable to emptying them on site should disposal be absolutely necessary. Alternatively, containers or toilets must be locked until safe disposal is possible.

For logistics during an event, the principle of minimising and not restricting public areas that serve the safety of the event applies. Rescue and escape routes must be kept clear or, if necessary, ensured during necessary delivery or disposal work by means of an escape and rescue route concept adapted to such situations.

Traffic routes and logistics areas

Before putting on an event, discussions must be held with the local security authorities during the planning phase. Depending on the scale of the event, there may be requirements for logistics areas or access routes and staging areas for security staff.

These are usually clarified in a cooperation meeting during the planning phase of an event and are reflected both in the approval and in a safety concept.

Emergency service requirements

The rescue service resources are determined by the local head of the rescue service or an authorised representative based on the scale of the event.

Aside from locally defining a logistics area, which could range from a basic ambulance service to a full emergency centre, consideration is also given to the types of emergencies that require additional forces and staging areas. The availability of these areas and the route to and from the staging area at the event must be clarified in the cooperation meeting. The access routes must also be checked and, if necessary, ensured through suitable traffic measures such as no-stop zones. Routes for emergency service vehicles must be planned in advance, communicated and, if necessary, secured and adhered to by all parties involved on the day of the event.

It may be necessary to ensure the possibility of transport by helicopter. A suitable landing site and a vehicle transport route to and from the helicopter must be defined and kept clear accordingly.

Preventative fire safety requirements

Event fire service operations are overseen by the local head of fire safety or their authorised representative. The definition of preventative fire safety can range from a simple fire station with or without a vehicle to the establishment of a temporary fire station on or near the event site. Access routes and potential staging areas for fire services are determined for each use case and must be secured with traffic measures, if needed.

Police and local police authority requirements

The police resources required for an event are determined by the responsible police organisation, usually the local police commander. This can range from a simple patrol of the site to the establishment of an on-site police station. The police resources are diverse and also require logistical consideration with regard to the public areas, access routes and logistics areas to be made available.

Other logistics areas

Depending on the type of event, additional logistics areas may be necessary for broadcasting vehicles, control rooms, stage structures or other institutions involved in the event and should be considered during planning. For events held on standing or flowing water, for example, this may involve rescue equipment for water safety, lifeguards and rescue boats.

Logistics processes before, during and after the event

Before an event, the traffic routes to the event area will be frequented by attendees to varying degrees depending on the time period: There is usually a short start-up phase, then a phase with high volumes of traffic followed by a phase with lower utilisation immediately before the event starts.

During the event, public areas, which must be kept clear in accordance with the specifications of the emergency and rescue services, must be monitored by municipal regulatory agencies or contracted stewards. Access to logistics areas and site access roads must be effectively restricted to authorised personnel only. Depending on the level of security required, mobile vehicle barriers or special access protection systems may also be used.

Public areas in the event area must be kept as accessible as possible during the event. Cables or lines must not pose a tripping hazard. Accordingly, cables or lines should be laid at a height or below ground. If this is not possible, their roll-over capability with a wheelchair and their perceptibility by visually impaired people must be ensured, e.g. by means of accessible cable bridges. The evacuation heights of operating or emergency vehicles and pressure point loads for lines laid on the ground must be taken into account.

A coordinated process should also be developed for clearing the logistics after the end of the event. The safe evacuation of the logistics areas and the removal of the supply infrastructure should always take place after the peak traffic caused by the departure of spectators.

5.6 Protection of local residents

Residents, especially in neighbouring areas, can be severely affected and impacted by arriving and departing traffic as well as people searching for a parking space at an event. If unreasonable inconvenience is to be expected for local residents, suitable countermeasures should be considered. Countermeasures could be, for example, access restrictions or the establishment of a temporary local resident parking zone with the issue of parking authorisations. The legal basis for this is provided by Section 29 of the German Road Traffic Regulations (StVO) and the associated administrative regulations. These traffic measures are ordered by the responsible road traffic authority. Before and during the event, stewards may be deployed to provide traffic control duties. In public areas, they must have the necessary sovereign authority.

6 Public transport, shuttle bus, coach and taxi services

6.1 Public transport services

6.1.1 Basic principles

Public transport, with its buses and trains, is an indispensable mode of transport for many events and often accounts for a significant ratio of the modal split. As part of services for the general public, public transport enables many people to participate socially and culturally in events.

In general, a high share of public transport in the total volume of traffic should be aimed for at events in order to ensure that journeys to and from events are environmentally friendly and sustainable. Public transport requires significantly less space per person than motor vehicles, meaning a high ratio of public transport can significantly reduce the amount of infrastructure required for moving and standing motorised traffic. For example, regular bus services, tram/metropolitan rail services, underground and suburban rail services can transport many more people to and from events than a motorised traffic infrastructure. In addition, a high ratio of public transport results in a large potential savings in parking bays. Particularly at events where a large number of people are expected to travel to and from the event, forward-looking planning and high-quality public transport is therefore an important part of traffic management.

The aim of planning and traffic management in this context is to ensure that public transport services meet demand and are largely accessible and that public transport operating procedures are as smooth as possible.

Public transport planning must take into account the arrival and departure routes for motor vehicles, the existing public transport services and any additional services to be provided, the capacities of vehicles, stops and stations, traffic control and routing, including the provision of information and the subsequent pedestrian routes. The preparation of measures in the event of deviations from the planned target status also plays a major role here, in order to be able to make timely adjustments should disruptions occur.

Early coordination with the responsible public transport authorities and transport companies and their responsible involvement when planning and organising traffic management for travelling to and from an event must be ensured. This primarily involves the event organiser, the transport company, the police and fire service and the municipal administration with its public order offices. Planning and organising traffic management for arrivals and departures for the respective event must be discussed and coordinated within this group, which must be expanded depending on the task at hand. Depending on the contractual basis for the transport implementation (service contract, gross/net contract), additional coordination may be required with the responsible authorities, such as federal states, districts, independent cities or their responsible organisations, regarding the financing of the additionally desired or planned journeys. As a rule, the offer of combined tickets must be agreed upon by the event organiser and the transport company.

Step 1

The first step is to evaluate the type of event with regard to a typical choice of means of transport with rather high or rather low use of public transport. For example, experience shows that the use of public transport is low at an event with a very high ratio of coaches. If a combined ticket is offered for the event, a higher use of public transport is to be expected. In addition to estimating public transport demand, an estimate must be made of how the people travelling to and from the event will be allocated to the rail and road-based public transport services. The distribution of local residents in the catchment area can help here. Experience from previous and/or similar events should also be taken into account. Further information on estimating the traffic and crowd flows can be found in Section 4.

Step 2

Initially, it is necessary to determine which forms of public transport are available in what quality (quality of offering) and can be used by different target groups for travelling to and from the event. For example, the degree of accessibility of public transport systems must be clarified in order to be able to communicate statements about their accessibility and usability by people with disabilities (see Table 2 in Section 4.3). Conventional scheduled services will be relevant for events with a high number of people travelling to and from the event. In addition to long-distance transport, regional rail transport with local and suburban trains, underground, light rail and tram traffic as well as bus transport are generally relevant for conventional scheduled services. Flexible forms of service, such as scheduled on-demand services, call-and-collect services with taxis or bundled on-demand services can play a supplementary role, e.g. for cultural events with small numbers of people and in areas with dispersed settlement structures. Bundled on-demand services can also be included outside of local public transport. Alternative forms of service, such as car sharing or ride sharing as the organised shared use of vehicles, are generally an exception, as a larger ratio of people travelling to and from events will tend to use privately organised car pools. Bike hire systems, on the other hand, are (whenever available) becoming increasingly important.

In order to ensure safe and convenient arrival and departure, it should then be checked whether the available standard offer can accommodate the additional event-related demand. For this purpose, the total number of people expected from event and normal traffic should be compared with the capacity of the public transport service determined.

Step 3
In the third step, public transport measures should be planned and implemented. If not already agreed, the allocation of a combined ticket for travelling by public transport purchased with the admission ticket and other measures to ensure a high ratio of public transport should be examined. The combined ticket has proven to be an essential prerequisite for the smooth management of event traffic at events with a high number of people travelling to and from the event. Experience shows that the combined ticket can achieve a public transport share of the modal split of around 60% on average and up to 95% in individual cases. The travel authorisation purchased with the ticket should be generously configured for the event in question.

If necessary, public transport capacities can be increased through additional public transport services. The availability of vehicles and staff plays just as important a role in any increase in public transport services, especially during peak hours, as the maximum capacity utilisation of the rail or road infrastructure. During the standard traffic period, there is usually sufficient capacity available for additional public transport services.

At train stations and stops, it may be necessary to plan and implement special provisions for capacity expansion, to prevent pushing and jostling situations and to inform people travelling to and from events.

The organisation of data and information exchange between those involved in traffic and crowd management, such as transport companies, public authorities, road traffic authorities and administrations, state and federal police forces, municipal offices, car park management companies, fire services and rescue control centres, should be prepared and coordinated.

Local residents should be informed at an early stage about areas and times with expected high capacity utilisation to reduce public transport demand in normal traffic. It is advisable to prepare and provide navigation systems for orientation, e.g. at interchanges, on arrival, attendance and departure, e.g. via local radio, press, social media, dynamic passenger information, displays, loudspeakers, loudhailers.

It must be clarified at an early stage how any additional public transport services will be financed. The event organiser and other organisations involved, including the federal states and local authorities, can make joint financing arrangements, especially for socially and culturally significant events.

6.1.2 Integrated traffic control centre

For events with a large number of people arriving and departing, integrated traffic management via an integrated traffic control centre will be an important element. Experience shows that only by combining all known information can accurate statements be made about the current traffic situation in the entire transport network and about what options are available to those involved to ensure meaningful interventions. It must be noted that high capacity utilisation and overloading in moving traffic, e.g. tailbacks in front of available parking facilities, can also cause disruptions in the public transport network. In such cases, it is important to anticipate the traffic situation and constantly compare the target and actual situation, e.g. with messages of impending tailbacks at available parking facilities, in order to ensure smooth operating procedures with traffic control and guidance interventions, including prepared public transport measures such as diversion routes or temporary special lanes. Incident management is necessary, in which measures and implementation are coordinated and defined in advance.

The relevant institutional and organisational arrangements for an integrated traffic control centre, including the requirements for the exchange of data and information and the establishment of measures, can vary greatly – an overview and recommendations, including the information strategy, can be found in VDV announcement 10013 (Association of German Transport Companies) [VDV 2010].

6.1.3 Ensuring a high ratio of public transport

In addition to the aforesaid combined ticket as a mandatory requirement for events with a high volume of people, there are various ways of influencing or increasing the ratio of public transport at all events. A coordinated and well-communicated strategy with regard to private and public transport services can lead to noticeable shifts in the modal split.

Motivation for using public transport can be, for example, knowledge of reduced or expensive parking facilities, costs, convenience, environmental aspects, accessibility or safety criteria. Corresponding information should be communicated at an early stage in connection with advertising measures, for example for the combined ticket.

In order to ensure a high ratio of public transport, the available parking facilities should be deliberately kept to a minimum and be subject to high parking fees. In return, the public transport services should be discounted and advertised accordingly. For example, special tickets can be issued for the event, such as:

- a combined ticket (admission ticket is also a public transport ticket),
- a day ticket that is valid for several days (e.g. for two or three-day events),
- a single day ticket which, due to a special regulation, allows the holder to bring guests,
- a single ticket that is valid as a day ticket,
- a parking ticket that is also a public transport ticket or
- a (digital) public transport ticket that entitles the holder to hire e-bikes, e-scooters, pedelecs or bikes at a reduced rate. Depending on the local offer, it may make sense to set up a geofencing zone for electric scooters at the event location or far away from the event location to avoid uncoordinated parking of the devices or their use after drinking alcohol.

The installations at stops and adjacent pedestrian routes should be improved, for example by providing more toi-

lets, temporary weather proofing, additional seating, visually attractive signposting, good lighting, refreshment facilities and long-term improvements such as escalators and lifts. Attention should be paid to cleanliness and the presence of staff at stations, stops and adjacent pedestrian routes.

Attention should be paid to a demand-orientated public transport service, in which, for example, certain routes see more frequent services to enhance travelling to and from the station by public transport. Free shuttle services directly to the event site are also conceivable (see below).

6.1.4 Public transport capacities

To ensure that operating procedures run as smoothly as possible, it is essential to offer sufficient public transport capacity for travelling to and from the event.

The capacity of public transport depends on the type of services, the frequency of services, unobstructed routes, calling at stops and the vehicles used. For light rail vehicles and trams, the German Ordinance on the Construction and Operation of Tramways (BOStrab) limits the length of trains to 75 m, provided they are part of the public road traffic. Exceptions are possible. In the case of rail traffic, the length of the stops served also plays a decisive role, as this often limits the maximum train length. Depending on the rolling stock being used, multiple unit trams (or grouped buses) are possible, for example, provided that the relevant platforms are long enough. The maximum number of passengers to be transported in the relevant periods must always be agreed with the transport companies involved.

The following information can be provided in general terms:

- The planned value of the capacity of public transport vehicles equates to the available seats and standing areas and depends on the respective vehicle, the design or model series and the number of passenger seats accommodated in the vehicle. According to the Guideline of the Association of German Transport Companies [VDV 1990], determining the capacity involves calculating the standing area by subtracting the seating area from the usable area and dividing it by 0.25 to ascertain the number of standing spaces with a crowd density of 4 pers/m^2. The permissible capacity, on the other hand, results from the permissible vehicle mass or the permissible axle load and may deviate from this result.
- According to publication 4 of the Association of German Transport Companies [VDV 2019], the available space during peak hours should be configured in such a way that the occupancy rate as an average value over the 20-minute peak generally does not exceed 80%. This value is to be understood as a limit value that should not be exceeded, as otherwise stable operation can no longer be guaranteed. Over the peak hour, the occupancy rate should not exceed 65% on average as a guide value. According to publication 4 of the Association of German Transport Companies (VDV), the limit value for determining the number of standing spaces is 4 pers/m^2. For reasons of comfort, lower occupancy rates (2 or 3 pers/m^2) can also be used. The Association of German Transport Companies (VDV) makes no other recommendations for event transport.
- For the comparison of the number of expected persons in the sum of event and normal traffic with the capacity of the determined public transport service, it is recommended to set the capacity at 65% of the sum of the capacity of all relevant vehicles in the relevant period of arrival and departure and to set the number of standing spaces at 4 pers/m^2. An exception is long-distance transport, where it should be assumed that all seats are occupied without the use of standing areas. The time period relevant to the analysis results from the duration of the arrival and departure.
- With such an approach, fluctuations in transport demand, short-term disruptions to operating procedures or extended passenger changeover times within the period under consideration are possible without jeopardising the smoothest possible operating procedure. Passengers travelling to and from the station can be transported with the highest possible quality.
- In deviation from this, higher occupancy rates can be set or additional public transport services ordered in consultation with the transport companies involved, based on an estimate of the performance and network capacity of public transport and knowledge of peak demand on individual routes. High occupancy rates are to be expected, especially for departures that take place over a short period of time.

Table 8 provides a rough overview of the capacity of different public transport vehicles. More detailed information can be obtained from the respective transport companies.

Table 9 contains examples of capacities for scheduled services.

The determined capacities of the public transport services form a basis for estimating whether the existing services are sufficient to accommodate the expected demand in the sum of event and normal traffic. Peak demand must be considered separately. If this is not the case, measures must be examined, prepared and implemented. If capacities are to be increased, this can be achieved using various measures.

One common measure is to increase the frequency of services, for example by implementing the timetable for weekend events that would otherwise apply on weekdays. Another measure would be, e.g., the exclusive use of accessible vehicles.

Operating times can, e.g., be extended to night-time traffic. Additional special traffic by increasing the frequency of services, extending the duration of services or adding individual journeys, as well as additional stops for scheduled services or shuttle buses, can expand the public transport services. The local council must be notified of any deviations from the timetable (including additional journeys). At the end of the event, waiting or on-demand trains, buses or taxis can be used.

Table 8: Capacity of public transport vehicles with 4 pers/m² for standing areas (approximate, exact values can be obtained from the respective transport companies)

Public transport vehicle	Capacity per vehicle (4 pers/m² for standing areas)
Collective taxi	4 seats
Minibus	8 seats
Midibus	approx. 45 seats and standing spaces
Standard bus service (12 m long)	approx. 70 seats and standing spaces
Standard articulated bus (18 m long)	approx. 105 seats and standing spaces
Five-section low-floor tram as a multi-articulated vehicle (30 m long and 2.30 m wide)	approx. 50 seats and 100 standing spaces depending on the type of design
Metropolitan train with double traction (55 m long and 2.65 m wide)	approx. 140 seats and 200 standing spaces depending on the type of design
Six-coach underground train (115 m long and 2.90 m wide)	approx. 200 seats and 700 standing spaces depending on the type of design
Four-coach suburban train (length 65 m and width 3.00 m)	approx. 175 seats and 300 standing spaces depending on the type of design

Table 9: Typical public transport capacities in each direction during the normal traffic period with standard intervals and 65% capacity utilisation (approximate and exemplary, exact values can be obtained from the respective transport companies)

Vehicles used for public transport	Interval in minutes	Typical capacity of a public transport service per direction
Midibuses, e.g. 45 seats and standing spaces	30 minutes	approx. 60 pers/h and direction
Standard bus services, e.g. with 70 seats and standing spaces	20 minutes	approx. 140 pers/h and direction
Standard articulated buses, e.g. with 105 seats and standing spaces	20 minutes	approx. 210 pers/h and direction
Tram/metropolitan rail services, e.g. with double traction and 175 seats and standing spaces each	10 minutes	approx. 1,200 pers/h and direction
Underground trains, e.g. long trains of the MVG series C 1 in Munich with 920 seats and standing spaces	5 minutes	approx. 7,200 pers/h and direction
Suburban trains, e.g. long trains with DB 474 series electric multiple units with triple traction and 515 seats and standing spaces each	20 minutes	approx. 1,000 pers/h and direction
Regional trains, e.g. RegioShuttle RS1 650 series with double traction and 175 seats and standing spaces each	30 minutes	approx. 450 pers/h and direction
Long-distance trains, e.g. Intercity-Express (ICE) 4, 12 coaches with 830 seats	60 minutes	approx. 830 pers/h and direction

The use of long trains, multiple units or articulated buses can help to increase capacity.

Faster journey times can also result in capacity increases. Possible measures in this context include special public transport prioritisation at junctions, establishment of temporary or long-term bus lanes or limitation of the number of intermediate stops to reach the end station faster.

With an increase in public transport capacity, the following orientation values can be used to estimate maximum interval times.

- In road-based public transport (trams and buses), the maximum capacity depends, among other things, on the quality of road traffic. For prioritised routes, a 2-minute interval (30 vehicles per hour and direction) can be implemented, otherwise a 5-minute interval (12 vehicles per hour and direction). Flexible operating concepts can be offered independently of this for buses.

- In rail traffic in accordance with the German Ordinance on the Construction and Operation of Tramways (BO-Strab) (trams, metropolitan and underground trains), intervals of less than two minutes can also be achieved on special or independent rail lines (> 30 trains per hour and direction).

- In regional rail transport, intervals are generally longer (12 trains per hour and direction), although some suburban train systems can operate at significantly shorter intervals depending on the route infrastructure.

It must be noted that a maximum increase in public transport capacity can only succeed and make sense if all routes and services on the journey to and from the event can accommodate the corresponding crowd flows. For example, train stations, stops and adjacent pedestrian routes must be designed to allow longer trains or buses to stop, to enable passenger changeovers with high crowd flows and to ensure stable operations. The adjacent pedestrian routes, such as routes between the train station and entrances, the upstream waiting zones and the number of security search points must be designed in such a way that they can cope with the huge crowds of people that may occur, e.g. after a train with several carriages pulls in. Further information on this can be found in Sections 8 and 9.

Traffic control and traffic management measures can be considered as supporting or alternative measures. For example, advance information can be used to redirect people arriving and departing from individual to other forms of public transport with a higher capacity, e.g. from tram traffic to suburban rail transport. In addition, potentially short public transport journeys can be redirected to bicycle and pedestrian traffic.

If the public transport capacities are insufficient, changes to the event concept, such as offering entertainment before and after the main event, can also be considered in order to extend the duration of arrivals and departures and thus reduce the peak volume. It may also be possible to make early arrival and late departure more worthwhile, e.g. by offering entertainment before and after the main event at the event location.

When analysing public transport capacity, it must be noted that different target groups may need to be taken into account. For example, people with disabilities or groups of people who need to be separated ("fan separation") may require special provisions.

6.1.5 Train stations and stops

Train stations and stops must be able to cope with the expected number of people arriving and departing. In many cases, they also represent the "gateway" to the event. They should therefore be attractive and convenient, e.g. in terms of supply and disposal or information. An accessible design of the facilities not only fulfils the requirements of people with limited mobility but also facilitates the use of the facilities for all users.

For events with a large number of people arriving and departing, it may be necessary to take provisions in case of overcrowding at train stations and especially on train and bus platforms. On arrival, for example, it must be ensured that those arriving can leave the disembarking areas quickly. When departing, there must be no overcrowding on train or bus platforms, as otherwise there is a risk of waiting passengers being pushed onto the tracks or road (separating elements may then be required). In such cases, adjacent pedestrian routes should be designed sufficiently long and wide. In addition, overcrowding can be avoided by implementing measures to buffer the crowd flows, e.g.

- attractions on pedestrian routes that grab the attention of those arriving or departing,
- queuing systems that constantly provide information, or
- an event programme in which the "highlight" is not at the very end but is, e.g., the second to last item on the agenda.

Further information can be found in Sections 8 and 9.

In addition, further measures may be required at train stations and stops when planning and putting on an event. For events with a high number of people arriving and departing, capacity checks of waiting zones and dwell areas, routes via footpaths, stairs, entrances, exits and adjacent pedestrian routes (see Section 8) will be necessary.

As far as possible, the directions of travel should not change when there is a very high volume of people waiting on a platform. Otherwise, there is a risk that people will gather on the platform for subsequent services, thus obstructing and disrupting people waiting for the currently approaching vehicle (i.e. the "wrong passengers" will be standing at the edge of the platform). If track utilisation or the timetable cannot be altered, it is a good idea to set up buffer areas in front of the train station or stop, if possible, separated according to the direction of travel, which are then opened at the appropriate times to reach the train station or stop.

Depending on the event, it may be necessary to provide separate routes for groups of people to be separated, e.g. for "fan separation". Depending on local conditions, it may also be necessary to provide separate accessible routing for people with disabilities. In the case of long-lasting and simultaneous arrival and departure traffic, the footpaths for arrivals and departures should be separated from each other in order to avoid bidirectional or multidirectional crowd flows (see Section 8).

Special provisions for connections, such as adjustment of transfer times, schedule synchronisation or segregation of transfer routes, are advisable for heavily frequented connection points.

Depending on the basic parameters, it may be necessary to adapt the stop concept. For example, certain stops can be excluded if capacity overruns are otherwise to be expected. Non-event-related normal services can be shifted to other public transport services or stops. It may be necessary to relocate stops due to an event-related change in traffic routing. It may be advisable to set up additional stops, e.g. temporary and largely accessible special stops in the vicinity of the event. It should be noted that it may be advantageous to position the stops as close as possible for reasons of convenience, but that a greater distance is preferable for safety reasons (segregation of crowd flows/ buffer areas/exclusion zones). Temporary or long-term expansion measures at stops, such as train or bus gate extensions or signalling changes, can also be useful.

It may be necessary to provide for operational regulations, such as slow entry into stops or instructions to not stop in certain conditions. Operational provisions also include staff-assisted handling of vehicles and assistance with boarding and disembarking or merging into moving traf-

fic. It is also possible to temporarily increase the number of ticket machines or to deploy staff to sell tickets.

It is recommended that other modes of transport, such as moving motor vehicles or bicycle traffic, be physically separated from stops and neighbouring pedestrian routes in order to avoid hazards and disruptions. Public transport routes and stops should be largely accessible and usable and must not be subjected to external use, e.g. parked or stopped motor vehicles or parked bikes.

Information for people travelling to and from the event plays a particularly important role. It should be borne in mind that people travelling to events are usually already "in event mode" in their vehicles, but at the latest when they arrive at train stations and stops, meaning that arrival, attendance and pedestrian routes at, from and to train stations and stops are to be regarded as part of the overall event. Accordingly, all information should be adequately communicated to ensure people arriving at, attending and departing from the event can enjoy a relaxed event experience and are able to travel to and from the event as safely and as conveniently as possible.

Detailed information on the requirements for new stops and waiting zones can be found in the "Recommendations for Local Public Transport Systems" (EAÖ) [FGSV 2013].

6.2 Shuttle transport services

Depending on the local conditions, it may be useful or necessary to set up shuttle transport services. This is particularly the case if the event location can or should only be accessible to motorised individual traffic to a limited extent. In addition, the protection of local residents or environmental concerns may make shuttle services necessary.

The following can be organised, for example:

- shuttle transport services to and from available parking facilities (including coach parking spaces),
- shuttle transport services to and from special traffic hubs, such as airports or train stations,
- shuttle transport services for special groups of people, e.g. VIPs,
- shuttle transport services between different event locations.

The requirements and conditions listed in Section 6.1 apply to shuttle services (with shuttle capacities) and shuttle bus stops, including the neighbouring pedestrian routes.

It should be checked whether regular service stops can also be used by shuttle services. If additional shuttle bus stops are set up, they must be largely accessible, and the trafficability and manoeuvrability of such buses at the end stops must be ensured, if necessary by paving additional areas. Separate waiting zones and queuing-up spaces for shuttle buses must be taken into account, if necessary. Information on the space requirements is included in the "Recommendations for Local Public Transport Systems" (EAÖ) [FGSV 2013]. Turning curves for assessing the correct traffic areas for buses are listed in the "Guidelines for Design Vehicles and Minimum Turning Curves for Testing the Trafficability of Traffic Areas" (RBSV) [FGSV 2020].

As with all routes of arrival, attendance and departure, it is important to ensure that everyone is well informed. Separate signposting to the entrances and back to the shuttle bus stops may be necessary. If the get-on stop differs from the get-off stop, signposting for the return journey is particularly important.

Regulations for the shuttle services should be agreed, drawn up and communicated in advance. This concerns, for example, special and separate traffic routing for shuttle buses only, the shared use of bus lanes, access checks and signalling measures, maximum standing times or special provisions for passenger changeovers. The responsibilities for the shuttle services must also be defined. Responsibility for operations lies with the operations managers in accordance with the German Ordinance on the Construction and Operation of Tramways (BOStrab) or the German Ordinance on the Operation of Motor Vehicle Companies in Passenger Transport (BOKraft) or with the on-site traffic management staff. Outside the public transport system, the event organiser is responsible, for example, for the access routes to the event location.

6.3 Coach traffic

For events with a large number of people arriving and departing and larger catchment areas, it may be necessary to take special provisions for coaches. In such cases, early consultation should take place with tourism associations, agencies and coach companies to assess the need for special measures.

A coach parking space concept or a coach stop concept may be necessary. The concept to be pursued depends mainly on the availability of spaces at the event location. If sufficient space is available near the destination and the impact of coach traffic is low, a coach parking space concept can be chosen. An acceptable distance between coach parking spaces and entrances/exits is 200 to 300 m; in exceptional cases, such as longer events, up to 1,000 m is satisfactory. If these conditions are not met, a coach stop concept is a viable option.

The coach parking space concept means that:

- coaches utilise the parking space at the event location,
- passengers generally board and disembark coaches at the parking space close to the destination, although greater distances may also be relevant for safety reasons (see Section 6.1.5),
- coaches remain in the parking space until the return journey,
- the parking space must be configured for on-peak times, as tailbacks outside the parking space or incorrectly parked coaches in the vicinity can be a major obstruction for other traffic.

The advantages of a parking space concept are generally that coach passengers can be dropped off and picked up close to their destination, empty coach journeys can be

avoided and it is easier for coach drivers to comply with driving and rest times, as the coach remains in the parking space after dropping off its passengers. A disadvantage, however, is the space required near the destination. The parking concept can incorporate a central coach parking space or several parking spaces distributed around an event location. Depending on the location of the event, it may also be possible to organise coach parking on public roads by making temporary or permanent changes to the infrastructure for standing or moving traffic.

Access to the coach parking spaces should be facilitated by parking guidance systems and, if necessary, by displaying the current level of occupancy. If several parking spaces are available, the nearest one to the respective access road should be indicated first. Parking spaces for special attendee groups, such as people with limited mobility and pre-reserved parking spaces for coaches, should be designated separately.

As with all routes of arrival, attendance and departure, it is important to ensure that everyone is well informed. Separate signposting to the entrances and back to the coach parking spaces may be necessary. If a coach parking space is not within sight of the exit or if there are several coach parking spaces in different locations, special attention must be paid to careful signposting. This also applies if several exits are opened at the end of the event that differ from the entrance. In the case of larger groups and several coach parking spaces, it may be advisable to have stewards or staff accompany them.

The coach stop concept to be implemented as an alternative or in combination includes:

- passengers disembarking and boarding the coach and the coach being parked at separate locations,
- stops being located close to the destination, if possible no further than 200 m away from entrances/exits,
- disembarking and boarding taking place at different stops for organisational reasons (in this case, very careful signposting or accompanied guidance should be provided from the event location back to the coach),
- coaches travelling to a parking facility in the meantime.

Sufficient stand-by areas must be provided for passengers to congregate in the walkway area at stops for boarding and disembarking to ensure people are not forced to stand in traffic areas. If a very high volume of coaches is expected, it may be useful to allocate "slots" for dropping off and picking up groups in order to avoid congestion at coach stops.

The route for coaches to the parking facilities should be clearly signposted. Parking spaces are essential to allow coach drivers to rest. Distances of more than 2 km between stops and parking spaces are not recommended. Additional journeys between the stop and the parking facility may make it more difficult to comply with rules on driving and rest times.

Parking facilities can have a much simpler design than coach parking spaces. Coaches can also be parked more densely here, as there are no boarding and disembarking procedures.

Information on parking spaces and/or stops for coaches should be included in the information concept for the event, as should information on available parking facilities and other transport services. Tour groups and coach passengers, like other groups of people, usually find out in advance about the traffic conditions at the event location.

Further information on planning facilities for coach parking at events can be found in the "Notes on Parking Coaches in Cities" (H RS) [FGSV 2018b].

6.4 Taxi services

At all events, it should be borne in mind that there might be a large number of taxis. In addition, it may be advisable to use or set up special forms of collective transport such as call-collective taxis, on-demand buses or theatre-collective taxis.

For events with a high level of or special taxi services, the expected demand should be estimated and compared to the available capacity. Information on collective taxis can be found in Section 6.1.

With regard to taxi ranks (including parking areas for taxis) and taxi lanes, the space requirements and availability of space should be determined. If existing spaces are not sufficient, additional spaces should be reserved. Taxi lanes are generally located in the immediate vicinity of the entrances/exits, although greater distances are preferable for safety reasons (see Section 6.1.5) and within the meaning of crowd management (see Section 8).

Operation of the taxi ranks must be organised. Care should be taken to ensure that waiting taxis or waiting passengers do not have a serious impact on other modes of transport. If necessary, special provisions should be taken for exiting and re-joining moving traffic.

In addition, further measures may be necessary as part of the preparation and management of taxi services. These include, for example, the (possibly temporary) paving, extension or relocation of existing taxi ranks. It may be necessary to set up new taxi lanes at entrances/exits. The operational management of taxi ranks must be reorganised, especially in the case of high frequencies. It may be necessary to provide special traffic guidance for taxis. This may involve various taxi services for arrivals and departures. Changes to traffic routing may also include lane closure measures to prevent taxis from stopping "abruptly" and obstructing bicycle and pedestrian traffic. It may be important to deploy law enforcement staff, e.g. to prevent taxis from double parking.

Measures should be coordinated and planned at an early stage with the involvement of the local taxi association, taxi collective or larger taxi companies. In particular, if taxi services are to be integrated into public transport services, the public transport authorities and transport companies should also be involved.

7 Bicycle traffic

7.1 Arrival and departure traffic routes

The traffic and mobility management of an event should be organised in such a way that the ratio of bicycle traffic to overall event traffic is as high as possible. The following fields of action for bicycle traffic are relevant:

- routes for travelling to and from the event,
- design of the routes used and the parking facilities,
- signposting and signage.

The relevant parameters for processing the fields of action are the volume of bicycle traffic when travelling to and from the event and the number of people attending (arriving and departing by bike) at the same time, in particular the respective load peaks (see Section 4).

Step 1: Determining arrival/departure routes

The paths and routes for arrival and departure by bike must be determined and agreed between the event organiser and the local authorities. If necessary, experience gained from other events can be used.

Step 2: Checking capacities and potential for conflict

Bicycle traffic routes should be designed in such a way that conflicts with pedestrians, public transport and motorised individual traffic are avoided as far as possible. Conflicts in terms of road safety and a reduction in capacity can be mutually dependent, especially between bicycle and pedestrian traffic. High utilisation rates of the respective traffic facilities lead to shared use of the traffic areas of the other mode of traffic and can, therefore, also lead to safety-relevant situations. Flows of bicycle traffic should, therefore, be routed as separately as possible from flows of pedestrian and motorised traffic. Possible options for this include:

- routing along on-road cycle lanes, provided the risk of conflict due to competition for space with adjacent motorised traffic appears justifiable,
- routing along separate cycle lanes, provided that no critical contact with any adjacent pedestrian traffic is to be expected,
- routing of bicycle traffic via routes other than those used by pedestrian and motorised traffic,
- if necessary, separation of bicycle traffic from motorised or pedestrian traffic, e.g. by means of crowd barriers.

7.2 Signposting/traffic control

The same principles apply to signposting and traffic control for bicycle traffic as for motorised traffic (see Section 4). The "Leaflet for Route-Indicating Signage for Bicycle Traffic" [FGSV 1998] in particular should be taken into account as a relevant set of regulations. The aforesaid leaflet includes all the essential regulations. As such, any redundant content has been removed from this leaflet.

7.3 Bike racks

In addition to the convenient, safe and efficient routing of bicycle traffic to the event location, the availability of bike racks is of central importance for the acceptance of the bike as a viable means of transport for travelling to the event. A sufficient number of bike racks should therefore be planned as close as possible to the entrances/exits of the event. As with the considerations regarding public transport and motorised individual traffic, it should also be borne in mind that safety reasons (see Section 6.1.5) and crowd management (Section 8) may prevent the planned proximity between parking facilities as well as entrances/exits.

In this context, it should also be noted that incorrectly parked bikes are not convenient from the user perspective but can also pose a high risk potential, especially in the event of a crowd surge. For this reason, careful planning of bike racks is particularly important.

Existing parking facilities should remain as accessible and usable as possible.

7.3.1 Choice of location

The following aspects are particularly important for the acceptance of parking facilities:

- Most direct possible access to the bicycle traffic network.
- Free use or,
- if use is associated with costs, the offer of additional services such as security, e-bike charging stations or a repair service.
- Parking facilities should be directly associated with the destination and accessible within a short distance.
- Facilities located in front of the destination are better accepted than those located behind it. The positioning of parking facilities should therefore be aligned with the actual route to the event.
- Parking facilities should be clearly and uniformly signposted.
- Parking facilities should be illuminated to ensure a sense of security.
- In the case of a large parallel crowd flows, the bike racks should be arranged separately away from the flows (see [FGSV 2012c; ADFC 2014; BaSiGo 2015]).

7.3.2 Structural design

The facilities should be arranged in such a way that bikes can be locked up and parked without falling over. For this

purpose, parking facilities equipped with hoop bike racks are preferable.

Seeing as a bike is generally around 0.7 m wide and 2.0 m long and space is required for parking and retrieving it, the distance between hoop bike racks should be at least 1.0 m (see Figure 8).

If the hoop bike racks are placed too close together, it is likely that not all the parking areas will be used. In addition, bikes are more easily damaged when parking them and leaving the parking facility or clothes become soiled. If the space between the hoop bike racks is too great, there is always a risk of additional bikes being pushed between correctly parked bikes, thus blocking access to the correctly parked ones.

At events aimed at families in particular, it should also be taken into account that cargo bikes or bikes with children's trailers have increased space requirements.

Temporary parking spaces with transportable bike racks are ideal for events at varying locations. Transportable bike racks based on the hoop bike rack principle are recommended. For this purpose, hoop bike racks are connected to each other by cross bracing at the bases. For events with only a temporary high demand for parking, transportable bike racks can also be set up as larger row systems. If necessary, they should be fixed with plugs and screws to prevent theft or unintentional displacement. (see [FGSV 2012c; ADFC 2014]).

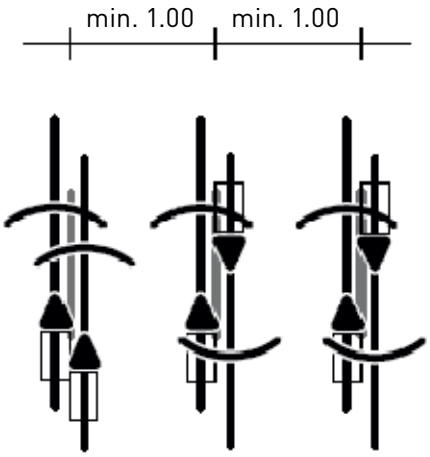

Figure 8: System sketch of bike racks (source: FGSV 2012c)

An alternative to the aforesaid parking facilities could be crowd barriers or crush barriers, as they can also be installed in outdoor areas at a low cost. However, the sometimes thinner bars of conventional crowd barriers might not provide optimum protection against theft. In this case, additional staff should keep an eye on the bike racks.

7.4 Organisation

Staff employed at the parking facilities may be able to offer additional services (bike cleaning, luggage storage, etc.) or provide information material about the event. The opening hours of such bike stations should be coordinated with the actual event.

One member of staff can guard around 100 bike racks and manage the storage and retrieval of bikes. The number of staff deployed at the bike racks should be increased, especially if one or more of the following conditions apply:

- If numerous bikes are handed in or collected in a short period of time due to pronounced peaks in arrivals and departures. This is the case, e.g, at the start and end of concerts and football matches when most people are arriving or departing respectively. In the case of longer-lasting events, such as town shows, on the other hand, it can be assumed that arrivals and departures are more evenly distributed.
- If further services are to be offered in addition to security, storage and retrieval of bikes.
- If, due to limited visibility of the parking facilities, one person alone cannot keep a close eye on the area assigned to them.

Permanently operated bike stations can be managed by specialist bike companies, building services, non-profit organisations, kiosk tenants, taxi companies or mobility centres. Depending on the company profile, they can also offer bike maintenance and repair services. Operators of temporary or short-term-use bike stations can also be event organisers (see [FGSV 2012]).

8 Planning for and controlling crowds of people

8.1 Fields of action

Not only the routes of arrival and departure by public transport but also the pedestrian routes in public areas and movement areas at the actual event site must be planned carefully. It is advisable to consider the pedestrian routes of arrival, attendance and departure in an organised manner (Figure 9). Special attention should be paid to the needs of people with disabilities and accessibility issues during every stage of planning.

Crowd management, as defined by Fruin (1971), includes both goal-oriented planning for crowds of people in the various phases of the event and continuous monitoring of the planned processes as well as continuous comparison of actual events with the planning and advance planning of intervention and correction options.

In addition to comfort aspects, the aim is in particular to avoid hazards resulting from putting on the event by optimising the coordination between demand and the available space and routes.

Localised congestion, gatherings of people or high crowd densities, including actual pushing and jostling, will be unavoidable at many events, at least temporarily and/or locally. They are not necessarily dangerous but must be recognised, observed and evaluated and measures must be planned and prepared to be able to intervene depending on the situation and with only a short amount of response time.

The planning and approval process for an event must therefore focus on adequately identifying hazards that could lead to personal injury and eliminating them as far as possible at the planning phase, or at least minimising them. This includes both providing suitable measures in the implementation phase and making the necessary arrangements.

The scope of the consideration includes the normal operation of arrival and departure, attendance and the best response to possible disruptions and hazardous events.

In Section 8.2, the respective procedures are explained on the basis of general interrelationships, before specific procedures are listed in Sections 8.3 to 8.6 (Figure 10).

The listed fields of action can also be worked through individually – however, they are interlinked with numerous interactions and with reference to traffic management so that complete processing is recommended.

The overarching and safety-relevant objectives, according to which

- all people travelling to the event can be in the public areas at a time when the expected experience begins,
- no hazardous situations arise during any phases of the event,
- an adequate response to faults and hazardous events can be achieved,

require careful planning, which has to take into account the following aspects in detail and comprehensively in their respective dependencies.

8.2 General procedures for designing and inspecting facilities for crowds of people and for managing crowd flows

The expected traffic loads on the arrival and departure routes must be estimated in accordance with the procedures described in the previous sections.

To avoid hazardous overloading of individual areas, individual time zones on the individual pedestrian routes should be considered and the actual demand and available space and routes coordinated. The expected crowd flows over time form the basis for planning and evaluating the facilities and services to be provided.

Depending on the event and task, the time intervals to be considered can be hourly and/or minute-based loads. Additional information is provided in Annexes D and E.

Criteria to be used in these time intervals include expected, achievable and actual crowd flows, crowd densities when standing and moving, average speeds and the profile of the people or groups of people under consideration.

This section describes a general procedure for designing and evaluating facilities for crowds of people and for dealing with the resulting crowd flows.

Step 1: Determining and visualising pedestrian routes

Route relationships to be considered

The first step is to record the connections between the event site and the adjacent areas, in particular to the nearby train stations and stops as well as the parking areas and bike racks. One form of representation can be so-called "web charts", i.e. the visualisation of routes between train stations, stops, parking areas, bike racks and public areas on a map (see Figure 11 for an example).

Pedestrian routes between local residential areas and public areas should also be included if pedestrian traffic is expected from the local neighbourhood. If there are several alternative routes, the advantages and disadvantages should be compared and, if necessary, a preferred route selected. This differentiated approach may also be necessary to determine separate accessible routing.

The expected crowd flows should be visualised on a scaled site plan. The visualisation should be on a scale of 1:500 (1 cm ≙ 5 m), but in no case on a scale smaller than 1:1,000 (1 cm ≙ 10 m). It must be ensured that the un-

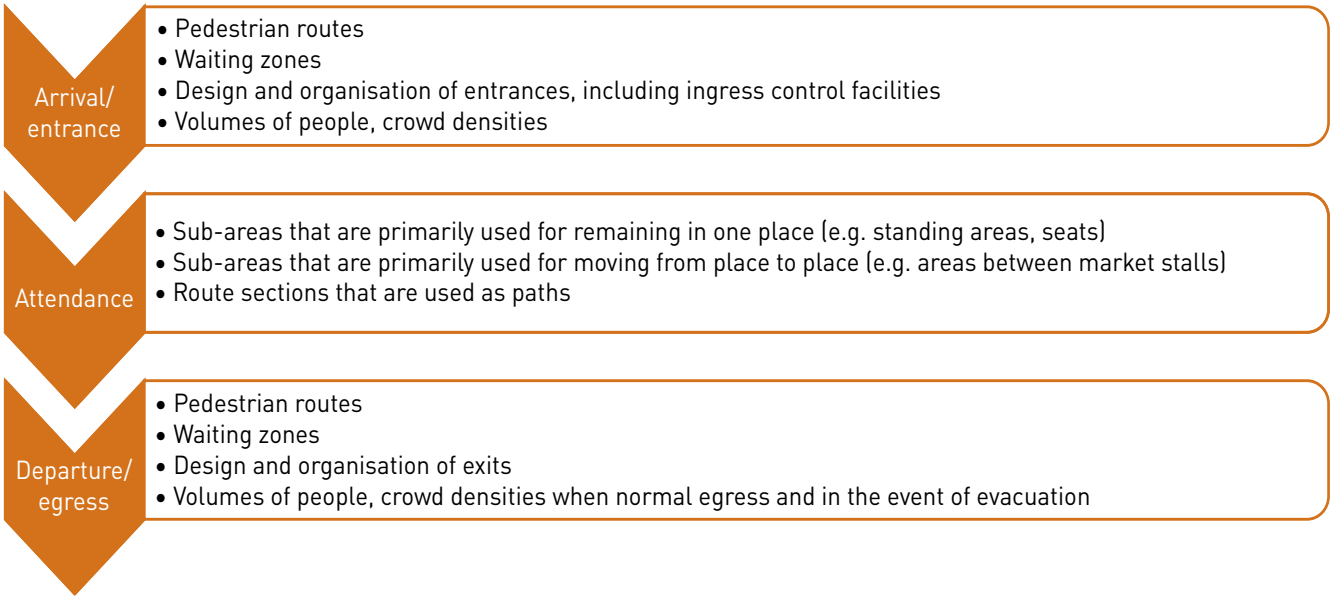

Figure 9: Phases of an event to be considered (as a minimum) when planning for crowds of people

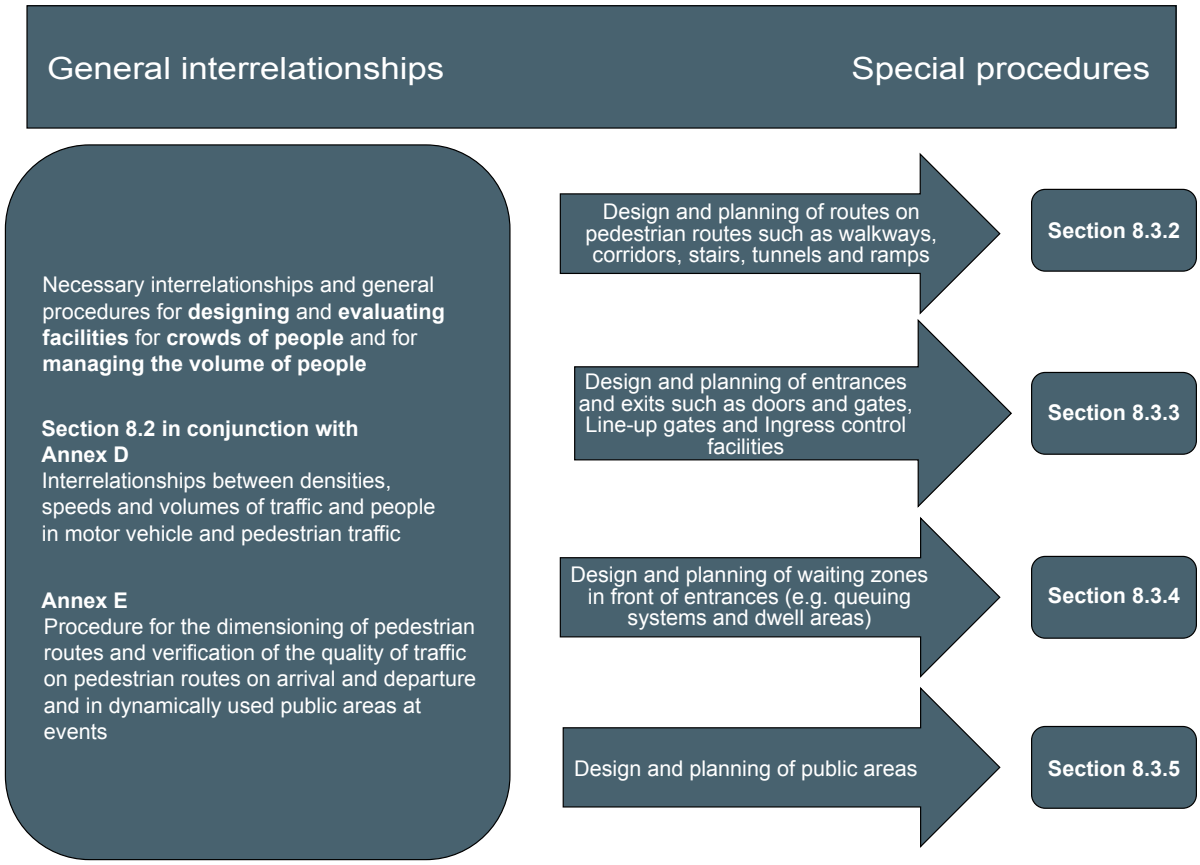

Image 10: General and specific procedures for designing and checking facilities for crowds of people and for managing crowd flows

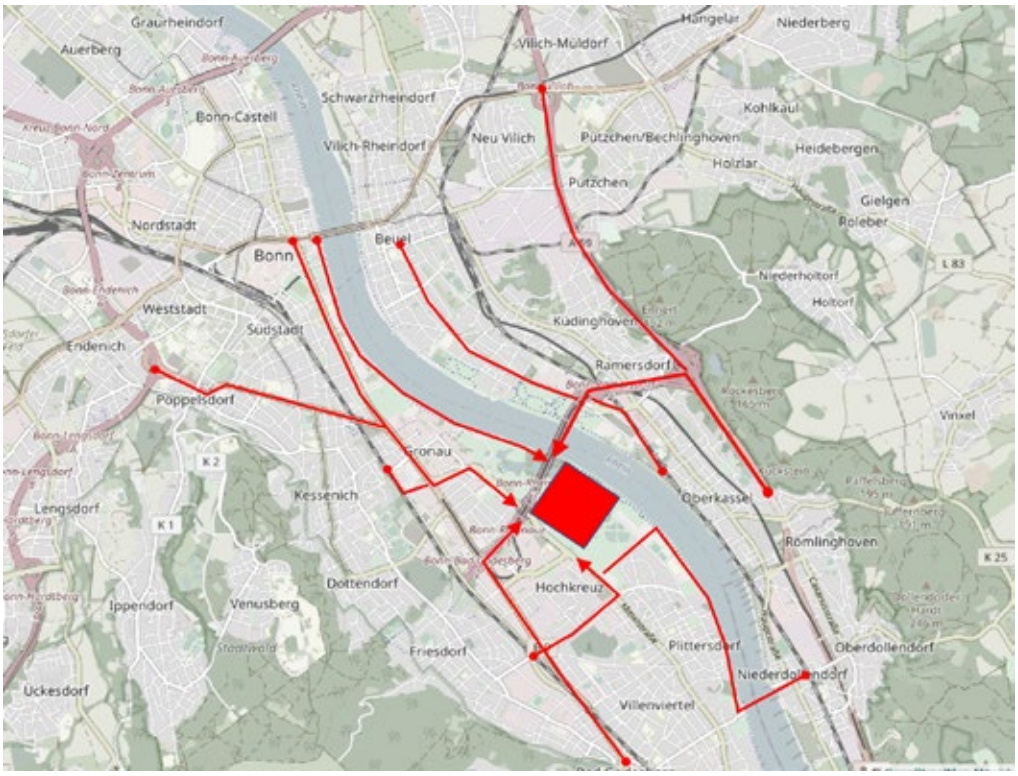

Image 11: Example of a presentation of web charts (base map: OpenStreetMap contributors)

derlying plans correspond to the actual situation on site. Plans, including cadastral maps, are often out of date and must always be compared with the actual conditions on site.

Time intervals to be considered

Forecasts are usually prepared in 60, 30 or 15-minute intervals. The relevant time intervals are those periods in which, according to the forecast in Section 4, the highest demand for people is expected in individual areas of the pedestrian routes and public areas. A visualisation helps to identify those areas that could potentially experience high capacity utilisation and are, therefore, relevant for further consideration (see Figure 12). They can be train stations and stops, narrow sections along pedestrian routes, security search systems and upstream waiting zones, doors and gates, stairs, tunnels and ramps on arrival and departure routes. In public areas, they can be standing and sitting areas and narrow sections along footpaths between market stalls or similar.

The duration of the relevant time intervals is based on:

- the level of detail of the forecast of the expected arriving, departing and attending people,
- the scale and type of event,
- the course of the event,
- the duration and distribution of arrival and departure times, and
- the frequency of high-demand public transport services (see Section 4.2).

A separate plan should be created for each of the relevant time intervals (e.g. as a separate layer for CAD plans).

For larger events with several pedestrian routes in particular, it is advisable to show the crowd flows for arrival and departure as arrows and to vary the thickness of the arrows according to the respective crowd flows (see Figure 13).

To visualise the attendance phase, the expected number of people present at the same time should be shown, dif-

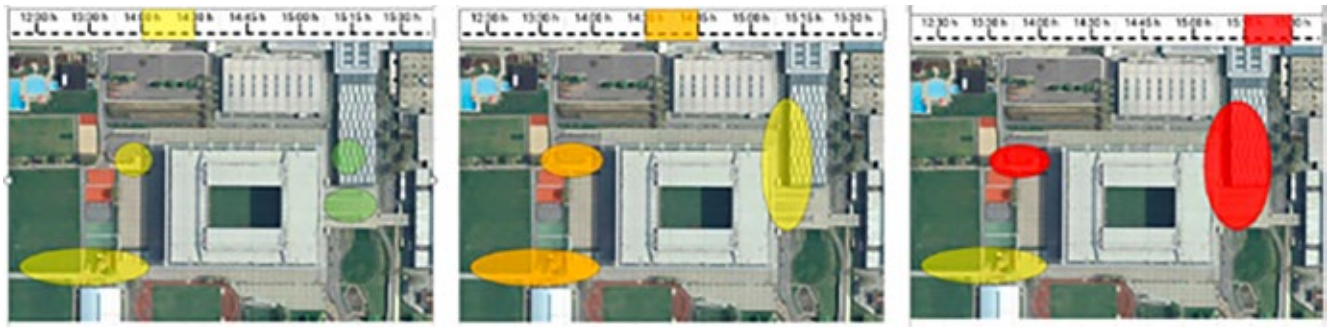

Image 12: Visualisation of areas (size) and densities (colour) on a the time line (source: Zimme)

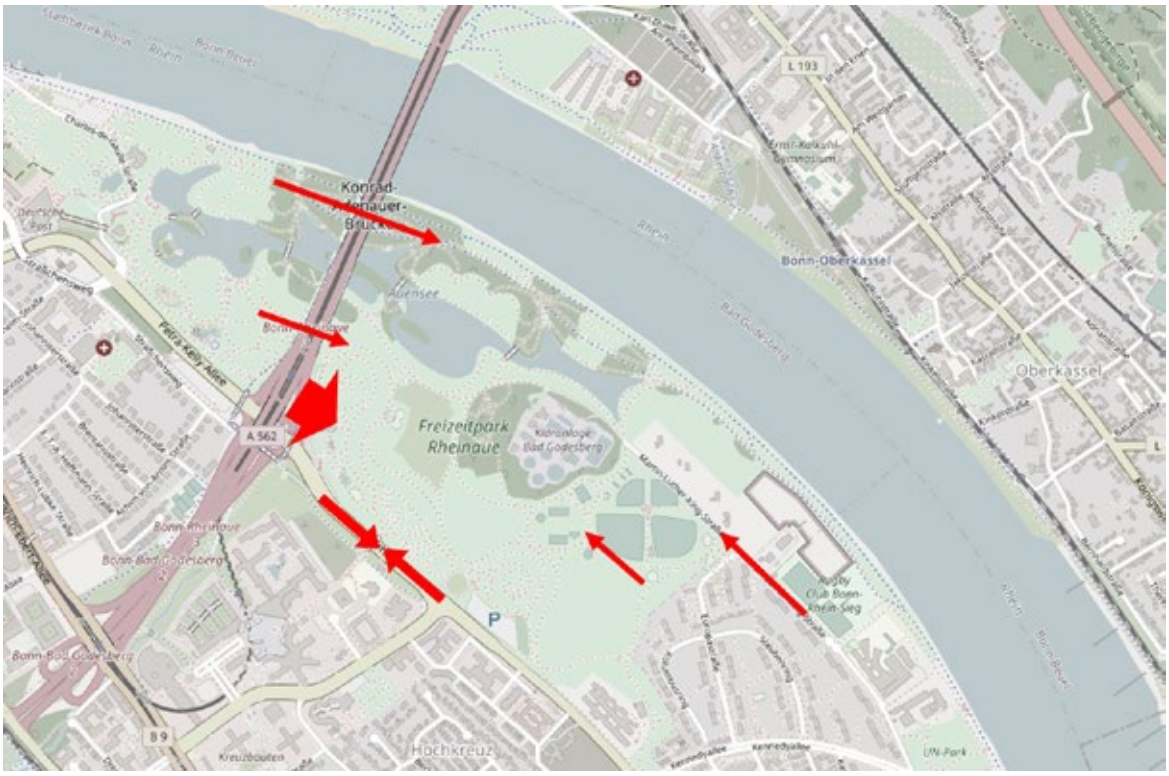

Image 13: Example of a representation of crowd flows on pedestrian routes
(base map: OpenStreetMap contributors)

ferentiated according to individual sub-areas, if necessary. Here too, it can be helpful to visualise the respective occupancy by time periods on several plans.

Step 2: Designing facilities and services, evaluating capacities and the quality of traffic flow

After identification and visualisation, the existing facilities and services must be checked for their suitability for the planned event.

Individual requirements and information on suitability testing and the design of facilities and services can be found in ordinances (e.g. the German Model Ordinance on Places of Assembly (MVStättVO) and state building regulations) and standards published by the German Institute for Standardisation (e.g. [DIN EN 13200]) – however, in most cases they fall short and/or fail to consider the complex interrelationships.

For example, it is not enough to design a public area according to how many people can be evacuated safely during a reasonable amount of time. Rather, it also plays a role whether the expected movements can be achieved in normal operation, even taking into account expected peaks in attractiveness, and whether the expected number of people can reach the public areas as planned and expected and leave them again in a reasonable amount of time.

In practice, standardised values are often applied. In reality, however, they can be influenced by a variety of basic parameters – "appropriateness" always requires a precise consideration of the factors relevant to the planning with regard to the actual spatial and temporal conditions and the expected audience profile.

The aim of designing or evaluating facilities on pedestrian routes is generally neither over-sizing nor under-sizing, but rather achieving conditions in which high crowd flows can be managed without causing personal injury. This also includes the processing or resolution of congestion in a reasonable amount of time, i.e. in a time that is acceptable to attendees.

To assist with this, Annex D explains the general interrelationships between crowd flow, crowd flow density and speed to be used as a basis for the design and evaluation.

Annex E also describes the procedure for designing pedestrian routes and verifying the quality of traffic on pedestrian routes for arrivals and departures and in dynamically used public areas.

This procedure is to be used to categorise the quality of traffic flow into three levels of quality: GREEN, YELLOW and RED. The categorisation forms a basis for assessing the expected crowd flows and any necessary measures. At the same time, the estimate is already the basis for evaluating the ACTUAL situation when putting on the event (see Section 9). The comparison with the estimates not only helps with regard to a systematic presentation but also with regard to quickly recognising any deviations between reality and planning.

The assessment must always be carried out on an individual basis: crowd densities in public areas must, e.g., be assessed differently from comparable crowd densities on pedestrian routes. But even within these categories, it is almost impossible to make generalised definitions. The overall context must always be considered – both in re-

lation to the assessment of the stages and the planning of the measures.

The procedures listed in these recommendations refer to unidirectional and bidirectional crowd flows, i.e. one-way and two-way traffic of average groups of people with normal mobility.

If other circumstances exist or are to be expected, different conditions will result. For example, to illustrate extremes, users of wheeled walkers are slower on level ground than marathon runners.

Deviating conditions should be taken into account as part of an individual hazard assessment. As a rule, deductions are made for deviating conditions – for example, for paths across meadows or uneven terrain or for groups of people with limited mobility – which relate to the approach of the achievable crowd flows or specific flows.

For people with severe walking impairments, a reduced locomotion speed of between 0.5 and 0.8 m/s should generally be applied [FGSV 2011, p.51]. However, specific reduction factors cannot be specified here, as no generally valid findings are available. The level of reduction values to be applied always depends on an individual hazard analysis.

Bidirectional crowd flows that are close to the respective capacity limit of the area should be avoided wherever possible – this helps to minimise any risks of congestion and to reduce the risks of capacity-related diversions to adjacent traffic facilities, such as busy roads.

If this is not possible even after examining all the available measures, organisational and staff measures need to be implemented to not only continuously monitor these crowd flows, but also to be able to intervene at short notice.

The entrance/exit areas for narrow sections play a particularly important role here, as they not only serve as relief zones or as response areas for possible temporary intervention measures (e.g. closures), but also because multidirectional, i.e. crossing, crowd flows can often occur at these points.

There are currently no reliable reduction factors or design procedures for multidirectional crowd flows or for the interweaving or disentanglement of crowd flows. Findings indicate that the achievable crowd flows in such cases are significantly lower than the achievable crowd flows for unidirectional and bidirectional crowd flows. Reductions should be applied here as part of the planning process, although no generally valid findings are available and no specific value can be recommended.

If multidirectional crowd flows cannot be avoided in an area, the area should be relieved as much as possible – in other words, it should be checked which superstructures are actually necessary in the area or how the arrangement of these superstructures or even the additional installation of guiding superstructures can affect the routing of the flows. In general, attempts should be made to separate and equalise individual flows as much as possible. In addition, organisational and staff measures for monitoring, control, routing or closure may be necessary.

The demand-oriented assessment of installations for crowds of people and for handling people at these installations is primarily aimed at preventing personal injury. The question of whether personal injury occurs in clusters of people due to pushing and jostling and pressure situations depends on several factors (see Figure 14).

A basic distinction begins with the question of whether the footpaths under consideration are primarily intended for movement (dynamic utilisation) or whether they are primarily intended for standing or sitting (static utilisation). Depending on the surface, special procedures are required, which are described in more detail in Section 8.3 (and see Figure 15).

Annex E contains a procedure for suitability testing and designing routes and facilities on pedestrian routes. The procedure offers the possibility of making a rough assessment or design using manual calculations. If there is fundamental uncertainty regarding the feasibility or usability of areas or terrain, e.g. in the case of complex terrain structures, dynamic processes or very limited capacities, it may be useful to use microscopic crowd flow simulations as an alternative to manual calculations.

Within these simulations, the resulting crowd flows, conflict points and quality levels are calculated and visualised. Before carrying out a simulation, the questions to be answered must be formulated quite clearly. As with all methods, the input parameters must be determined as detailed and comprehensible as possible. A simulation therefore does not replace the analysis of the respective questions but serves as a tool to automatically process the input data and visualise the results. The following aspects are required as input data for a simulation: specific questions that are to be answered with a simulation – questions can be, for example: How long does it take to reach, leave or clear public areas? What crowd densities can be expected in public areas? Where do problematic densities occur? What capacity does the area have in order to be able to leave or clear it in an acceptable time without critical situations occurring?

- Information on the spectator profile and the event,
- Scaled geometry with all relevant details in relation to accessible areas.

The results can be visualised in the form of videos and/or with the help of colour-coded evaluations – e.g., so-called heat maps (see Figure 16 for an example) can make the quality levels of the individual areas visible at a glance. To test measures, planning variants can be simulated and compared with each other.

Although simulations are a solid tool for planning support and are more accurate than manual calculations due to the microscopic approach, they are in no way a substitute for an individual hazard assessment and intensive study of the issue in question. Results must always be critically scrutinised and checked for plausibility.

If manual calculations or the use of simulation models show that pushing and jostling or queues are to be expected, they must be assessed. Factors here include, for

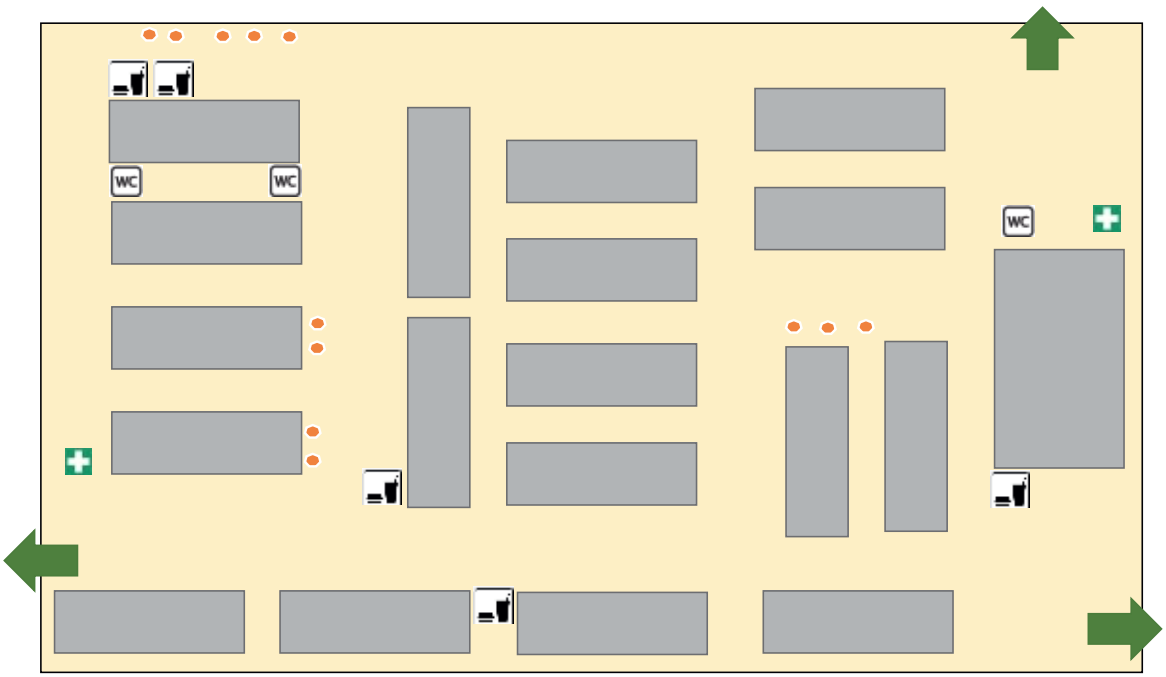

Image 14: Example of an event site consisting of many small areas, each of which are both a dwell areas and traffic areas

Image 15: Example of a compaction and the convergence of flows from various directions

example, the duration or the expected crowd density in a pushing and jostling situation. The possibility of implementing measures also plays a role in the assessment, as do the respective purpose of the area under consideration, the orientation options, the composition and expectations of the people and the options for communicating information.

Situations involving personal injury cannot be described solely by objective, measurable factors, but also by the subjective judgement of the people in a cluster of people. The following play a role in this case:

- the concern or fear of missing out on an expected experience,
- the perception of an actual immediate and serious hazard,
- the perception of a suspected immediate and serious hazard,
- the perception of limited opportunities to exit the situation,
- the judgement that it is necessary to exit the situation immediately, and
- a lack of information about the situation.

Studies have shown that, in addition to a lack of coordination of processes, an inadequate circulation of information is one of the most common causes of accidents at events. A lack of information can both trigger situations (e.g. due a surging crowd or people trying to escape) and exacerbate an already problematic situation.

One aim when designing, and inspecting pedestrian routes and public areas is to create forgiving structures that can tolerate or compensate for deviations. This is achieved through proper area planning and the interaction of area design with staff or organisational measures to control and guide people to the respective area.

Step 3: Creating a catalogue of measures

If remaining deficits and possible hazards due to excessive crowd flows and/or excessive crowd densities are identified in individual facilities or areas of an event site, measures must be developed, checked for their effectiveness, selected and implemented to eliminate or at least minimise these deficits. Such measures include, for example:

- expanding the available space,
- changing the routes,
- reducing the crowd flows,
- segregating the crowd flows over time,
- "clearing" areas by creating areas with good visibility,
- intensifying control and guidance, e.g. through messages, signage and/or other forms of signposting, and
- increasing the deployment of staff for control and guidance in both normal and damage situations.

If it is not possible to avoid deficits above a mutually accepted residual risk in advance of an event, a different event concept and/or event location should be selected or, in case of doubt, the event should be cancelled.

8.3 Special procedures for designing individual areas

8.3.1 Preliminary notes

In addition to the general procedure, there are special requirements for different routes, areas and spaces that must be considered individually or that demand special attention.

These include the following sections:

- pedestrian routes for arrival, attendance and departure,
- entrances/exits, including the associated infrastructure,
- waiting zones and dwell areas in front of the entrances,
- public areas.

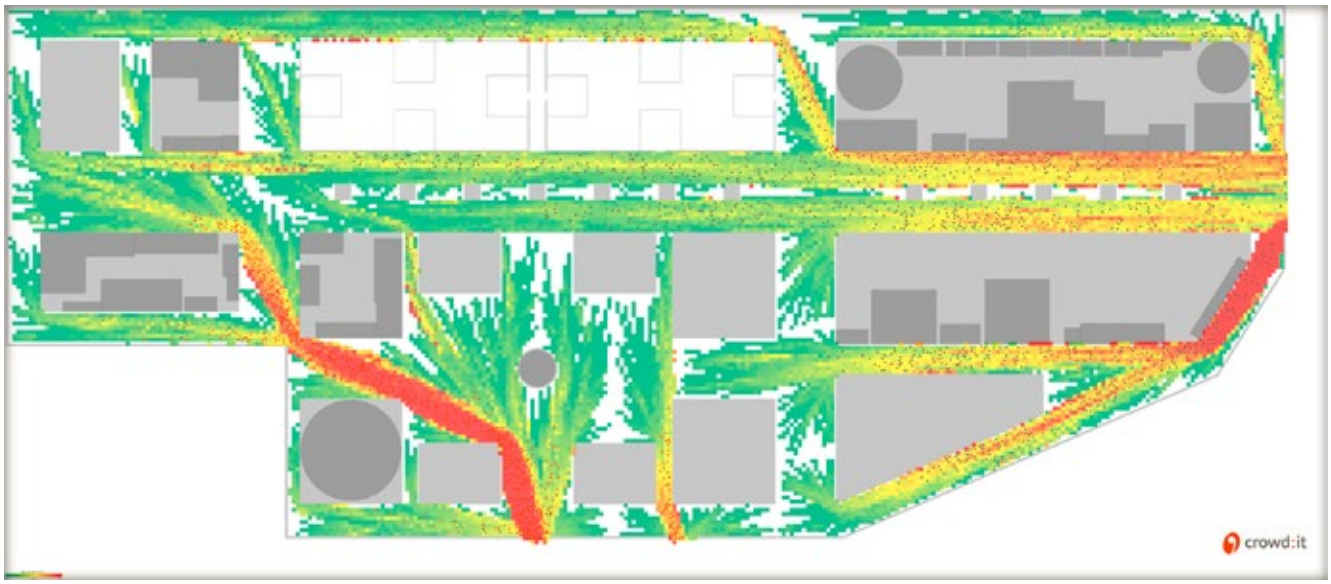

Image 16: Sample presentation of the simulation results as a heat map (source: accu:rate)

8.3.2 Pedestrian routes for arrival, attendance and departure

The explanations below refer to the pedestrian routes for arrivals and departures as well as to public areas used as paths.

On routes used to get to the desired destination, it should be ensured that the expected traffic loads can be managed without longer-lasting congestion, or actual pushing and jostling.

Pushing and jostling are fundamentally relevant to safety – especially on dynamically used routes. These routes require special attention when planning and putting on an event. The primary safety objective remains the avoidance of congestion or actual pushing and jostling. The secondary safety objective is the preparation and implementation of measures, e.g. to recognise and resolve potentially hazardous situations such as pushing and jostling.

In this understanding, dynamically utilised public areas are areas that are primarily used for effective movement through the area – in contrast to statically utilised areas, i.e. areas that are primarily used by standing people, such as waiting zones or, e.g., stage areas (see Section 8.3.5).

When considering pedestrian routes, the purpose of use must be taken into account in addition to the distinction between predominantly statically or dynamically utilised areas.

A distinction must be made between routes that

- on arrival serve to get to the public areas,
- on departure serve to leave public areas,
- in public areas that serve to provide the experience, and
- in public areas that serve as transfer routes to reach a destination.

In principle, the aim should be to separate routes with high loads from other flows as far as possible. To prevent mutual hazards, avoid crossing, mixing, or juxtaposing pedestrian routes with a high volume of motor vehicle and bicycle traffic – e.g. to prevent hazards caused by people stepping into the road or a cycle path due to congested walkways.

If separation cannot be achieved, additional safety measures must be considered. When considering these safety measures, it must be ensured that they do not lead to any hazards, e.g. barriers intended to separate passenger vehicles and pedestrian traffic that may topple over.

If it is not possible to avoid high traffic loads, it must be ensured that there are options for relief, e.g. by temporarily diverting flows of traffic, that access critical routes, e.g. those used by emergency services, is possible at all times.

The same applies to routes used for departure and leaving public areas, where congestion, as well as pushing and jostling are also possible, e.g. at junctions directly adjacent to the exit, on pedestrian routes that cross parking facility exits, or at stops (see Figure 17 for an example).

Pedestrian routes should be tested and designed in accordance with the information and procedures in Annexes D and E.

- The following should be noted when assessing the results. A GREEN quality of traffic flow should be aimed for in all partial and time zones on pedestrian routes that are used to get to public areas on arrival or to get to stops on departure. Identifiable deviations in the planning phase should only be tolerated if, e.g, staff and organisational measures ensure that the situations can be continuously monitored and that measures for any necessary control tasks are planned in advance. It must also be shown that any expected deviations can be tolerated by the expected target group.
- Situations with a YELLOW quality of traffic flow can be accepted for all other partial and time zones on pedestrian routes that are used for movement. This applies, e.g., to pedestrian routes to parking bays and public areas that provide the experience, or are transfer routes. Organisational and/or staff measures for continuous monitoring and any necessary control intervention must be planned and provided for at the same time.
- An expected RED quality of traffic flow at dynamically utilised areas is not acceptable for the evaluation and design as part of the planning and approval process. If it becomes apparent in the planning phase that situations with a RED quality of traffic flow may arise on routes used for movement and getting ahead, a separate hazard assessment and replanning process must be carried out (see Section 8.2, Step 3). A special situation arises if utilisation of an area changes temporarily – e.g. if it is planned and intended for people to remain standing in a public area that is actually used for movement, e.g. to watch fireworks. In this case, the change of utilisation also changes the acceptance of the quality of traffic flow – however, it must be ensured that measures are taken at the end of the temporary change of utilisation to achieve at least a YELLOW quality of traffic flow as quickly as possible.

Examples of the design of pedestrian routes and dynamically utilised public areas can be found in Annex C.

In addition to the measures mentioned in Section 8.2, it may be necessary to provide additional measures for particularly congested pedestrian routes as part of the planning process. In particular, if alternative routes are to be implemented or routes promoted, they must be activated – often simultaneously reducing the attractiveness of the pedestrian route to be relieved.

Such measures include:
- the establishment of (temporary) guidance systems, e.g. through colour-coded sign-posting,
- the establishment of upstream programme items (information, entertainment) on certain routes to increase their attractiveness or
- the installation of "inviting" lighting.

Routes that are particularly attractive and therefore particularly busy, e.g. because they already allow a first glimpse of the event, can be made "unattractive", e.g. by in-

stalling privacy screens. This applies in particular to routes that lead directly past or above the event site. The same applies to routes that already allow the event to be experienced (e.g. by listening to the programme). If this cannot be prevented in terms of organisation or planning, members of staff must be deployed to address and, if necessary, actively redirect people.

Another factor to consider when planning pedestrian routes is ensuring accessibility for people with limited mobility. If certain routes cannot be found, accessed or utilised by people with limited mobility and/or orientation skills, while other routes are at least largely accessible, this information should be communicated well in advance, both in terms of time and location, to enable those concerned to plan accordingly (see Table 2: Overview of possible information content for various target groups via possible communication media). If it is known that at some point a route is unsuitable for certain groups of people, e.g. some distance from the disabled parking bays, this fact must be clearly stated at the start of the route. Further information on planning accessible traffic facilities can be found in the "Notes on Accessible Traffic Facilities" (H BVA) [FGSV 2011].

It must be noted that there should be longer routes and also relief zones between the start and end points of the pedestrian routes, e.g. between stops and entrances or between exits and the train station. If necessary, they can be used to extend the available space, keep groups of people waiting and segregate flows. Without such routes and relief zones, a disruption could lead to tailbacks on the pedestrian route. If it is not possible to provide adequate relief zones due to various circumstances, it is, e.g., worth considering the closure of side roads and paths or the utilisation of private parking areas.

8.3.3 Entrances and exits, including security search points

Entrances and exits to and from public areas are facilities to which special attention must be paid when planning and putting on an event.

Entrances

- are important, as they offer people travelling to the event a first impression of the event,
- offer areas of action for controlling people and communicating information,
- are areas of action for stewards – with potentially far-reaching consequences for the overall safety of the event (e.g. due to limited opportunities to carry out security searches),
- must be able to withstand the traffic load even in the event of fluctuations and deviations from the forecast,
- must be able to accommodate large gatherings of people in an unprotected space,
- must also be accessible to people with disabilities.

Exits

- define the end of the experience and may therefore determine the overall impression of the event,
- must have an acceptable quality of traffic for the departure of people,
- must take into account the possibly changed personal profile (exhausted, disappointed, inebriated),
- must be able to accommodate large gatherings of people in an area that is no longer protected,
- must also be accessible to people with disabilities.

Table 10 provides an overview of the various types of entrances/exits as well as the respective challenges and requirements.

Image 17: Example of a situation on departure with direct access to a stop (source: Nowak)

Regardless of the respective type, each entrance/exit must

- be adequately dimensioned for the crowd flows expected in individual time intervals and the overall time estimates used as a basis,
- have adjoining areas in front of/behind the entrance/exit or access points, which must be kept clear of unnecessary superstructures, etc. Necessary superstructures must be arranged in such a way that they do not cause delays (e.g. information boards in front of which people may stop and block crowd flows),
- at least be capable of being organised in case of an emergency (e.g. clearing congestion),
- be defined – i.e. that areas of responsibility are separated or clearly assigned,
- be adequately equipped for use (e.g. lights for use in the dark, ground protection for weather-dependent access in green outdoor areas, deployment of trained staff).

Areas that are used simultaneously or successively as entrance/exit are subject to special requirements in terms of the area design and any necessary separation of crowd flows. Special challenges arise if entrances are to be used as emergency exits or emergency routes for evacuation (see Section 10) or if emergency exits or emergency routes run directly next to entrances. In this case, it is necessary to plan for any closures of the entrances in advance, to plan organisational measures to quickly clear the entrances and waiting zones and/or to plan for the use of markings or only lightweight materials to enable fast removal.

More recently, entrance/exit areas have also become the scene of threats and actual attacks – due to the fact that a large number of people often gather there in a defined area at a defined time, making them an easy target for attacks.

In addition to the question of the transfer of responsibility, which needs to be clarified, coordinated measures must be taken, particularly where entrance/exit areas, including the associated dwell areas, are directly adjacent to roads with traffic, in order to rule out both motivated attacks and possible traffic accidents. Entrance/exit areas with the associated waiting zones should also be considered as part of an access protection concept.

Additional requirements must be placed on events with organised entrances, exits and security searches. Many personal injuries that have been recorded at events worldwide with security searches are (partly) caused by the planning or control of these entrance areas in particular.

Entrance areas with security searches must be designed in such a way that the crowd flow can be managed without congestion or crowd pressure developing in public areas or waiting times becoming too long. The waiting zones before and after the entrances/exits must be dimensioned in such a way that they can accommodate an agreed and acceptable number and density of people. Further information on this can be found in Annexes D and E.

The following must be taken into account in the planning process:

- the forecast number of arriving and departing people,
- the desired quality levels of traffic flow on pedestrian routes to and from the public areas (see Section 8.3.3),
- the time required for security searches and the resulting flow capacity of the security search points, and
- the capacity of the waiting and buffer zones.

At events with security searches, infrastructural measures are often taken to separate people queuing in the search zone (see Figure 18 for examples). Standard (DIN) EN 13200-7 provides the following information on the design of separating elements:

> "Separating elements must be fixed to the floor and be at least 1.1 m tall, with the upper section rounded off.
>
> The turnstile within the spectator separating element must be at least 0.6 m wide and allow any waiting spectators to leave the queue immediately, if necessary. Separate entrances with a wider turnstile and easier access must be provided for people with pushchairs and prams as well as for wheelchair users.
>
> Spectator separating elements must be designed in such a way that they can withstand a horizontal static load of 0.8 kN/m at a height of 1.1 m without being damaged."

To calculate a sufficient number of turnstiles and security search points, the number of people arriving per time interval, the total admission period and the flow capacity per turnstile must be taken into account.

The flow capacity depends on:

- the number of people per turnstile,
- the intensity of the security searches,
- the attendee profile,
- the security search requirements (ban on bags, glass, etc.), and
- the conditions (homogeneity of the flows of arriving people, crowd density, atmosphere) in the waiting zones in front of the entrances.

There are no verifiable approaches for calculating flow capacity according to these basic parameters due to the large number and complexity of the aforesaid influencing factors. The minimum flow capacity that must be achieved in order to avoid unacceptable tailbacks and to ensure that the actual event is reached on time must be checked individually for each event.

The "Guide to Safety at Sports Grounds", which is used in English-speaking countries, and standard (DIN) 13200-7 state that the crowd flow or flow capacity to be applied as a rule is set at a maximum of 660 persons per turnstile per hour.

Surveys in German-speaking countries indicate that, depending on the basic parameters, an average time requirement of 7 to 30 seconds per person can be estimated. Approximations of 2 to 8 persons per turnstile per minute therefore seem appropriate – however, these values should also be checked individually. If there are any doubts about the values to be applied, an on-site test is recommended, if possible under the conditions prevailing during the event.

Table 10: Types, challenges and necessities of and at event entrances/exits

Type of entrance	Uncontrolled and spatially undefined entrance	Uncontrolled entrance	Entrance with security searches and throng development in the waiting zone	Entrance with security searches and a well-regulated crowd guidance system in the waiting zone
Examples of typical events	Town show, market festival	Fun fair, Christmas market	Sporting event, professional football matches	Concert event
Event description	Uncontrolled, not explicitly designated transition from the public area to the (private) public area	Uncontrolled but spatially defined transition from the public area to the (private) public area	Security search points mostly in conjunction with separating elements, uncontrolled access with self-organised queuing in the waiting zone	Security search points mostly in conjunction with separating elements, controlled access with orderly queuing in waiting zones
Use of resources in the entrance area	No use of materials, no organisational measures, no deployment of staff	If necessary, use of materials (entrance gate or similar, taking into account accessibility), no organisational measures, no deployment of staff	Use of materials and deployment of staff, organisational measures at security search points	Use of materials and deployment of staff, organisational measures at security search points and in waiting zones
Possible special challenges	Lack of orientation for arriving persons, precise definition of areas of responsibility necessary, lack of organisational options and limited space in the event of disruptions (e.g. if closures are necessary)	Definition of areas of responsibility necessary, congestion at entrances possible, limited ability to act on the part of those waiting, limited communication options with those waiting	Congestion at the entrances likely, limited ability to act on the part of those waiting, limited communication options with those waiting, definition of areas of responsibility necessary	High demand for material and staff resources, enabling people to leave the queuing system, definition of areas of responsibility necessary
Measures to be examined	Marking of the entrance situation, including signposting, keeping the entrances clear of superstructures and attractions that could cause people to stop moving, marking of the areas to be kept clear, pre-planning of possible restricted positions, separate signposting for people with disabilities in case of limited accessibility	Marking of the entrance situation, including signposting, keeping entrances and waiting zones clear of superstructures and attractions that could cause people to stop moving, marking of the areas to be kept clear, pre-planning of possible restricted positions, enabling communicative influence, pre-planning of any control measures in waiting zones, separate signposting for people with disabilities in case of limited accessibility	Setting up the entrance situation, including signposting, keeping entrances and waiting zones clear of superstructures and attractions that could cause people to stop moving, marking the areas to be kept clear, enabling communicative influence, pre-planning of any control measures in waiting zones, pre-planning of any measures to speed up security searches (e.g. activation of reserve turnstiles), ensuring that at least one of the separating elements is accessible to people with disabilities or separate accessible routing	Setting up the entrance situation and the queuing system, including signposting, keeping entrances and waiting zones clear of superstructures and attractions that could cause people to stop moving, marking the areas to be kept clear, enabling communicative influence, pre-planning any control measures in waiting zones, pre-planning any measures to speed up security searches (e.g. activation of reserve turnstiles), pre-planning of successive removal of the queuing system, ensuring full accessibility to the crowd guidance system and the separating element for people with disabilities, if necessary limited to selected routes, or separate accessible routing and entrance design

The following must be taken into account with regard to the deployment of staff at the security search points:

- The total number of staff to be deployed must be sufficient – this also includes having back-up staff available.
- The splitting of staff into stewards must be justified in a public order service concept with a description of tasks to be performed.
- The gender profile of the members of staff should correspond to the gender profile of the persons expected and being checked.
- The members of staff should not be assigned multiple tasks (e.g. checks and simultaneous supervision of the waiting zone).
- Staff should be positioned to fully control arrivals and, if necessary, to stop the influx of people or to close the turnstiles.

It should be taken into account that the actual number of people arriving per time interval may deviate from the forecast values (see Section 4).

The requirements of people with limited mobility and/or people with special needs must be taken into account when planning admission. While the level of protection, e.g. for security searches, must also be maintained for these groups of people, special measures may be necessary when implementing the checks. They include, e.g., wider entrances or specially trained staff. The same applies, for example, to recognise people in need of help and/or assistance in a queue – here too, trained staff are required to offer proactive assistance, e.g. by using a different entrance.

If the scheduled admission times are shortened due to unforeseen events on arrival, e.g., the planned security search processes must also be carried out faster. As it is rarely possible to postpone the start of the programme or spontaneously increase the number of search points, any deviation should be planned for from the outset so as not to jeopardise the necessary searches and the orderly process.

Similar to the entrances, the design of the exits also requires intensive consideration. This applies not only to emergency exits, for which requirements must be met. The design and organisation of the regular exit is also subject to basic parameters that must be observed, especially

- in the case of a very young audience (high number of people being picked up, for whom parking spaces, waiting zones and rendezvous points must be set up),
- in the case of a spatially restricted connection to a stop (overlapping of exit and waiting zones, lack of buffer zones when waiting for transport),
- if there are multiple and confusing routes behind the exits when departing people have to be routed in different directions,
- if, in contrast to entrance, exit takes place at a specific time and a large number of people want to pass through the exits at the same time, and/or
- if the spectator profile has changed during the course of the event (e.g. higher ratio of exhausted, inebriated, frustrated, euphoric people).

The planning and design of the exits must ensure that the expected number of departing people can leave the public areas in a reasonable amount of time. It must also be ensured that it is possible to address and organise people departing the event (e.g. stop their departure or close the exits) at any time. Areas of responsibility must also be clearly defined, particularly with regard to the transition from the areas belonging to the event to the public area.

8.3.4 Waiting zones in front of the entrances/exits

Sufficient space must be provided for people waiting at the entrances/exits to and from public areas. Provisions must be taken for congestion and managing waiting people – both during normal operation and in the event of a damage situation.

Special consideration must be given to the fact that the areas intended for the management of waiting persons are often subject to multiple uses. They can be areas of action, utility areas or even relief zones in the event of evacuation. In addition, they can be movement areas for vehicle traffic, waiting zones for vehicles and deployment areas for police, fire and ambulance services. As part of the planning process, it must be ensured that the areas are suitable for this multifunctional use. Waiting zones should be clearly laid out to ensure that new spectators can recognise the situation at the actual search points. Repeatedly, failure to recognise the situation of those waiting at the front has led to tragic accidents ("failure of front to back commu-

Image 18: Examples of separating elements (source: Bernd Belka, Special Security Services Deutschland)

nications"). Scenarios should be drawn up as part of the planning process that also take into account disruptions, such as a possible delay in the start of admission. When planning the various areas and zones, it is therefore necessary to forecast the maximum number of people that the waiting zones can or must accommodate at individual time intervals, taking into account defined scenarios and planned or situational multifunctional use. In addition, the management of waiting people, such as the organisation of queues and communication with waiting people, must be prepared and implemented.

The crowd densities that can be planned and tolerated in the waiting zone when putting on the event depends on how the waiting zone is organised, e.g. whether orderly queuing systems are planned,

- which audience profile is expected,
- whether the waiting zone is multifunctional,
- whether everyone in all the waiting zones can be informed and addressed,
- whether sufficiently trained staff are available to direct, guide and address waiting people,
- whether the waiting zones are free from fixtures and obstructions,
- how long phases with high crowd densities last,
- whether a rapid transfer of information between those involved and swift and coordinated responses to any disruptions can be ensured,
- whether particular behaviour of individual groups of people, such as a high level of dynamism or aggressive behaviour, is to be expected.

Annex D contains information on the effects of different crowd densities. These can be used to determine appropriate crowd densities for specific waiting zones. It should be noted that getting through a cluster of standing people with a crowd density of around 2 pers/m² is fraught with difficulties and delays, for example in a rescue situation. From 5.5 pers/m² upwards in a cluster of people, independent movement is no longer possible without pushing, shoving or using force. Depending on the prevailing conditions, it is therefore advisable to use rates of between 1 and 4 pers/m² when designing individual waiting zones.

Depending on the volume of people and the spectator profile, additional infrastructure must be provided for the guidance of waiting people – this applies in particular to guiding arrivals to entrances in a controlled manner and to installing pressure-reducing barriers.

A well-regulated crowd guidance system is particularly necessary when

- a large number of people arrive within a short space of time or more time is needed for security searches, as this could lead to uncontrolled gathering of people with potentially high crowd densities in front of entrances,
- if the uncontrolled gathering of people waiting would restrict the necessary special areas (emergency exits, access for wheelchair users, etc.) or the areas of action of the stewards, and/or
- if an uncontrolled gathering of waiting people could create pressure or unpleasant situations for people travelling to the event due to pushing and jostling and/or a lack of orientation and decision-making options.

When planning the infrastructure, it must be ensured that it does not block the areas and routes intended for escape routes and emergency exits.

There are various options when it comes to organised crowd guidance systems – the most common type are straight line guidance systems and a "Disney" style queuing system (named after the queuing system employed in most theme parks). This system (see Figures 19 to 21 for examples) should be planned to start at the separating elements, utilising the available space and is characterised by its

- compact,
- stretched and
- switchback sections.

Given the audience profile and available space, it may be wise to create additional subdivisions within the well-regulated crowd guidance system to manage the waiting crowd more effectively (Figure 22). This may be necessary, e.g., in the case of very long waiting times to allow people to exit the queue or in the case of expected problematic waiting behaviour ("rush to pay") to limit the number of a people pushing forward. This type of subdivision enables the security operatives and stewards to address and influence individual behaviour.

The sample structure in Figure 22 and the example in Figure 23 show the staggering of the materials used. Pressure-resistant materials are used near the entrance, while only guidance materials are utilised in more distant areas.

The design of a well-regulated crowd guidance system must always be adapted individually to the basic parameters resulting from the event planning as well as to the possibilities resulting from the area. It must be ensured that people can exit the system if they decide to do so or if safe evacuation is necessary. The creation of bidirectional crowd flows ("turning round" in the system) must be avoided.

The establishment of a well-regulated crowd guidance system must be accompanied by organisational and staff measures. Simply setting up a "material park" is neither expedient nor sufficient. The members of staff deployed must not only have an understanding of how the system works but must also have good communication skills.

Information and communication in the waiting zone

In many cases, the amount of time people travelling to the event spend in the entrance systems far exceeds the time required to pass through the security search points. This can be a few minutes or even several hours. It must be ensured that communication with all those waiting is possible throughout the entire period – this is particularly relevant in the case of very long waiting times, complex access situations, incidents and damage situations. If the

expected waiting time changes, the reasons for this must be communicated in good time – as well as the forecast duration of the delay or – if this is not yet known – a guarantee that information will be updated regularly. The information must be repeated regularly. In this context, it is crucial to ensure that those waiting are provided with clear, consistent information about any changes.

If unrest arises and people start pushing and jostling, it may be helpful if those arriving and waiting are informed that they will reach the public areas in sufficient time before the start of the expected experience.

Communication with those waiting can take place in various ways and must always be specifically adapted to the conditions on site. Depending on the possible number of people waiting, the options range from loudhailers and truck-mounted loudspeakers to stationary loudspeaker systems and/or video displays. In addition, the stewards have an essential communication task, which should not only convey information but also establish a relationship with the people waiting during normal operations, which can ensure that the necessary requirements are implemented quickly in the event of an incident.

Organisation in the waiting zone

In addition to the measures already mentioned, in most cases it is necessary to take further organisational provisions. These include keeping the areas clear of unwanted or disruptive superstructures and/or activities (e.g. people handing out leaflets, rubbish on the ground), as well as being in control of processes (e.g. escorting people through the waiting crowd).

In the event of congestion or an uneven allocation of people to the entrances, it may be necessary to actively control the continuous flow of people to the security search points. Sudden crowd movements or pushing and jostling must also be prevented. For this purpose, it may be necessary to

- block the view of the actual entrances: this prevents those in the back of a crowd pushing forward when the entrances open,
- arrange demarcated areas ("blocks") in the queues that can be processed "bit by bit",
- create organisational provisions to ensure people can exit waiting zones (e.g. to use the toilet facilities) and then return to their original position,
- ensure continuous surveillance and monitoring of queues – especially for longer waiting times in high temperatures or in areas without any shade, and
- deploy members of staff to explain the relevant queuing rules to those arriving.

8.3.5 Public areas

From a legal perspective, it is important to assess if an event in a public area falls within the scope of regulations, e.g. the German Model Ordinance on Places of Assembly (MVStättVO). In such cases, the regulations contained therein, which may vary from federal state to federal state, must be observed. (See Section 3).

Building law requirements focus, in particular, on ensuring that attendees can be evacuated via adequately wide emergency exit routes (see also Section 10). Consideration should also be given to people with disabilities.

However, this verification alone does not guarantee the functionality and safety of a public area. In order to ensure that people can stay safely in public areas, the following must be determined, estimated and assessed with regard to the possible capacity of an area:

- the amount of usable space available,
- the expected spatial distribution across the area or its various sections,
- the expected temporal distribution across the area or its various sections.

Section 4 contains information on estimating the expected crowd flows. Sections 5 to 8.3.4 deal with the question of whether and how the expected people can reach the public areas.

To determine the capacity of the public areas and thus also to estimate whether the expected number of simultaneous attendees can be accommodated in the areas, the utilisation of the public areas must first be differentiated. Public areas that are connected via pedestrian routes can contain individual sub-areas that, for example, enable

- sitting at tables,
- sitting in rows,
- standing on areas,
- standing on rows of steps,
- walking through exhibition spaces,
- walking between market or fairground stalls,
- walking from one sub-area to another,
- transferring individual groups of people, such as artists or athletes.

The utilisation of individual sub-areas may vary temporarily. In such cases, the respective capacities for individual time periods or utilisation sections needs to be determined. The decisive factor is the time period during which the least number of simultaneous attendees is possible (maximum capacity).

It must be noted that most sub-areas of a public area cannot be assigned exclusively to one type of use. For example, in areas used for standing or sitting, there will be movement activities at least at the start and end of an event to enter or exit these areas. During attendance periods, there will also be movement activities for individual supply and disposal as well as for responding to incidents. The resulting requirements (e.g. width between seats) must be taken into account when designing public areas.

The values specified in Section 1 "Area of Application" of the German Model Ordinance on Places of Assembly (MVStättVO) provide some reference values for designing sub-areas of public areas, which are to be applied if no (other) values are specified in the respective approval documents.

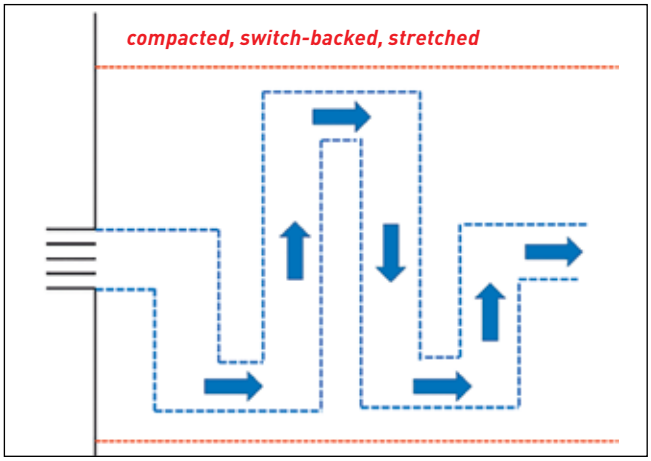

Image 19: Example of a "Disney" style queuing system (source: Bernd Belka, Special Security Services Deutschland)

Image 21: Example of a structured, well-regulated crowd guidance system (source: Bernd Belka, Special Security Services Deutschland)

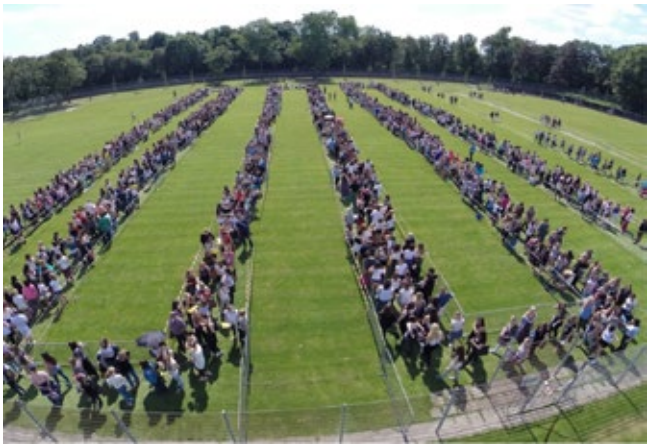

Image 20: Extensive, well-regulated crowd guidance system (source: Lannert/Special Security Services)

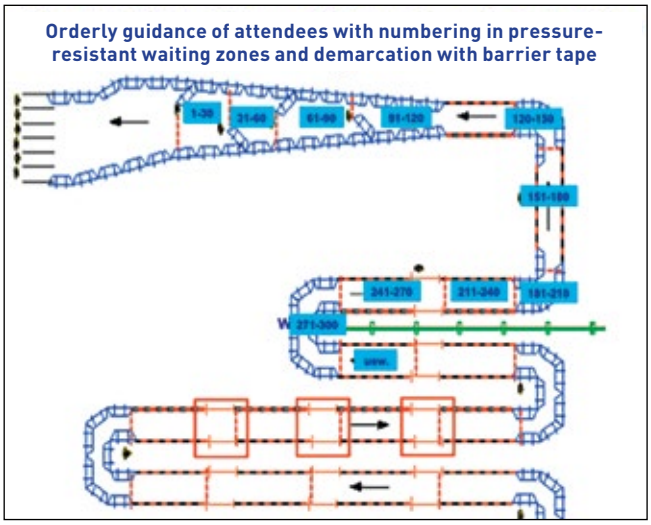

Image 22: Example of a queueing system with infrastructural and organisational "dividing up" (numbering) (source: Bernd Belka, Special Security Services Deutschland)

Image 23: Example of a queuing system with numbering of early arrivals and separation using barrier tape (source: Lannert/ Special Security Services)

"1. For seats at tables:
One attendee per m² of floor space in the assembly room,
2. For seats in rows and for standing spaces:
At least two attendees per m² of floor space in the assembly room,
3. For standing spaces on rows of steps:
Two attendees per linear metre of row of steps,
4. For exhibition rooms:
One attendee per m² of floor space in the assembly room".

It is recommended that these crowd densities are also used outside the scope of the German Model Ordinance on Places of Assembly (MVStättVO) for an initial approximate design of sub-areas used accordingly.

In cases where these values are used for large areas, it will generally be possible to fulfil the requirements resulting from movement activities in these areas, such as rescue operations. Irrespective of this, it is advisable to divide the entire public area into small area units and to consider each area separately with regard to its use.

As part of the planning process, the (assumed) distribution of attendees should also be taken into account – this includes both sub-areas that are used for standing and paths in the public areas. In order to be able to plan areas, routes, information, necessary guidance measures and staff deployment, it is necessary to estimate where and when how many people will be in certain sub-areas of the public areas. On this basis, movements along routes or paths in the public areas, i.e. activities for accessing and leaving individual sub-areas of the public areas, can be derived.

Such activities can be expected or recorded once during a limited period of time (e.g. when accessing and later leaving seats at a concert event), several times during limited periods of time (e.g. between the tent city and the stage at festivals) or continuously during an event (e.g. at town shows with several stages or markets).

In any case, it should be noted that the utilisation of area units can influence each other. For example, disturbances in one area can have an impact on upstream or neighbouring areas. Where possible, these impacts should be examined as part of the planning process and in any case be included in a modular catalogue of measures ("if – then" modules). To this end, it is essential to always consider the overall system in addition to the respective sub-areas, both in the context of planning and in the context of the implementation of measures.

The influence not only affects the statically utilised areas but also the adjacent statically and dynamically utilised areas.

For the design of sub-areas and paths in public areas, the following basic parameters should first be taken into account and the resulting requirements clarified:

- user profile of the sub-areas and paths,
- special features resulting from the profile and expectations of the attendees (e.g. the primary expectations and needs at concert events are to see and hear what is happening on stage and to interact with like-minded people),
- general needs that complement primary expectations (require, e.g., adequate catering and disposal options, such as toilet facilities),
- needs to support self-competence by providing sufficient and unambiguous information,
- adherence to the announced processes (for example, concertgoers are used to waiting at the entrances, bars and toilet facilities – however, "trying their patience" can lead to a deterioration in the overall experience and a bad mood combined with impatience), as well as
- provision of a safe and convenient environment.

With the exception of the regulations on safe evacuation in the event of disruptions and hazardous events, there are currently no requirements for the safest possible occupancy or for the assessment and design of sub-areas and paths in public areas. The orientation towards the values for crowd density specified in Section 1 "Area of application" of the German Model Ordinance on Places of Assembly (MVStättVO) is a first indication but no guarantee for safe or uniform occupancy and/or utilisation of sub-areas and paths in public areas.

For example, even with an average occupancy of 2 pers/m², there can and will generally be individual sub-areas in which there are people with a crowd density of 4 to 5 pers/m² and other sub-areas in which the crowd density is only 0.5 pers/m². Crowd densities in individual sub-areas and there again in individual clusters of people depend on the aforesaid basic parameters, the location and function of the sub-areas and the installations, sight lines, attractions and superstructures located there. In most cases, this allocation will change several times during the event period.

In this respect, it should be estimated which sub-areas are used by how many people, for how long and by which type of people. As described above, a distinction should be made between sub-areas that are primarily used for remaining in one place during individual time periods and paths that are primarily used for moving from place to place during individual time periods.

Sub-areas that are predominantly used for remaining in one place during individual time periods can generally be measured using the crowd density values specified in Section 1 "Area of application" of the German Model Ordinance on Places of Assembly (MVStättVO). If it is to be expected that attendees will be unevenly distributed across the respective sub-area, as is often the case at concerts with standing spaces at in-front-of-stage areas, for example, the expected allocations and resulting occupancy or expected crowd densities should be estimated.

Annex D contains information on conditions resulting from various crowd densities.

Sub-areas that are expected to fill up particularly quickly and sub-areas where high crowd densities are expected should be continuously monitored during the event.

It is recommended to create an evaluation matrix with GREEN, YELLOW and RED qualities of traffic flow, similar to pedestrian routes, for the primarily statically utilised public areas and to continuously compare actual filling and utilisation with the plans. The evaluation of the quality of traffic flow differs significantly from that of the paths in a static context. While a GREEN quality of traffic flow in a primarily static context represents a completely unproblematic condition, a RED quality of traffic flow in a static context describes a condition in which critical situations can occur, but do not necessarily have to. While measures must be provided for this state, a YELLOW quality of traffic flow is defined in particular by the provision of modular options and a clear monitoring and, if necessary, decision-making mandate both in the direction of a RED and GREEN quality of traffic flow.

It must be noted that specifying an overall occupancy rate or an occupancy rate for sub-areas as part of the planning and/or approval process requires this occupancy rate to be monitored during the event. In the event of imminent overcrowding, measures must be planned for such cases that include, for example, the temporary closure of the entire area or sub-areas as well as the management of people waiting or remaining in front of the entrance.

Paths that are primarily used for moving from place to place in public areas during individual time periods should be designed similar to pedestrian routes (see Section 8.3.2 and Annexes D and E).

If the expected YELLOW quality of traffic flow on paths during individual time periods in public areas is determined during the planning process, it is recommended to continuously monitor the actual situation, including the mood, at least throughout these time periods. As part of the planning process, organisational measures should be planned in advance that can provide a remedy in critical situations, if necessary. If, during the planning process, the expected RED quality of traffic flow is identified on paths during individual time periods in public areas, the plans should be changed and, for example, larger areas should be provided and/or time sequences modified.

The above recommendations apply in particular when longer time periods lasting several minutes are affected. In contrast, short-term congestion, such as immediately after the end of an event, tends to be the norm and only poses a risk if an expected experience or necessity, e.g. the last train home, is missed or could potentially be missed. Expected situations in public areas should therefore always be assessed against the background of the expected timing and duration of an event and the expected mood of the people who are affected by loss times and/or who would be in the pushing and jostling situation.

As part of the assessment, it must also be taken into account that, in addition to the expected crowd densities, the crowd flows or achievable rates of passage may be decisive and relevant to the assessment. If high crowd densities develop with congestion, the achievable crowd flows on paths are low. If subsequent people want to reach a sub-area of the public areas via these paths, congestion can increase as a result of the reduced achievable rate of passage and the loss times may increase exponentially. In this respect, the information in Sections 8.2 and 8.3 and Annexes D and E should be used to assess the YELLOW and RED quality of traffic flow on paths during individual time periods in public areas.

9 Monitoring, assessment and control of crowds of people arriving at, departing from, and attending an event

9.1 Recognising a potential danger and hazard assessment

In addition to planning for crowds of people, an essential part of crowd management, as defined by Fruin above, is subsequent continuous monitoring and, if necessary, intervening control.

The need to deal with situations in which an area or route belonging to an event is occupied by too many people, either in whole or in part or in individual sections, must be regularly reviewed as part of a hazard assessment. As a consequence of a recognised probability of occurrence of hazards, measures must be introduced which should necessarily be planned in advance of the event (see Section 8). A distinction must be made between

- overcrowding caused by exceeding the authorised capacity solely in quantitative terms,
- overcrowding caused by overloading the existing sub-areas of an area without security searches,
- overcrowding of a sub-area of a route or an area despite overall sufficient areas and capacities,
- localised or temporary congestion or pushing and jostling on a route section or in sub-areas of an area.

One of the most common reasons why controlling interventions become necessary is the need to disperse or reduce the size of an excessively large crowd of people. Reasons for this can include overloading in an area or route section, as well as the actual or the expected occurrence of pushing and jostling or congestion. In many cases, this results in very different occupancy rates in individual sub-areas of an event site, so that overcrowding usually affects individual areas (see Figure 24 for an example) and individual clusters of people.

Quantitative arguments can only be made in the event that the expected and, if applicable, authorised number of people present at the same time is exceeded: The number of expected and, if applicable, authorised number of people present at the same time determines the start of overcrowding. Much more frequently, however, overcrowding conditions will have to be assessed subjectively – on the basis of the basic parameters but also the individual experience of the assessor. As part of the preparation, it is advisable to carry out exercises, e.g. to assess densities from various perspectives. Comparative material can be helpful here, such as pictures of previous or other events at the event location or – provided the observation is always from the same perspective – an actual simulation and visualisation of various crowd densities in the specific area from the specific perspective.

In the case of public areas with security searches, imminent overcrowding can be determined by counting and analysing the crowd flows at the security search points and comparing them with the expected and, if applicable, approved number of people present at the same time. This also applies if sub-areas of public areas are demarcated.

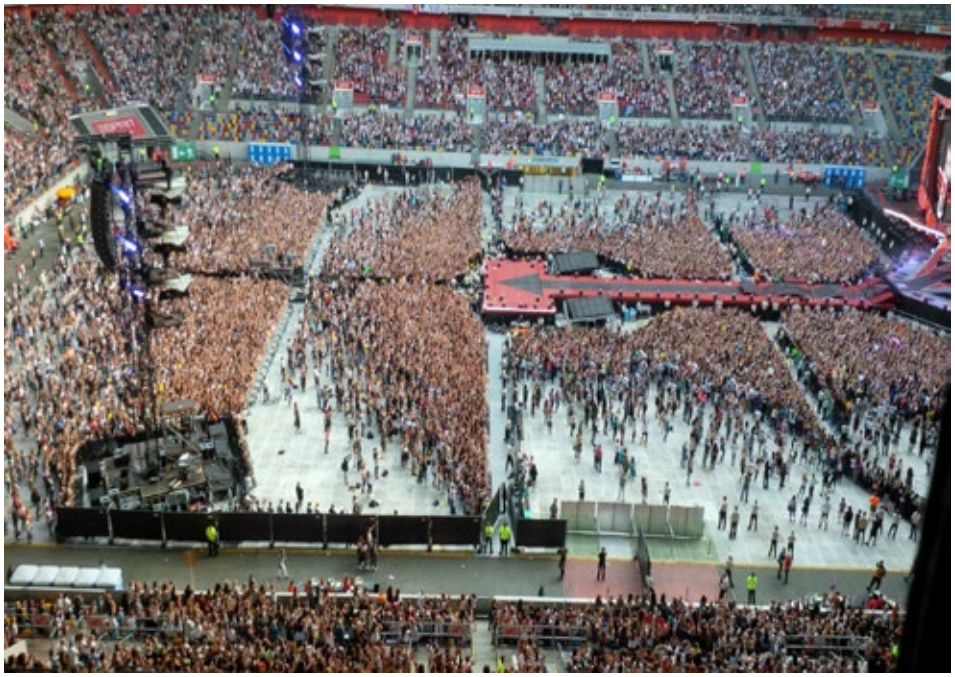

Image 24: Different occupancies in one indoor space (source: Zimme)

Image 25: Difficult-to-estimate density due to varying light conditions (source: Nowak)

Here, the allocation of wristbands, admission tickets, etc. that have been counted beforehand can help to avoid overcrowding. In public areas, sub-areas or route sections without security searches, a number of factors must be taken into account for the assessment. These include – if recognisable – the event, the atmosphere or the basic spatial parameters. The timing of the start, course and end of an event, the expected duration of the disruptions and the waiting-for-service tolerance of those affected must also be taken into account.

In order to support both the detection and the assessment of an emerging or already existing overcrowding situation, the situation and the mood should be continuously observed from a higher observation point (if possible).

Depending on the viewing angle and lighting conditions, however, it is impossible to estimate the crowd density (Figure 25 serves as an example). Situation reports from visual inspections can help to estimate crowd density in addition to recording the respective mood.

All observations should be collated to enable a realistic assessment of the overall situation and the situation in sub-areas and route sections. It is advisable to have these observations carried out and evaluated by an inter-organisational and experienced team – error messages due to subjective assessments are significantly reduced as a result.

Reported crowd densities should be regularly compared with the targeted crowd densities as part of the planning process in order to recognise deviations at an early stage and prepare measures adequately.

To be able to assess and systematically document observations, markers should be defined for the public area as a whole, which are linked to measures (e.g. at 80% occupancy, people are discouraged from travelling to the event via all media channels). Conversely, the predefined evaluation criteria for planning the area or route sections should serve as the basis for ongoing assessment and continuous comparison. In doing so, the respective situations should be assigned to the GREEN, YELLOW or RED quality of traffic flow and specifically to the respective affected sub-areas or route sections (see Section 8). Descriptions of the conditions to be recorded in the respective quality of traffic flow and corresponding instructions for actions for members of staff can help to record developments and prepare coordinated measures (see Figure 26 for examples).

Combining the reports from various routes/area sections also helps to create an overall picture and recognise options for action – e.g. if an area is assessed as having a RED quality of traffic flow but all neighbouring areas have a GREEN quality of traffic flow, they can be used as relief zones (see Figure 27 for an example).

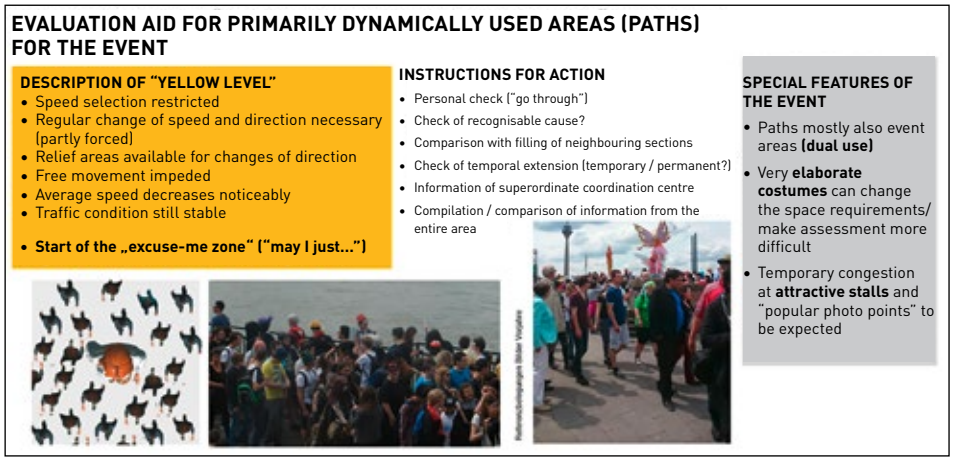

Image 26: Example of an aid for assessing situations with instructions for action to the staff on site (source: Funk)

Image 27: Temporary congestion at an entrance area (source: Funk)

9.2 Measures to eliminate or minimise hazards

Overcrowding, congestion and pushing and jostling can occur, for example, when

- the areas being used are not designed for the actual number of attendees,
- widths vary due to narrow route sections,
- narrow sections, superstructures or existing obstructions exist,
- superstructures, existing obstructions or narrow sections exist, thus reducing the existing space,
- the individual behaviour of people (e.g. stopping to get their bearings) causes a disruption to the overall crowd flow in this area (creation of a mobile bottleneck),
- a special attraction can be experienced that brings people together in a certain area or at a certain point (e.g. a sub-area directly in front of the stage or a place to shelter in the event of a downpour),
- an unusual situation or event leads to uneven occupancy of the area (e.g. an "island effect" when lighting a Bengal flare), a disruption or change in the time sequences of events leads to a change in the planned use of the area (e.g. in case of safe evacuation of the event site).

The hazards arising from such situations result from

- high crowd densities in individual clusters of people (e.g. people are pressed up against walls, superstructures or obstructions, people can no longer get their bearings, people can no longer decide freely about their movements, wave movements can occur, individual people can trip and fall, other people can fall over people who have tripped and fallen), and
- limited ability of the emergency services to respond (e.g. difficulty in reaching and caring for an injured person in the middle of a crowded sub-area).

The possible measures differ with regard to the type of overcrowding recognised. Depending on whether the overcrowding is a formal exceedance of the expected and possibly authorised number of attendees at the same time, an overcrowding of a limited area with existing relief zones or an overcrowding of the entire event area that cannot be delimited, different decisions must be weighed up and different objectives must be pursued with regard to the necessary measures.

For example, it may be necessary to accept formal overcrowding to prevent actual overloading of an area (e.g. in the case of a hazardous pressure situation in waiting zones that can only be relieved by the entrances). Decisions and measures must never be implemented in an uncoordinated manner and without considering the consequences for the system as a whole. Investigations and analyses of accidents in recent years have shown that uncoordinated measures were one of the causes of personal injury. It is important to keep an eye on the overall system and make joint decisions on measures if hazards are recognised in sub-areas of this overall system. If individual decisions are only made taking into account a local situation and without looking at the overall system, it can have fatal consequences in other sub-areas or route sections of the overall system.

Careful planning is crucial for the ability to eliminate or minimise hazards, providing a range of services tailored to the people expected and preparing measures to be able to react adequately and in good time to such imminent situations. Further information can be found in Section 8 and Annex F. Spontaneous decisions regarding measures to be implemented quickly usually have to be made if no suitable measures have been planned in advance for imminent hazards. Measures that should be implemented regularly in the context of overcrowding – and should therefore always be planned in advance – are

- the removal or widening of narrow sections (by moving fences, removing chained-up bikes),
- the optimisation of the flow of people (through the conversion of a two-way traffic system into a one-way traffic system, diversions),
- reducing the attractiveness of a sub-area (by blocking sight lines, relocating offerings),
- segregation in terms of time (by postponing the start of the event, offering entertainment before and after the main event to encourage phased arrivals and departures or postponing individual programme items),
- relieving a sub-area or reducing the crowd flow arriving in this sub-area (by "dividing up" people into small groups, i.e. only allowing as many people onto the platform as can be transported by the next train, through temporary closures), or – if not otherwise possible
- accepting the risk and improving deployment options in the event of overcrowding (more accident assistance points, fire safety stations in the sub-area).

While an imminent or recognised overcrowding or overcrowding of an entire area over a longer period of time up to the entire duration of the event is unacceptable, the possibility of the occurrence of local or temporary congestion in public areas can be accepted in sub-areas – e.g. if congestion occurs in parts of public areas as part of an event

lasting several days on a particular evening (e.g. on the evening of a fireworks display) or at a Christmas market.

In this context, it is important to reach an inter-organisational agreement on this circumstance, in which all the parties involved should assess the risk based on the same level of knowledge. All subsequent measures taken must be coordinated to alleviate the situation (e.g. by opening relief zones) and to prevent any deterioration of the situation (e.g. by diverting emergency vehicles that would drive through an already overcrowded area). In such cases in particular, responsibilities must be clearly described and allocated – responsibility gaps must be avoided at all costs.

While communicating the "full" (sold out) status for ticketed events is straightforward and widely accepted without the need for additional measures, it definitely requires more effort for generally free and open-access events.

The following options for action exist:

- attempt to minimise the number of people by providing information ("please stay home"),
- redirect people to longer routes to ensure a time relief for arrival,
- make distractions offered on pedestrian routes more appealing to retain people,
- stop people arriving by public transport,
- close off pedestrian routes used for arrival,
- close the entrances.

In most cases, a combination of these measures will be necessary.

Informing all people travelling to the event is an essential prerequisite for overcrowding management. The information to be provided should clearly and unambiguously convey the reason for the measures being taken and the consequences for people arriving, attending and departing. Further information can be found in Section 8.3.4.

When redirecting people, it can be expedient to shift the time and space required to reach stops or to fill available parking facilities. Depending on the area concept, it can help to relieve the burden if those arriving get to the public areas at a different time and/or place. This can relieve some sub-areas or route sections and make greater use of those that are less frequented. In addition, longer pedestrian routes, e.g. between parking areas and entrances, can create both segregation of crowd flows and time relief.

If public transport is to be stopped in whole or in part for arrival at the event, consideration must be given to the fact that those buses and trains that are no longer travelling in the direction of the event may not be available for the departure. In this respect, such measures must be coordinated with the transport companies concerned and care must be taken to ensure that a departure can be made with acceptable waiting times despite the partially reduced public transport services – this applies all the more in the event that public transport services represent a capacity in the context of emergency planning.

Redirecting can also be used to set up temporary or permanent one-way traffic on pedestrian routes. In complex event sites with numerous paths and junctions, the closure of certain paths can be used to control crowd flows in such a way that people can only walk in one direction along a route. Although this does not generate more space or widen route sections available, the available space is better utilised if people move in one direction only (see Annexes D and E).

Closing off routes or entrances can generally lead to new hazards caused by high crowd densities and bad atmospheres.

If routes or entrances are closed off, these closures should, wherever possible, be arranged at junctions or forks in the route. It must be ensured that people can be redirected or guided away from closures – this helps to prevent high crowd densities and people walking towards closures and having to turn back and walk in the opposite direction through large clusters of people.

The implementation of physical barriers must be planned in detail. In particular, the following must be observed:

- suitable and sufficient materials for closures must be available at the closure site for the crowd profile.
- Trained and sufficient number of people must be available to staff the closure points. It should be noted that staff at closure points are often under a great deal of stress (people refused entry often have an unfriendly and aggressive stance towards staff). Experience in dealing with people and de-escalation and communication skills are important prerequisites for the staff deployed at these points.
- People should be informed about the situation and what their options for action are – e.g. is it worth waiting, are there alternative attractions, will they be able to leave the site?
- Strategies should be planned for dealing with people waiting at a closure point or those who are turned away. For example, discussions can tie up stewards (including dealing with aggressive individuals), or those turned away may attempt to gain access elsewhere.
- There should be an area concept for the respective closure point. If there are waiting times, the maximum duration and/or the maximum number of people waiting should be determined, communicated and recorded by area occupancy (maximum 4 pers/m^2) to avoid, for example, impacts on the street space or excessive crowd densities. If necessary, several restricted areas or several waiting zones should be provided to "divide up" clusters of people into smaller groups, enable communication and intervention and create relief zones.

When dealing with such situations and finding solutions that make sense for the respective situation and context, consideration must be given to the respective possibilities and basic parameters. Blanket solutions or solutions "according to a checklist" are usually ruled out in this situation, which has a potentially critical impact both externally

and internally – the focus is on the specific and individual assessment of the respective situation.

If congestion occurs, it should generally be resolved as quickly as possible, or at least reduced. In addition to the options already mentioned, suitable measures include addressing people waiting from the back to the front and providing them with viable options, e.g. alternative routes. If the congestion is starting to ease or can be relieved in the immediate vicinity (e.g. by removing superstructures that restrict the crowd flow), it is crucial to inform those affected by the congestion.

9.3 Documentation and follow-up

In addition to the general decisions and events to be documented, it makes sense to regularly document the development of the flow of people during an event. Documentation collects reliable information for follow-up purposes and helps to visualise developments, prepare them for future events and provide a solid basis of data quality.

Suitable sources and procedures are traffic surveys of all traffic modes, which should be used or carried out automatically or manually. In addition, information from security search points, such as the time it takes to check tickets, can be used to derive daily load curves and use them for future forecasts. Taking videos or photographs of the same event area can also be helpful. Such recordings can help to gain a better understanding of crowd densities – especially if good estimates or specific survey results are also available for the time period in question. It must be ensured that measurable reference variables, like defined area sections, are visible in the images, which must be taken from a straight, overhead view (90°) showing heads and shoulders. The results of the feedback from the pedestrian routes and public areas should also be included in the documentation to complete the overall picture.

As part of the follow-up, it should be checked whether the assumptions made in advance were correct. If deviations are recognisable, it should be checked,

- what the reasons for the deviations are,
- whether the findings are transferable, and
- to what extent an appropriate response was made.

It should be discussed whether the planned measures were effective and what potential for improvement can be recognised for subsequent events. As the assessment of crowd density is also partly a matter of subjective perceptions, it can help to bring the assessments together as part of an inter-organisational follow-up and to compare and document assessments and opinions.

10 Safe evacuation as part of the management of disruptions and hazardous events

10.1 Object of consideration

Disruption and emergency planning for events is a discipline in its own right and cannot be presented in full in this context. However, it is worth pointing out some aspects in which the planning of areas and routes as well as the planning for and management of people play a relevant role. For this reason, this section focuses primarily on aspects of safe evacuation.

Other scenarios and other important aspects of emergency planning or the in-depth consideration of organisational measures, e.g., must be considered elsewhere.

Evacuation is a "connection scenario", i.e. other scenarios may have already been triggered and processed before an evacuation takes place (e.g. preparing for a storm or dealing with a bomb threat).

If the event has to be evacuated due to an unforeseen event, the German Model Ordinance on Places of Assembly [MVStättVO 2014] demands that the measures planned for quick and orderly evacuation be summarised in an evacuation plan, unless they are already part of the safety concept.

If an evacuation plan is created, it must be ensured that a holistic assessment is performed. It must be guaranteed that everyone who is to be evacuated can be brought to safety within a reasonable period of time. Special consideration must be given to people with disabilities. The time available must be determined individually in the context of the event and depends on the evacuation scenario. Only assumptions about the actual sequence of events can be made during the planning phase – however, it should be ensured that the planned evacuation scenarios already address the variety of implementation alternatives. For example, if an event is evacuated during ingress phase, the escape route directions and other measures may have to be selected differently than at an evacuation during the actual event. Evacuation concepts must be individually tailored to the environment and the situation on site and can be standardised in terms of their structure and the issues that need to be addressed, but not in terms of their specific contents.

10.2 Identification of relevant evacuation scenarios

A risk analysis must be carried out in order to define relevant scenarios that could lead to a complete or partial evacuation. This risk assessment is already carried out as part of the general safety planning for the event. This assessment must also be carried out for the actual evacuation scenario – this can be done using the procedure described in draft standard DIN 18009-1. This involves comparing the probability of occurrence with the extent of damage and selecting those scenarios that have a high probability of occurrence with a corresponding extent of damage.

This selection process is shown schematically in Figure 28. On the one hand, it shows trivial scenarios (green dots) that have hardly any consequences should they occur, e.g. if only a very small amount of the attendees are affected by an evacuation. On the other hand, there are inadmissible evacuation scenarios (red dots) in which, e.g., escape route widths are too narrow or there are insufficient escape routes available. In between are the so-called relevant evacuation scenarios (yellow dots), which would result in a corresponding extent of damage if they were to materialise. The relevant evacuation scenarios can be clustered based on their similarity (e.g. a partial evacuation due to a local fire event that can occur at many different locations within an area) and finally a relevant evacuation scenario (blue dots) can be selected from the cluster.

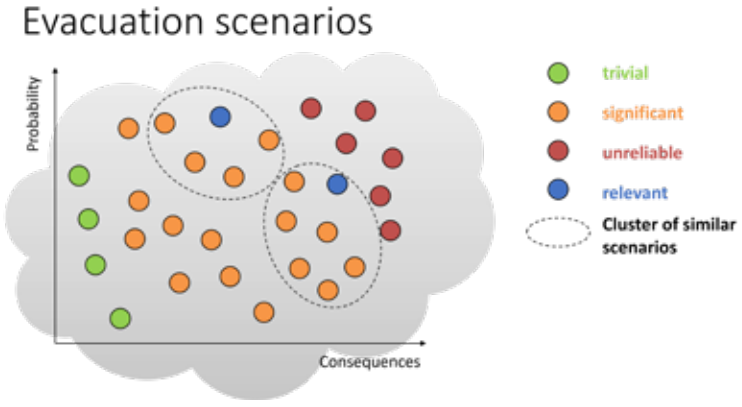

Image 28: Categorisation of possible evacuation scenarios into trivial, significant, impermissible and relevant (source: Benjamin Schröder)

The procedure for identifying relevant evacuation scenarios is carried out in several stages. Firstly, the characteristic properties of the event are determined using the following categories. Relevant evacuation scenarios are defined from these characteristic properties (see Figure 28). These in turn are used to derive relevant evacuation scenarios, which are analysed in the evacuation concept.

10.2.1 Categories for determining the characteristic properties

The following categories must be included when determining risks for the event in general and for the planning and implementation of an evacuation in particular (based on [Künzer; Hofinger, 2018]):

- risks and hazards,
- environment and infrastructure,
- occasion and type, and
- people.

These aspects are explained below.

10.2.2 Risks and hazards

Risks and hazards form the basic building block for determining possible evacuation scenarios. Which risks and dangers are generally considered to be particularly high for the event in question? Which events can actually trigger a partial evacuation? It is necessary to determine which events are individually categorised as significant for a given event.

Examples of risks and hazards for an event in general, which can regularly lead to a partial evacuation, are

- thunderstorms,
- terrorist threat,
- fire, or
- overcrowding.

Environment and infrastructure

The following conditions must be systematically analysed on site in relation to the specific evacuation context:

- relief areas inside and outside the public areas and their access capacities,
- planned or necessary person guidance measures in terms of space and time (see Section 9),
- infrastructural bottlenecks or special features (roads, walkways),
- escape routes (type, number, location, direction), and
- usability of escape routes and areas for people with special needs.

Safe areas in terms of evacuation must be selected in such a way that a sufficient relief area is available. Areas that are already in use during the event are only suitable for this if the crowd density in these areas is generally low and they offer sufficient capacity. In the case of safe areas outside the event area, it must be ensured that they are available and as accessible as possible without barriers. If necessary, a cascading evacuation must be carried out to ensure that relief areas are evacuated first before the actual evacuation of the event begins. An example of this is the evacuation of areas in front of an event tent before the actual tent is evacuated.

Care must also be taken to organise evacuation directions and times in such a way that crossing pedestrian traffic is avoided wherever possible.

When determining evacuation directions, it must be noted that some main routes may also be closed off and spectators may have to be redirected.

Occasion and type

The following aspects relating to the occasion or type of event must be taken into account:

- course of the event: ingress and egress phase (e.g. concert) versus continuous arrival and departure (e.g. fun fair),
- duration of the event,
- length of stay of the spectators,
- type of arrival (traffic mode),
- volume/communication options/public address system,
- lighting conditions, and
- information channels: notification of and communication with persons arriving, attending and departing.

All these factors must be considered both as part of general safety planning and when planning and implementing evacuation.

Particular attention should also be paid to times that would pose a challenge for evacuation. This is regularly the case at the interfaces of event phases, e.g. when an event is already quite full but admission is still under way, i.e. people are still queuing in front of the entrance while at the same time people are attempting to leave the event site.

Depending on the modal split, people will have different tendencies to choose their escape route. It should, therefore, be borne in mind that, depending on the cause of evacuation, people will tend to go to their car/bike/public transport and choose the same route they took on the way there.

In principle, the communication channels must be taken into account during evacuation, especially in the case of very complex event sites or high levels of noise. Can individual sub-areas of the event be specifically addressed to initiate partial evacuation? Is communication ensured even if the main electricity supply fails (e.g. via a back-up power supply or loudhailers)?

The same requirements apply to lighting: are escape routes lit well enough to direct people safely, e.g. even at night? Are signage and signposting recognisable even in poor lighting conditions?

People

Not only people arriving, attending and departing but also stewards as well as the event organisers and their staff must be taken into account. The following aspects are relevant, among others:

- profile of the audience,
- people's local knowledge, abilities, conditions (awake, tired, inebriated, etc.) and limited mobility of people, and
- the number and qualifications of stewards.

Different audience profiles require different types of communication and lead to different behaviour, including response times and route choice as well as acceptance of and compliance with instructions from safety personnel. They must therefore be considered both in the risk assessment and as part of the actual evacuation plan. They can be mapped with the help of various space requirements, response times, speeds and route selection, among other things.

10.2.3 Determining the relevant evacuation scenarios

The evacuation scenarios are defined by combining the individual characteristic properties. It is not necessary to analyse every possible combination (see Figure 28); the aim is to work out the relevant order of events and the relevant evacuation scenarios derived from them.

These relevant evacuation scenarios must be plausible and documented.

The evacuation scenarios are essentially to be analysed and described with regard to two main aspects, proof of sufficient dimensioning and usability of the escape routes and the organisational measures. Both main aspects are analysed below.

10.3 Proof of adequate assessment of escape routes

In the simplest case, proof can be provided via plausibility checks using the length and width of the escape routes as prescribed in the German Model Ordinance on Places of Assembly [MVStättVO]. For this purpose, it must be proven that the escape routes are not used by more than the maximum permitted number of people at any one time. It must also be demonstrated that the stipulated length of escape routes is not exceeded.

If it is not possible to provide evidence on the sufficient length and width of escape routes, an evacuation simulation can be employed.

For the relevant evacuation scenarios defined according to the aforesaid procedure, it must be demonstrated that the required evacuation time is less than or equal to the available evacuation time (see Figure 29).

The available evacuation time is determined for this purpose. This can vary depending on the actual evacuation scenario.

It is advisable to coordinate the available evacuation times with the authorising bodies in advance.

When determining the required evacuation time, it should be noted that it is made up of various partial times and that a detection and alarm time must be added to the actual evacuation time. These times are not considered within an evacuation simulation but must be added separately – if applicable.

A standardised procedure for creating a simulation can be carried out in accordance with [draft standard DIN 18009-2 2021]. This standard has its main area of application in buildings and fire protection. By adapting the boundary conditions as described above, this procedure can nevertheless be used for events. As events often involve more complex escape route interrelationships and often time-delayed evacuations, the use of microscopic models is recommended.

A structured procedure for creating evacuation analyses based on individual models is explained in detail in the Guidelines for Microscopic Evacuation Analyses [RiMEA 2016].

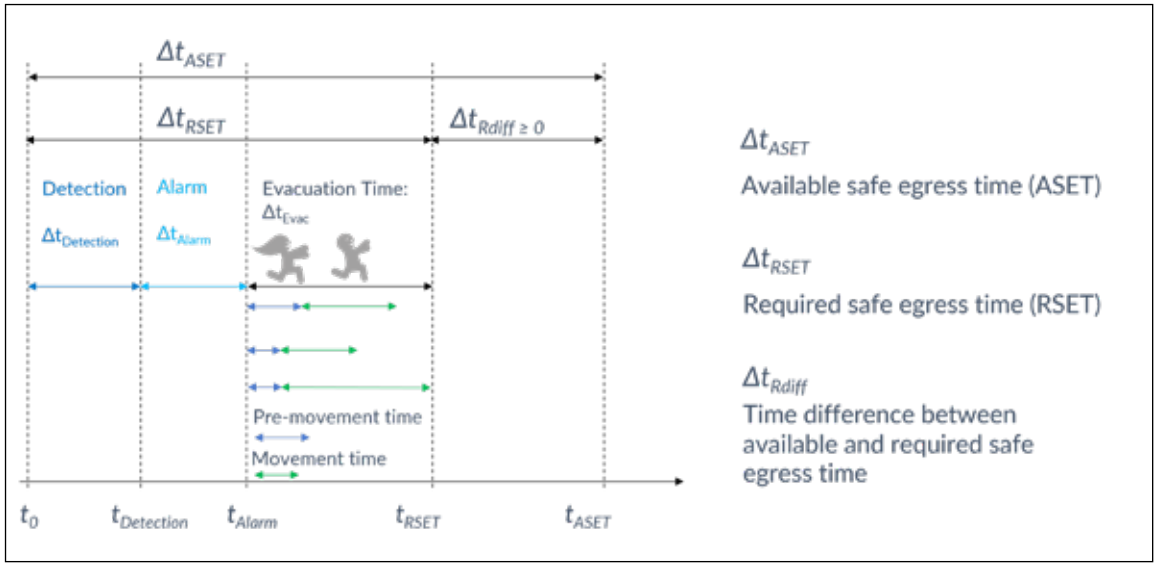

Image 29: Available vs. required evacuation times and their composition
(source: Angelika Kneidl, based on Figure 28 from [draft standard DIN 18009-2 2021])

In addition to checking whether the required evacuation time is less than the time available, congestion must also be analysed.

If it is already recognisable during the risk assessment that one or more congestion situations may occur during evacuation, they must be assessed individually. According to the German Model Ordinance on Places of Assembly [MVStättVO 2014], a 1.20-m-wide escape route at outdoor events with 600 people can cause congestion, especially if the routes experience unbalanced volumes at full capacity utilisation. Avoiding congestion therefore does not have to be the goal of an evacuation and cannot be adhered to in this manner, rather congestion must be evaluated based on the criteria of significance.

Congestion must first be described, e.g. using the following criteria:

- duration of congestion,
- location and extent of congestion,
- location-related accumulated duration of congestion,
- individual congestion times,
- accumulated individual congestion times,
- influence on the evacuation time, and
- intensity and extent of congestion: number of people involved.

Evaluation of the congestion based on these factors is also part of the evacuation concept. The following aspects can help here:

- reason for evacuation,
- motivation of those affected,
- type of utilisation,
- factors relevant to the scenario,
- deviation from a scenario that complies with building law, and
- location and extent of congestion.

Assessment of the criticality of a congestion situation cannot be made unambiguously on the basis of quantitative parameters; rather, it is the responsibility of the person preparing the analysis to make and justify this assessment.

In addition to a sufficient assessment, the planning of an orderly evacuation also includes organisational aspects that must be documented in an evacuation concept.

10.4 Organisational measures

Even though building law generally assumes that evacuation can, e.g., be carried out without further assistance in the context of places of assembly, supporting measures are necessary in most cases to ensure that evacuation can be implemented and carried out quickly. This applies in particular in complex contexts, for example due to a large number of changes of direction or routing through unfamiliar areas or in temporary event areas where a lack of local knowledge or, e.g., the immediate inner-city context must be taken into account.

If this is the case, in addition to measures based on the deployment of personnel, other measures independent of personnel deployment should be planned and implemented, especially since, depending on the cause of the evacuation, it may be possible that people who are intended to be in charge are not available due to the need for self-protection.

Organisational measures are described in the respective evacuation scenarios. Resources defined in the evacuation scenario must be checked regularly for completeness and effectiveness.

When determining organisational measures, a distinction must be made between:

- planned evacuation with organisational lead time or spontaneous evacuation during which the measures are implemented in the course of evacuation, and
- partial or complete evacuation. In the case of partial evacuation, it must be possible to respond flexibly to evacuation directions and safe areas depending on the site and type of incident.

For partial evacuation, "if-then scenarios" are useful when planning – e.g. when it comes to quickly checking evacuation directions.

Rapid and reliable information transfer is the basis for all evacuation scenarios. This applies to both internal and external communication.

The following applies to internal communication:

- The responsibilities for the respective triggers must be defined in advance.
- Although evacuation decisions are determined by responsibility, they should be coordinated between all those involved wherever possible.
- The consequences of the evacuation decision must be taken into account by all those involved.
- All those involved must be aware of the respective tasks and requirements of everyone.
- Reliable and fail-safe means and channels of communication must be available.

The following applies to external communication:

- Availability must be ensured for those individuals for whom the information is relevant. Depending on the complexity of the event, this can lead to a large number of parallel communication channels. Control mechanisms for checking whether the notification has been received (e.g. acknowledgement functions) must also be taken into account.
- It must be possible to prepare information in advance (e.g. as a recorded announcement) as well as provide it on the spot.
- Communication must also be maintained at a possible assembly point (e.g. vehicles for a thunderstorm warning at a festival).

For internal and external communication, it is advisable to record the time taken to pass on information via the var-

ious communication channels, e.g. how long it takes for all stall operators at an event site to be informed about something.

In addition, members of staff should also be trained to ensure that information is consistent both between those providing the information and between the various communication media being used.

In most cases, it is not enough to simply provide emergency exit signs to ensure the use of previously unknown routes or routes that contradict experience. Instead, the use of these routes must be actively encouraged and supported. This can be done through additional lighting, guidance measures or other "inviting" measures.

The guidance of people should always appeal to two senses – in most cases these are sight (signage, lighting, active guidance) and listening (speech, public addresses, audible signals).

Separate procedures or resources must be provided as part of the planning process to support, guide and direct people with limited mobility.

Supporting or guiding people places special demands on those in charge of evacuation. To ensure evacuation is carried out safely in an emergency, evacuation practice drills must be undertaken with all those involved in evacuation procedures. For example, it can be useful to study past causes of evacuation and think through your own options for action based on these events.

If evacuation of the entire or partial area does not necessarily mean cancellation of the whole event, procedures for restarting the event must be defined. These include, e.g.:

- release procedures: who decides that the area may be entered again (e.g. with regard to damage after a storm)?
- Security procedure: are all persons checked again?
- Prioritised access, e.g. for staff.

Evacuations must be well thought out, planned and practised in advance, taking into account various causes – wherein the large number of causes and the associated requirements necessitate a flexible approach. The scenarios already identified in the safety concept can often lead to an evacuation – it must therefore be ensured that recognised risks and the stated processes are seamlessly linked, such as coordinating the "storm" scenario with all its necessary preparatory and monitoring measures with a potentially subsequent "evacuation of the event area due to a storm" scenario.

11 Regulations, laws, ordinances and literature

11.1 Codes of practice

DIN	DIN EN 13200-7	Spectator facilities – Part 7: Entry and exit elements and routes		1)
	DIN 18009-2	Fire safety engineering – Part 2: Simulation of evacuation and personal safety (draft)		
FGSV		Fact Sheet for Directional Signage for Bicycle Traffic (FGSV 245)	[FGSV 1998]	2)
		Notes on the Parking of Bikes (FGSV 239)	[FGSV 2012c]	2)
	BBSV	Terminology Relating to Road and Transport (FGSV 005/1)	[FGSV 2020b]	2)
	EAM	Recommendations for the Implementation of Mobility Management (FGSV 167)	[FGSV 2018a]	2)
	EAÖ	Recommendations for Public Transport Facilities (FGSV 289)	[FGSV 2013]	2)
	EAR	Recommendations for Standing Traffic Facilities (FGSV 283)	[FGSV 2005]	2)
	ESN	Recommendations for the Safety Analysis of Road Networks (FGSV 383)	[FGSV 2003]	2)
	EVE	Recommendations for Traffic Surveys (FGSV 125)	[FGSV 2012]	2)
	H BVA	Notes on Accessible Traffic Facilities (FGSV 212)	[FGSV 2011]	2)
	H RS	Notes on Parking Coaches in Cities (FGSV 283/1)	[FGSV 2018b]	2)
	HBS	Handbook for the Design of Road Traffic Facilities (FGSV 299)	[FGSV 2015]	2)
	M Uko	Fact Sheet on Local Accident Investigations in Accident Commissions (FGSV 316/1)	[FGSV 2012b]	2)
	RBSV	Guidelines for Design Vehicles and Minimum Turning Curves for Testing the Trafficability of Traffic Areas (FGSV 287)	[FGSV 2020a]	2)
	RSAS	Guidelines for the Safety Audit of Roads (FGSV 298)	[FGSV 2019]	2)
	RUB	Guidelines for Diversion Signage (FGSV 327)	[FGSV 2021]	2)
VDV		Guideline for Determining the Capacity of Passenger Transport Vehicles for Statistical Purposes	[VDV 1990]	3)
	VDV announcement 10013	Local Public Transport in Integrated Traffic Management – Experiences with an Integrated Traffic Control Centre and Consequences as Well as Recommendations for Everyday Life and Other (Large-Scale) Events	[VDV 2010]	3)
	VDV announcement 7031	Traffic and Operative Management in Local Public Transport at Large-Scale Events	[VDV 2013]	3)
	VDV publication 4	Transport Accessibility, Transport Services and Network Quality in Local Public Transport	[VDV 2019]	3)
BMV		Guidelines for the Installation of Non-official Signposts for Trade Fairs, Exhibitions, Sporting and Similar Temporary Large-Scale Events (FGSV 329/5)*)	[FGSV 2010]	2)
	RWB	Guidelines for Directional Signage on Highways Other than Motorways (FGSV 329)*)	[FGSV 2000]	2)

*) Title additionally included in the FGSV Reader "Premium" under this FGSV no.

11.2 Laws and regulations

German Federal Law Gazette (BGBl).	BOKraft	German Ordinance on the Operation of Motor Vehicle Companies	4)
	BOStrab	German Ordinance on the Construction and Operation of Tramways – Tramway Construction and Operating Regulations (FGSV R 113)*)	2), 4)
	StVG	German Road Traffic Act (FGSV R 128)*)	2), 4)
	StVO	German Road Traffic Regulations (FGSV R 050)*)	2), 4)
German Federal Gazette (BAnz)	VersammlG	German Act on Assemblies and Processions	5)
	OwiG	German Act on Administrative Offences	5)
	VwV-StVO	General Administrative Regulation for German Road Traffic Regulations (FGSV R 051)*)	2), 5)

*) Title additionally included in the FGSV Reader "Premium" under this FGSV no.

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2) **FGSV Verlag GmbH**
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All FGSV publications listed are also available digitally for the FGSV Reader and are included in the comprehensive "FGSV - Technical Regulations - Digital" subscription.

3) **Association of German Transport Companies (VDV)**
Address: Kamekestr. 37-39, D-50672 Cologne
Tel. +49 221 57979-0
E-mail: info@vdv.de, Internet: www.vdv.de

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12 Directories

12.1 List of figures

12.2 List of tables

12.3 List of abbreviations

ADFC	German Cyclists Association
BaSiGo	Safety and Security Modules for Large Public Events
BASt	Federal Highway Research Institute
BGB	German Civil Code
BOS	Public safety authorities and organisations
DB AG	Deutsche Bahn Aktiengesellschaft
DFI	Dynamic passenger information
DIN	German Institute for Standardisation
FGSV	Road and Transportation Research Association
IAA	International Motor Show
IHK	Chamber of Industry and Commerce
Kfz	Motor vehicle
HGV	Heavy goods vehicle
LOS	Level of service
LSA	Light signal system
LStrG	German State Roads Act
LStVG	German State Criminal Law and Ordinance Act
MIV	Motorised individual traffic
MVStättVO	German Model Ordinance on Places of Assembly
ÖPNV	Local public transport
ÖV	Public transport
Pkw	Passenger vehicle
POG	Police and Public Order Law
QSV	Quality of traffic flow
SOG	German Security and Order Law
SPNV	Regional rail transport
StGB	German Criminal Code
VDV	Association of German Transport Companies

13 Terms

13.1 Terms according to the definitions of the FGSV

Bicycle traffic
Transport of people and, where applicable, of goods by bike.

Bike rack
Generally a covered parking area with locking options for bikes.

Bike sharing
Publicly accessible bikes intended for general use, which can be used independently by people for a fee, usually following Internet-based registration.

Bike-and-Ride facility; Bike+Ride facility; B+R facility
A parking facility or parking structure assigned to a train station and/or one or more stops for bikes of public transport passengers.

Capacity
a) In traffic engineering: Largest volume of traffic that a flow of traffic can reach under the given structural, traffic and operational conditions.
b) In public transport: Maximum possible number of passengers in a vehicle.

Capacity reserve
Difference between capacity and the volume of traffic resulting from traffic demand.

Congestion
Traffic condition on a free route due to overloading or special events with temporary standstill.

Design volume of traffic
Volume of traffic on which the traffic engineering design of a traffic facility is based.

Flag stop
A place for boarding and disembarking on a railway line where trains cannot pass.

Flow load
Volumes of traffic on the routes of a network or at a junction, broken down by start and end points.

Flow of traffic
Traffic elements moving in the same direction on a traffic route.

Footpath
Movement of a person on foot.

Fundamental diagram
Graphical representation of the relationship between speed, volume of traffic and traffic density for a given route section under given basic parameters.

Inventory audit
Safety audit of an existing traffic route.

Journey; route
Movement of a person from a starting point to a destination in order to carry out a specific activity.

Local residents
a) According to road law: Persons with ownership or possession of land adjacent to a road.
b) Within the meaning of road traffic law: Persons travelling by a means of transport on a section of a public road to or from a destination located there.

Means of transport
Vehicles for the movement of people and/or goods.

MIV; motorised individual transport
Passenger transport using motorised means of transport that are not generally accessible.

Mobility
Generic term for mobility options and mobility behaviour.

Mobility management
Target-oriented and target group-specific influencing of mobility behaviour with coordinating organisational, informational and advisory measures, possibly also involving other stakeholders beyond traffic planning.

Mobility service; transport offering
Independent, marketable services for the movement of people or goods.

Modal split [choice of means of transport]
Percentage split of traffic between different modes of transport.

Mode; transport mode
Differentiation of traffic according to groups of modes of transport and pedestrian traffic.

Narrow section
Spatially limited route section with a reduced width of the traffic area.

Overloading
Traffic condition in which the traffic demand exceeds the capacity of a traffic facility or means of transport.

Parking area; car park
Area consisting of several parking spaces or parking bays.

Parking area; parking space
Area intended for parking vehicles, including the manoeuvring area.

Parking bay
Part of a traffic area demarcated for parking a vehicle.

Parking facility
Sum of parking areas within a specific area.

Parking space
Parking area for a vehicle outside the public traffic areas.

Parking structure; garage
Building or section of a building for parking one or more vehicles.

Passenger transport
Generic term for commercial passenger transport as well as private and public passenger transport.

Passenger transport services
Movement of people by means of commercial or paid transport.

Peak hour
60-minute period with the highest traffic load of a day.

Peak traffic load
Highest traffic load within a given time interval.

Peak traffic period
Period of the highest volume of traffic of a mode, traffic route or traffic route network.

Pedestrian traffic (pedestrians)
On-foot traffic.

Public transport
Transport of people by generally accessible means of transport.

Quality level of traffic flow; QSV
Classification of the quality of traffic according to the Handbook for the Design of Road Traffic Facilities.

Quality of offering, connection-related; connection quality
Fulfilment of user-related requirements of a source-destination connection as described by certain evaluation criteria.

Quality of the traffic flow; quality of traffic
Summarised quality assessment of traffic flow.

Route
Selected or specified sequence of route sections for a specific source-destination relationship.

Route [partial route]
Section of a journey travelled by a means of transport or on foot.

Safety audit
Systematic, independent determination of possible safety deficits as a result of deficiencies in the design or construction of a traffic route.

Signposting
All measures and installations for directing and guiding road users to their destination.

Special usage, under public law
Temporary use of a public traffic area that goes beyond public use, subject to approval and, where applicable, a charge.

Stop
Marked place for boarding and disembarking from buses, trams or taxis on scheduled services.

Traffic control
Situation-dependent influencing of road users to change their driving behaviour, their choice of route or their choice of means of transport.

Traffic control
Influencing of the traffic flow by means of regulations, recommendations and instructions.

Traffic control, dynamic
Traffic-dependent influencing of the traffic flow by means of regulations, recommendations and instructions.

Traffic demand
Number of intended movements by road users.

Traffic density
Number of traffic elements in a flow of traffic per route unit at a point in time.

Traffic facility
Paved area for vehicle traffic and/or pedestrian traffic, including associated structures and equipment.

Traffic guidance system
System for the target-orientated guidance of road traffic with static traffic signs or variable message signs.

Traffic infrastructure
Traffic routes, including the associated operational installations and linking systems.

Traffic management
Target-oriented influencing of traffic to optimise the coordination between transport demand and transport services.

Traffic regulation
All regulations, measures and installations for organising and securing traffic.

Traffic volume
Number of all movements of people, vehicles or goods in an area within a certain period of time.

Traffic, bound; convoy traffic
Flow of traffic in which the speed cannot be freely selected.

Traffic, free; traffic, not bound
Flow of traffic in which the speed can be freely selected at any time and anywhere.

Traffic, partially bound
Flow of traffic in which the speed can be freely selected to a limited extent.

Train station
Transport and operational facility of a railway company for boarding and disembarking, loading and unloading and/or train formation.

Transport
Movement mainly people, possibly also goods, using means of transport.

Transport demand
Sum of all movements of people and goods in an area within a certain period of time.

Transport offering, mobility service
Independent, marketable services for the movement of people or goods.

Transport services
Traffic infrastructure and transport offerings that can be used for the movement of people and/or goods.

Travel chain; route chain
All journeys in chronological order that a person makes within a certain period of time.

Utilisation rate [load quotient]

Ratio of the volume of traffic resulting from traffic demand to capacity.

Volume of traffic

Number of traffic elements of a flow of traffic per unit of time at a cross section of a route or at a junction.

Walkway

Path intended for pedestrian traffic on which vehicle traffic is generally prohibited.

Walkway, independently guided; walkway, independent

Walkway away from roads.

13.2 Additional terms used in these recommendations

Cross section; road cross-section

Vertical section through the roadway or through the traffic facility at right angles to the road axis (better: Axis, as events also involve pedestrian routes, security search systems, public areas such as paths through market stalls and (emergency) exits).

Crowd density

Number of people per unit area at a point in time.

Crowd flow

Number of people within a given time interval at a location or on a route.

Crowd management

Systematic planning for an orderly movement or gathering of people as well as the continuous observation and management of an orderly movement or gathering of people.

Density of pedestrian traffic

Number of pedestrians in a flow of traffic per unit at a given time.

Departure pedestrian route; return pedestrian route

Section of departure from the public areas to the train station, stop, parking areas or section of a pedestrian route adjacent to a public area; includes exits, walkways, specially used roads, stairs, tunnels and/or narrow sections, also possible instead of pedestrian route: Footpath route (sequence of routes), not possible: Footpath (movement of people or complete departure on foot).

Emergency exit

Door, gate or narrow section for evacuation between public areas and emergency routes.

Entering

Process for ensuring an orderly arrival at the public areas.

Entrance

Door, gate or other element of the entrance on the pedestrian route of the arrival in front of the public areas.

Exit

Door, gate or narrow section on the pedestrian route of the departure, usually immediately behind the public areas; can be via security search systems, among other things, which are then dismantled.

Exiting

Process for ensuring an orderly departure from the public areas.

Law enforcement officers (cf. stewards)

Local authority staff, including their enforcement assistants, to ensure public safety and order.

Legal duty to maintain traffic safety; road traffic safety obligation
Legal obligation of the road construction and maintenance authority to protect third parties from road-related risks.

Normal traffic
Traffic volume and traffic load in normal conditions without event traffic.

Occupancy rate (standing traffic)
Standing traffic: Ratio of the number of vehicles parked at any one time to the number of available car bays and/or parking spaces.

Pedestrian route for arrival; "last mile"
Section of the journey from the train station, or other mass transit stop, from parking areas to the public areas or section of a footpath adjacent to a public area; includes walkways, (specially used) roads, stairs, tunnels, entrances, security search systems and/or narrow sections.

Public areas
Central attraction area of an event, such as rooms and halls or outdoor areas with seats and standing areas, areas of action, paths between exhibition and entertainment installations or paths between market stalls.

Public use
The use of public traffic areas for everyone within the scope of the dedication and road traffic safety requirements (source: Section 13 of the German Traffic Law (StrG)).

Queuing system
Installation for an orderly tailback of arriving people in front of separating elements and/or security search points.

Security search point
Location where arriving people are checked for admission authorisation or items they have brought with them.

Security search system
Facility for checking arriving people, usually with turnstiles and security search points as part of an overall security plan.

Separating element
Part of the queue line management system for separating arriving people across several turnstiles.

Stewards (cf. law enforcement officers)
Staff deployed by the event organiser to ensure a safe and orderly event at the event location. No performance of sovereign tasks.

Tailback
Traffic condition at junctions, crossing systems, narrow sections or check-in systems with multiple or prolonged standstill of vehicles or pedestrians. A long queue of stationary or slow-moving traffic or people extending back from a busy junction or similar obstruction on a flow of traffic.

Throng
Disorderly tailback of people arriving or departing.

Traffic control
All measures and installations for managing vehicle and crowd flows in the network.

Traffic control centre
Installation for controlling moving and/or standing motorised traffic, local public transport and/or people on the basis of traffic and environmental data as well as for controlling and monitoring traffic control systems and guidance measures.

Turnstile
Part of the entry procedure system for the separation and control of arriving persons with a width of 60 cm per unit.

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Annex A

Checklist for basic evaluation

Knowledge of the event location and determination of the nature of the event

Event organiser:

- Who is the event organiser and who is the operator?
- Does the event organiser have experience in planning and putting on this type of event?
  - If yes: Provide references
  - If no: Does the event organiser have experience in planning and putting on other types of events?
    - If yes: Provide references
- Is the event organiser also the owner or the operator of the event venue?

When does the event take place?

- Time of year
- Day of the week
- Time

Programme or contents of the event?

- Type of event (e.g. sporting event, cultural event)
- "Normal programme"
- Special individual events (e.g. evening events, fireworks)
- Does a particular item on the programme pose particular risks?
  - If yes: Which ones?

How long does the event last?

- Several hours
- One day
- One weekend
- Several days (including weekend)

Where will the event take place?

- In an already authorised event venue (e.g. stadium, festival or concert hall, exhibition grounds)
- Public traffic area
- Green space (festival meadow)
- Who manages the area?

Is it a

- self-contained, fenced-in event area, an open event area, or
- an open event area, or
- several event areas?

Does the event require

- additional areas in the public area, or
- is the event limited to a clearly demarcated area?

Is the event

- stationary, or is it a
- mobile event (e.g. a parade[2)])?

[2)] Note: A demonstration or procession, on the other hand, would not be an event within the meaning of these recommendations.

Continuation of checklist for basic evaluation

What legal basic parameters apply to the event at

- federal level,
- state level,
- municipal level?

Do approvals or permits

- still have to be obtained for the event, or
- is there a duty to obtain a permit for the event?

Is the event

- spectator related, or is it
- related to participants (e.g. marathon run, cycle race)?

How is access to the event or participation in the event controlled?

- Uncontrolled, ungated, free access without tickets
- Regulated or limited access, fenced event, participation only with an admission ticket

Possible influence of weather conditions on the event, e.g.:

- Large to very large influence when it is an open air event/little to no influence on indoor events
- Greater influence if free admission or no advance ticket sales/lesser influence for season tickets and/or if advance ticket sales have already taken place

Duration of the event:

- Delivery and set-up phase (i.e. start of initial impact, e.g. setting up road and traffic closures)
- Arrival or access of persons travelling to the event, including performers
- Start of the event
- Possible "highlight" of the event (e.g. fireworks display)
- End of the event
- Post-event entertainment/possibility to stay at the event location
- Departure of people, including performers
- Completion of removal and clearing up

What internal traffic needs does the event have?

- None or low internal traffic needs
- High logistical effort/complex internal traffic management, media coverage, continuous deliveries, etc.), financing the event
- How is the event financed, and
- are the planning and implementation of the traffic plan secured?

Repetition/frequency of the event:

- Has the same or a similar event taken place at the same event location in the past? Do some of the attendees have "experience" of past events?
- Has the same or a similar event already taken place at another event location?
- Are there any previous events that would be comparable to the upcoming event?
- Has the same or a similar event taken place before, but have so many parameters changed in the meantime that the previous and the upcoming event are not comparable?

What preparation time is to be allowed/expected/required as planning time?

- Experience has been gained from previous events and organisational structures and concepts can be used
- Event is new, organisational structures and concepts still need to be developed

Are there construction sites in the vicinity and on the access and exit routes that need to be taken into account?

Are there parallel events in the local region/community that have an impact on the event being prepared?

Special features of the event location:

- Event location situated in the town centre
- Distance of the event location from the town centre/nightclub district
- Distance of the event location from residential areas
- Spatial conditions of the event location and its immediate surroundings
- Availability of areas/area utilisation by the event organiser
- Location, number and width of entrances and usable emergency exits.

Initial consideration of people arriving and departing and the volume of people

Number of people:

- Absolute number of people over the entire duration of the event
- Distribution of the volume of people over the entire duration of the event
- Expected number of people on peak days/at peak hours
- (Daily) load curves (temporal distribution of people arriving and departing and attending)

Relation of the volume of people

- to the number of inhabitants
- to the number of daily commuters
- to other events that have already taken place in the town

Distribution of the origin of people travelling to the event:

- Regional
- National
- International

Special attendee groups:

- VIPs, guests of honour, sponsors, protected persons ,if applicable
- People with disabilities
- Families
- Social status/professional groups
- Business/leisure attendees
- Gender distribution
- Tendency to consume excessive amounts of alcohol
- Possible drug use
- Tendency to be aggressive (fan behaviour)

Arrival/departure behaviour of people:

- More motorised individual traffic (passenger vehicles, coaches)
- Shuttle services
- More public transport-orientated
- Organised arrival and departure
- Early arrival
- Lingering at the event location after the event has finished

Is accessibility guaranteed?

Initial assessment of the security situation at the planned event

Assessment of the security situation by the police:
- Unproblematic
- Simple security precautions required
- Considerable security precautions required

Assessment of the security situation by the event organiser, e.g:
- Spectator behaviour
- Expected weather conditions

Assessment by the authorities, e.g:
- Safety of the structures
- Safety of traffic routes
- Adequacy of planning

Is there a particular focus on safety precautions, e.g:
- Protection of individual VIPs or players?
- (Counter) demonstrations?
- Possible rioters?

Access and security searches:
- (Technical) equipment of security searches
- Duration of searches
- Banned objects
- Requirements on (stewarding) staff

Security precautions at the event location, in particular
- Escape and emergency routes/emergency exits
- Access protection concept
- Communication plan (internal communication and communication with spectators)
- Lighting
- Sufficient space for police and emergency services

Initial consideration of the accessibility of the event location

By public transport (consideration of all possible public transport options)
- Capacity of the individual services
- Capacity and equipment of the stops
- Distance from the stops to the event location
- Condition/quality of the routes from the stops to the event site
- Condition/quality/completeness of the existing footpath signposting from the stops to the event and back
- Degree of accessibility of public transport and the routes from the stops to the event site

By motorised individual traffic (including coaches)
- Location and cross section of the main access roads
- Traffic control at important junctions
- Location and number of existing parking areas, including stops, driveways and P+R (Park+Ride) sites
- Number of parking bays/parking spaces (differentiation between motorcycles, passenger vehicles, parking bays for people with disabilities and coaches)
- Distance of the parking areas from the event site
- Accessibility of the car parks

- Condition of the roads and footpaths leading to the parking areas
- Condition/equipment of the car parks
- Condition/quality of the pedestrian routes to and from the public areas
- Condition/quality in public areas
- Condition/quality/completeness of existing signposting (both roadside signposting to reach the parking spaces and signposting for pedestrian traffic from the parking spaces to the event and back)

For cyclists:

- Condition/quality of the bicycle traffic infrastructure
- Condition/quality/completeness of the existing cycle route signposting
- Condition/equipment of the bike racks
- Distance of bike racks from the event site
- Condition/quality/completeness of the existing footpath signposting from the parking facility to the event and back

For pedestrians:

- Condition/quality/degree of accessibility of the footpaths
- Condition/quality/completeness of the existing footpath signposting

For travelling to and from the event by taxi:

- Capacity of (local) taxi companies
- Capacity of the taxi rank
- Condition/equipment of the taxi rank
- Distance of the taxi rank from the event site

For logistics vehicles (also: supply and disposal):

- Access situation
- Parking facilities
- Loading and unloading zones

For special traffic (public safety authorities and organisations, media, VIP):

- Arrival and departure situation, special roads and paths to be kept clear, if necessary
- Parking areas, parking facilities

Established measures/experience from previous events

With many events, it is not the first time they have been held, so experience from previous and/or comparable events can be incorporated into the planning. In particular, it should be known what

- was well/not so well received by the audience
- worked out satisfactorily/unsatisfactorily
- helped to avoid/provoke traffic disruptions

Annex B

To-do lists

Checklist 0: Basic principles

– Legal basis – Applicable laws, regulations, directives, guidelines, etc. – Approvals and permits to be obtained, outstanding certifications, declarations of conformity, etc.
– Identification of all authorities, offices, departments and institutions that need to be involved – Determination of the organisational structures – Definition of all roles and responsibilities – Coordination of cooperation between all public safety authorities and organisations (BOS) and other parties involved Distinguish between: – Planning phase – Implementation phase (standard, damage and crisis situation) – Ensuring the transfer of information from the planning phase through to the implementation phase
– Formation of working groups – Ensuring the transfer of information between the working groups – Project management, including time planning – Consensus on the required contents of the safety and traffic concept – Documentation of the coordination results – Querying the requirements of the security authorities (emergency services, police, police authority...)
Communication and coordination between the parties involved – Planning phase – Implementation phase (standard, damage and crisis situation)
– Contacts and availability in the implementation phase (standard, damage and crisis situation) – Reporting chains
– Debriefing, documentation, arising from "lessons learned" for subsequent events

Checklist 1.1: General parking space capacity

– Expected demand/total number of parking spaces required (taking into account the expected occupancy rate of the vehicles) – Supply/total number of available parking spaces (if applicable, taking into account the rate of turnover if refilling of the parking spaces is possible or planned depending on the type of event) – Planning of possible overflow areas/availability of additional areas in the event of unexpectedly higher demand for parking
– Available capacities in (city centre) multi-storey car parks and/or in car parks belonging to retail outlets and commercial offices
– To what extent should/must public transport be promoted in order to relieve the burden on motorised individual traffic?

Checklist 1.2: Target group-specific parking

Special parking prioritisation/reserved parking areas for VIPs, artists, media representatives, etc. – Where (as close to the destination as possible in accessible areas and to ensure accessible access routes to the event)? How many parking spaces? – Signposting to the car park – How do these groups of people identify themselves/access credentials? – (Special arrival) information for authorised persons
Reserved parking areas for coaches – Where? How many parking spaces? – Signposting to the car park – Public relations/information material
Reserved parking areas for people with limited mobility – Where? How many parking spaces? – Signposting to the car park – (Special arrival) information for authorised persons
Other reserved parking areas (suppliers, staff, stewards, ambulance and rescue services, police and fire fighters, etc.) – Where? How many parking spaces? – How do authorised persons identify themselves/access credentials? – (Special arrival) information for authorised persons

Checklist 1.3: Access routes to the car parks and departure routes

Supra-local access routes to the event: – Are changes required compared to "normal" traffic routing? – Event-related additions to the supra-local signposting required?
Efficiency of the access and/or departure routes: – Estimate of which (various) arrival/departure routes will be used – Congestion-prone routes/junctions? – "Normal" traffic situation (without event traffic) – Overlapping of event traffic with rush-hour traffic? – Is it possible or necessary to use or set up a control centre to monitor and control traffic?
Is it possible or necessary to relocate non-event-related traffic? – Signposting for non-event-related traffic – Information for road users/public relations work
Access to and/or exit from the car parks: – Are changes required compared to "normal" traffic routing? – At which points should orientation be supported (e.g. confirmation of direction at junctions)? – Is there a risk of additional traffic load caused by drivers searching for parking spaces? How can drivers searching for parking spaces be avoided? – Is signposting continuous and consistent? – Is it necessary to offer additional signposting to individual car parks?

Continuation of checklist 1.3: Access routes to the car parks and departure routes

– Is there a parking guidance system that can be used? Does a separate parking guidance system need to be set up? – Does an existing parking guidance system need to be switched off/covered up, as it would otherwise be misleading for the event?
Do the police need to assist with traffic management?
Avoidance of construction sites that obstruct traffic/no break-open permits for public traffic areas in the vicinity of the event

Checklist 1.4: Loading of car parks

Car park management: – Is car park management planned? Where and how are parking fees paid? – Are access checks planned, and if so, where? – What is the maximum number of vehicles that can be checked in within a time unit? – How is the transition between moving traffic and standing traffic organised? – Is there a risk of tailbacks into the public road network? How large is the congestion zone up to the public road? – Is there an allocation of certain parking areas for certain purposes or groups of people? – Are there plans to stagger the opening and filling of certain parking areas?
– When will the car parks be open? – Communication about the timing required – How are extremely early arrivals of passenger vehicles dealt with?
Stewards to be deployed in the car parks: – Required number of stewards and training measures still required – Financing – Communication between stewards <> traffic management control centre
Emptying the car parks: – How is merging into moving traffic on the public road network organised upon departure? – Directional signage back to the public road network

Checklist 1.5: Lanes (drop-off/pick-up zones)

– Are drop-off/pick-up zones required (also: coaches)? – Where? For how many vehicles? – Where can the vehicles be taken for the duration of the event until they are picked up? – How can drop-off/pick-up zones be protected against misuse? – Signposting to the drop-off/pick-up zone – Public relations/information material

Checklist 2.1: Public transport capacity

Anticipated demand/required public transport capacity for arrivals and departures:

- What forms of public transport are available? (Regional or suburban trains, light rail, underground, trams, regular bus services)
- "Normal" demand (without event traffic) for the available public transport services
- Offering/available (free) capacity for the available public transport services
- Is the public transport service accessible and usable?
- Required additional transport/provision of additional capacity to ensure the required public transport service (e.g. use of long trains, multiple units or articulated buses, increase the frequency of services, establishment of additional services, extension of operating times, as well as additional stops for scheduled train services, limitation of the number of intermediate stops, public transport prioritisation at junctions, bus lanes)
- Note: For trams and buses, the maximum capacity also depends on the quality of road traffic
- Note: For all forms of public transport, the maximum capacity also depends on the capacity of the stops and stations
- Timetable? Observe the deadline for ordering additional transport services
- Timetable? observe the deadline for preparing timetables and duty rosters

- Will public transport services (running above ground) be affected by the event and will they have to be redirected or delayed, or will they be cancelled altogether?
- Will public transport services have to be cancelled, for example due to crossing crowd flows?
- Provisions to ensure that information can be exchanged between those involved in traffic and crowd management in arrival and departure traffic.
- Arrangements to allow intervention in traffic control and guidance, if necessary (e.g. preparation of loudspeaker announcements, scrolling signs in the dynamic passenger information system, etc.)

Combined ticket

- Period and scope of validity of the combined ticket
- Communication of the period and scope of validity of the combined ticket
- If combined tickets are not available:
  - Ensuring sufficient opportunities to purchase a travel ticket
  - Dealing with ticket inspections (or with "fare dodgers")

Arrival and departure information:

- Standardised information planning across "all channels"
- When creating information material, also take into account the needs of "normal" passengers, and people with disabilities

- Avoidance of construction sites on public transport routes
- Identification of possible or frequent obstructions on public transport routes and measures to avoid these disruptions

Checklist 2.2: Transfer points, stops and stations

Capacity on platforms/at stops:

- Identification of possible capacity bottlenecks and, if necessary, precautions against possible overcrowding at stops or platforms
- Separation of routes for arrivals and departures in the event of simultaneous arrivals and departures
- Precautionary operational regulations to rule out hazards in the event of imminent overcrowding (e.g. slow entry into train stations, passage arrangements, buffer zones in front of train stations and stops, establishment of queuing systems, temporary closures)

Supporting measures at stops and stations:

- Schedule synchronisation of transportation resources at transfer points
- Deployment of passenger assistance staff, in particular multilingual passenger assistance staff where necessary (e.g. international sporting events)
- Public transport information stands/distribution of information material
- Platform announcements (also in English, if necessary) and/or dynamic passenger information

Accessibility:

- Check for accessibility along the entire chain of the route (including passenger information)
- Are special measures to be taken for people with limited mobility (wheelchair users), for example, as accessibility is not guaranteed?

Checklist 3.1: Cycle routes and paths

- Where and how many cyclists are expected?
- Is road safety guaranteed? Are conflicts with pedestrians and/or motorised individual traffic to be expected?
- What is the condition (quality) of the cycle paths alongside roads?
- Is the event location reflected in the signposting?
- Will (non-event-related) bicycle traffic be affected by the event and need to be diverted?

- Integration of bicycle traffic into the traffic plan
- Inclusion of cycle routes and paths in the arrival information

Checklist 3.2: Bike racks

- Anticipated demand for bike parking facilities
- Number of existing parking facilities and, if necessary, addition of further parking facilities
- Check the position of existing bike racks (close to the event site)
- Check the condition and immediate surroundings of the bike racks
- Clarify whether there should (also) be guarded parking spaces
- Check whether a bike repair and/or bike valet service can/should be offered

- Clarify what shall happen to "incorrectly" bikes parked
- If necessary, deployment of stewards and/or (municipal) police officers to prevent bikes being parked "incorrectly"

Checklist 4.1: Footpaths to the event site, arrival and entrance

Required footpaths:
- To the event location or to the entrances
- and later back to the
  - Car parks
  - Public transport stops
  - Bike racks
  - Taxi ranks

Check the suitability of (existing) footpaths for:
- People with limited mobility
- Other special target groups (e.g. families with children)

With regard to:
- Distance
- Condition/quality
- Lighting

Adequate directional signage:
- To the event location or to the entrances
- and later back to the
  - Car parks
  - Public transport stops
  - Bike racks
  - Taxi ranks

- Will (non-event-related) pedestrian routes be affected by the event or will footpaths need to be closed?
- Do new/additional footpaths need to be created (and signposted)?

Are measures required to activate certain pedestrian routes and encourage their use?
- Signposting
- Lighting of the pedestrian routes
- Upstream programme items (information, entertainment)

Are measures required to restrict or prevent the use of certain footpaths?
- Signposting
- Closures (including the use of stewards)

- Integration of pedestrian traffic into the traffic plan
- Inclusion of footpaths in the arrival information

- Depending on the type of event and the expected attendees and arrival behaviour, what types of flows are expected and where will those be located?
- Where can relief zones be provided?
- Where can (localised) congestion and high crowd densities be expected?

Continuation of checklist 4.1: Footpaths to the event site, arrival and entrance

- At what crowd density is a risk potential seen and where are they expected?
  - Walkways, corridors, tunnels, stairs or ramps
  - Waiting zones in front of entrances, queuing systems
  - Entrances, doors, gates, queueing and separating elements, ticket and security search points

  or how must these walkways, corridors, tunnels, etc. be dimensioned to accommodate the expected crowd flows?

Forecasts of crowd flows:

- Visualisation on a (scaled) site plan
- Determination of suitable time intervals for creating the forecasts
- Note the number of people per time unit depends on the speed at which people want to move or can still move, for example due to initial congestion in the crowd flow

Flow capacity of the entrance areas:

- Are the entrance areas sufficiently dimensioned to handle the expected crowd flow without causing excessive waiting times?
- What access checks (ticket checks only or bag and identity checks?) are planned, where are they located, and how do these affect the flow capacity?
- How does the attendee profile and the number of stewards planned affect the flow capacity?
- With regard to the flow capacity of the entrance areas, should/must early and/or staggered arrival be promoted to ensure arrivals are segregated and the entrance areas are not overwhelmed?

- Can the expected crowd flow be managed in the entrance area or waiting zones without putting too much pressure on the public areas and/or causing congestion?
- Is it possible to forecast where and how long the high/highest phase of crowd density will last?
- Can the expected crowd flow still be managed if the crowd flow has already been congested?
- Are the entrance areas large enough to allow people to stop and get their bearings after passing through the security searches without causing congestion?

- Is it clear to everyone involved where/how the interface between responsibility for the public area and the area of responsibility of the event organiser is situated in the entrance area?
- Have joint and/or individual measures been agreed (both for normal operations and in the event of a damage or hazard situation)?

- Can/should the entrance area also be used as an interaction area or as the first opportunity to inform people arriving and, if necessary, to direct and guide them?
- Has it been taken into account that the entrance area is also an area of action for the stewards?
- Is disorderly "queuing" possible in the entrance areas or is queue management or the establishment of an (extensive) controlled crowd guidance system necessary?
- Controlled crowd guidance system available: What organisational and staff measures need to be taken to support this?
- Are the waiting and queuing areas free from unnecessary installations and obstructions?

Continuation of checklist 4.1: Footpaths to the event site, arrival and entrance

Design of the entrance area:

- To differentiate between the objective factors or circumstances and the subjective assessment, e.g. the concern arriving "too late" and the "fear of missing out"
- Objectives:
  - Coping with even very high crowd flows without personal injury
  - Processing or resolving congestion
  - Creating structures that forgive errors, misbehaviour and/or situations that deviate from the forecast/plan
- To be avoided: "Double occupancy" of areas (e.g. traffic area and possible relief zone)

Checking capacities and quality of traffic flow (at the entrance areas):

- Taking precautions to ensure that continuous monitoring of the entrance and the actual crowd densities is possible
- Planning of measures including provision of the necessary materials, equipment and staff in order to be able to implement corrective measures

- Can people arriving in the entrance areas be informed and addressed?
- Are there sufficient and comprehensively trained staff (stewards) available to direct and, if necessary, address people arriving at the event?
- Where and how many stewards are available?
- Ensure communication between stewards and security authorities
- How will people still travelling to the event be informed if the permitted number of people at the event site has already been reached and access to the site is no longer possible? Do the grounds and/or the access routes have to be closed, and is the material needed for closure and enough stewards available for this task?

Checklist 4.2: Footpaths at the event site, attendance during the event

- Where will there be high crowd densities at the event site – especially depending on the type of event and the expected attendee behaviour?
- Where might high crowd densities even be deliberately created by the attendees (e.g. because they are perceived as part of the event)?
- At what crowd densities is a risk potential seen, and where?

Forecast crowd flows and densities:

- Visualisation on a (scaled) site plan
- Determination of suitable time intervals for creating the forecasts

- What influence does the design of the public area or the way in which the public area is used have on the public area capacity?
- What influence does the attendee profile and behaviour have on the public area capacity?
- For example, can the public area still be used for the transfer of artists or athletes?
- When designing the public area or determining the maximum number of attendees permitted, the actual expected spatial and temporal allocation of the public to the area must also be taken into account. Will the people be evenly allocated across the public area or are there attractive areas that will be occupied first and/or in high density?

Continuation of checklist 4.2: Footpaths at the event site, attendance during the event

Design of the event area:
- To differentiate between dynamically and more statically utilised public areas
- To differentiate between different types of event and expected audience behaviour
- To differentiate between different event areas and surfaces
- To differentiate between unidirectional and bidirectional crowd flows
- To differentiate between objective factors or conditions and subjective judgement, e.g. aiming to leave a situation due to a personally perceived danger
- Objectives:
  - Coping with even very high crowd flows without personal injury
  - Processing or resolving congestion
  - Creating structures that forgive errors, misbehaviour and/or situations that deviate from the forecast/plan
- To be avoided: "Double occupancy" of areas (e.g. dwell areas and possible relief zone)

Determination of additionally required waiting zones (e.g. catering, toilets)

Check the capacities and quality of traffic flow during the event:
- Make provisions to ensure that continuous monitoring of the planned (event) process and the crowd densities actually occurring is possible (e.g. higher observation point, inspections to record crowd densities and, if necessary, the overall mood at the event site)
- Planning of measures, including provision of the necessary materials, equipment and staff in order to be able to implement corrective measures

- Can attendees be informed and addressed throughout the entire area?
- Are there sufficient and trained staff available to direct people?
- Where and how many stewards are available?
- Ensure that the stewards can communicate with each other and with security authorities

Designation of pedestrian traffic destinations at the event site:
- First aid/police
- Concessions/toilets
- Special event-specific destinations
- Emergency exits

Checklist 4.3: Exit (and evacuation)

- How far is it from each attendee's seat to the nearest exit that leads to a safe area?
- Does the arrangement/positioning of the emergency exits ensure the shortest possible distances?
- Is the signposting to the emergency exits clear and easy to recognise even in the dark or if there is smoke?
- Does the signposting to the emergency exits stand out clearly from the surroundings?
- Are there "extra" escape and emergency routes or do the escape and emergency routes also serve as "normal" traffic routes?
- Is it ensured that the emergency exits will not also be used as "secret" entrances?
- Are the escape routes wide enough to enable evacuation within the desired time? What are the evacuation times for the given escape route widths?

Continuation of checklist 4.3: Exit (and evacuation)

- Where and what flows of pedestrian traffic are expected, especially depending on the type of event and the expected arrival/departure behaviour ?
- Where can localised congestion and high crowd densities be expected?
- At what crowd densities is a risk potential seen where?
  - Walkways, corridors, tunnels, stairs or ramps
  - Exits, doors, gates

  Or, how must these walkways, corridors, tunnels, etc. be dimensioned to accommodate the expected crowd flows?

- What requirements does the audience profile and/or departure behaviour place on the exit or the areas immediately behind the exit? (For example, are a large number of people expected to collect their belongings?)
- Are exit areas designed in such a way that they can accommodate a large number of departing people and that it is still possible to inform and address these people, if necessary?
- Given the flow capacity, are the exit areas sufficiently dimensioned to enable the crowd flow to be managed without (longer) waiting times building up at the exit?

- Is it clear to everyone involved where/how the interface between responsibility for the public area and the area of responsibility of the event organiser is situated in the exit areas?
- Have joint and/or individual measures been agreed (both for normal operations and in the event of a damage or hazardous situation)?

- How are the transfer points between the public areas or the exit and the public transport stops or the car parks or bike racks dimensioned and designed?
- Can congestion in the event area be ruled out at these transfer points or is there sufficient space in the exit areas for possible congestion?
- Are the exit areas free from (unnecessary) installations and obstructions?
- Is the signposting/routing from the exit back to the public transport stops or to the car parks or bike racks clear and unambiguous?

Design of the exits:

- To differentiate between objective factors or conditions and subjective judgement, e.g. aiming to leave a situation due to a personally perceived danger
- Objectives:
  - Coping with even very high crowd flows without personal injury
  - Processing or resolving congestion
  - Creating structures that forgive errors, misbehaviour and/or situations that deviate from the forecast/plan
- To be avoided: "Double occupancy" of areas (e.g. traffic area and possible relief zone)

Review the capacity and quality of traffic flow (at the exits):

- Take provisions to ensure that continuous monitoring of the exit and the crowd densities actually occurring is possible
- Planning of measures (including provision of the necessary materials, equipment and staff) in order to be able to implement corrective measures

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- Can departing people be informed and addressed across the entire area?
- Are there sufficient and trained staff available to direct people?
- Where and how many stewards are available?
- Ensure that the stewards can communicate with each other and with security authorities

Continuation of checklist 4.3: Exit (and evacuation)

Determine (additional) required waiting zones: – In front of/at public transport stops (e.g. buffer zones, establishment of queuing systems) – In front of/at ticket purchase locations – In front of/at bike racks
Evacuation of the event area: – Definition/description of realistic events that can trigger a full or partial evacuation (these scenarios vary individually depending on the type and location of the event). – Determination of the available evacuation time (detection time + alarm time + actual escape time) depending on the respective evacuation scenario and comparison with the actual evacuation time required. – Creating/keeping clear sufficient relief zones (either still at the event site or outside the site) – Determine how people can be directed there (also taking into account attendee groups and behaviour, e.g. inebriated attendees, young guests, older audience, families, people with disabilities)
– Which routes are suitable as escape routes (i.e. are they sufficiently dimensioned with as few pinch points and bottlenecks as possible)? – What organisational measures need to be taken to initiate an evacuation or during the evacuation? Are the stewards prepared for a possible evacuation? – Which communication channels should be used to inform those in attendance about an evacuation? Who communicates information and how? – Is the public address system sufficient to inform everyone? If necessary, can individual areas of the event area be specifically addressed to initiate a partial evacuation?

Checklist 5: Taxi services

– Expected taxi services during arrival – Expected demand during departure/extent of taxi services during departure
– Are taxi services (arrival and departure) or passenger behaviour likely to have an impact on other modes of transport?
– Signposting for taxi services – Waiting zones for taxi customers during departure – Design of waiting zones and queuing-up areas for taxis – How can taxi waiting zones be protected against misuse by private vehicles (e.g. by "parent taxis")? – Involvement of the local taxi association/taxi union, including the use of internal taxi stewards, if necessary

Checklist 6: Special use of public traffic areas

(Additional) public traffic areas may be required for – Set-up and dismantling (logistics areas, material storage areas) – Logistics vehicles/vehicles for supply and disposal – Ancillary areas (e.g. toilet facilities) – Special safety zones, e.g. for security staff attending the event – Media vehicles and OB vans – Parking spaces and/or staging areas for emergency and rescue vehicles – Relief areas – Rescue and escape routes, first aid installations – Outdoor food concessions
Temporal subdivision of area utilisation – Set-up – Event phase – Dismantling
Possible consequences of area utilisation for, among others – Motorised individual traffic, non-event emergency vehicles, public transport, pedestrian and bicycle traffic – People arriving, departing and attending the event – The process of the event – Local residents
Required: – Organisable traffic sign planning, including diversion planning – Closures, including the adjustment and/or control of traffic light signal systems, if necessary – Public information
Special arrangements for local residents: – Provision of alternative parking facilities – Access options (supply and disposal, social services, emergencies) – Special information for affected local residents

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Annex C

Real and conceptual examples and experiences for the planning and realisation of events

C 1 Assessment examples

C 1.1 Testing the suitability of two sections of a pedestrian route when travelling to an event

Task

At an all-day event, sections of limited width lead to the public areas. The aim is to check whether the forecast volume of people travelling to the event can be routed to the public areas via these sections.

Forecast volume of people travelling to the event

In Table 11, the volume of people is forecast in 60-minute intervals for an example event and for two sections of a pedestrian route intended for arrival and departure. For the two sections T1 and T2, the time interval from 8 am to 9 am shows the highest volume of traffic with 35,000 and 11,000 people per hour respectively.

Table 11: Example flow of people in 60-minute intervals

Section	Time interval	$q_{A,60}$	$q_{B,60}$	$q_{60} = q_{A,60} + q_{B,60}$
T_1	8 am – 9 am	10,000	25,000	**35,000**
	9 am – 10 am	7,000	12,000	**19,000**
	...	...	...	**...**
	8 pm – 9 pm	20,000	2,000	**22,000**
	9 pm – 10 pm	25,000	1,000	**26,000**
T_2	8 am – 9 am	6,000	5,000	**11,000**
	9 am – 10 am	5,000	3,000	**8,000**
	...	...	...	**...**
	8 pm – 9 pm	3,000	2,000	**5,000**
	9 pm – 10 pm	2,000	1,000	**3,000**
T_n	...	...	...	**...**

Inspecting the traffic flow on the relevant section of the pedestrian route

Peak traffic can occur within the relevant time interval. In this respect, the test is based on the assessed volume of traffic (unit: persons per two minutes) on the basis of the two-minute interval with the highest number people.

For section T1 with a maximum volume of traffic of 35,000 people per hour (see example for step 2), the assessment-relevant notional volume of people for the two-minute interval is calculated as

$q_{f,2} = f_{60} \cdot q_{60} = 0.06 \cdot 35{,}000$ pers/h. = 2,100 pers/2 min.

With a volume of people of $q_{f,2}$ = 2,100 pers/2 min. and a usable width of B = 10 m, the specific flow is given as

the specific volume of people of $q_{s,2}$ for the 2-minute interval results in

$q_{s,2} = q_{f,2}/B$ = 2,100 pers/2min/10 m = 210 pers/(m · 2 min).

The specific volume of people of q_s then results in

$q_s = q_{s,2}/120$ s = 210 pers/(m · 2 min)/120 s = 1.75 pers/(m · s).

Test result

For the specific flow of q_s = 1.75 pers/(m · s), a RED quality level of traffic flow results for both one-way and two-way traffic. The section is not suitable for accommodating the forecast volumes of people arriving.

C 1.2 Examination of the suitability of an event location for an all-day event with a predetermined number of attendees

Task

An all-day event with attractions is planned from 1 pm to 10 pm with partly simultaneous arrival and departure. It must be checked whether the planned event can take place at the designated event location.

The event location is an outdoor, inner city space, demarcated by fencing, where a parade of cargo bikes with mounted jukeboxes is to take place around a building that cannot be used (see Figure 30). The spectators will mainly move along with the parade of cargo bikes, but can also stand and watch the parade in the available spaces. A stage will also be set up at the building. Arrivals and departures will take place via two entrances/exits, adjoining pedestrian routes with sections that, after deduction of edge distances, have a continuous width of 20 m and lead to and from the public areas via a 90-degree bend. At the two entrances, which are scheduled to open at 11 am, separating elements with 60 cm wide turnstiles will be set up for random bag searches. Twenty turnstiles per entrance can be set up in the limited space available in the two entrance areas. The public areas have a total size of 125,000 m². It is estimated that half of the public areas will be used by the moving spectators and half by the standing spectators. The aim is for arriving and departing people to use pedestrian routes without congestion, while recording high densities but short waiting times in front of entrances and public areas.

Forecasting arrivals, departures and attendance

A forecast of people arriving, departing and attending the event is available (see Table 12).

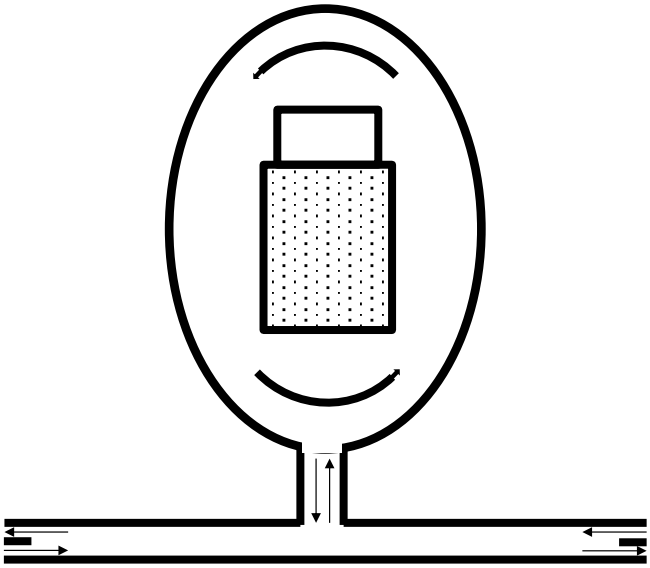

Image 30: Example location for an all-day event with a circuit for cargo bikes

Table 12: Example estimate of people arriving, departing and attending for a planned event with cargo bikes

Time	People arriving in the time interval via the security search points $q_{60,\ arriving}$	People departing in the time interval via the exits $q_{60,\ departing}$	People present at the end of the time interval in the public areas $q_{60,\ present}$
11 am - 12 pm	50,000	0	50,000
12.01 pm - 1 pm	50,000	0	100,000
1.01 pm - 2 pm	50,000	0	150,000
2.01 pm - 3 pm	50,000	10,000	190,000
3.01 pm - 4 pm	50,000	20,000	220,000
4.01 pm - 5 pm	50,000	20,000	250,000
5.01 pm - 6 pm	50,000	50,000	250,000
6.01 pm - 7 pm	20,000	50,000	220,000
7.01 pm - 8 pm	20,000	50,000	190,000
8.01 pm - 9 pm	0	50,000	140,000
9.01 pm - 10 pm	0	50,000	90,000
10.01 pm - 11 pm	0	90,000	0

According to this forecast, the maximum number of people attending at the same time is 250,000. The section to and from the public areas has a bidirectional maximum volume of 100,000 pers/h. Multidirectional crowd flows occur in the transitions between the public areas and the section as well as in the area of the 90-degree bend of the sections. At the entrances, a maximum of 50,000 pers/h are expected on arrival.

Examination of the requirements according to state building regulations

The first step is to check whether the requirements of the state building regulations of the respective federal state in which the event location is situated, which are based on the Model Ordinance on Places of Assembly (MVStättVO), can be complied with. For this purpose, the crowd density parameter specified in the scope of application for standing areas at a site is multiplied by the area of the public areas:

$$2\ \text{pers/m}^2 \cdot 125{,}000\ \text{m}^2 = 250{,}000\ \text{persons}$$

An initial examination therefore shows that the forecast maximum number of people present at the same time (250,000 persons) could be accommodated in the public areas, assuming an average crowd density of 2 pers/m^2.

Then, in accordance with the state building regulations of the respective federal state in which the event location is situated, it must be checked whether the people attending at the same time can be evacuated within a reasonable time period. As a generalised rule, proof is therefore provided if the clear width of each section of the emergency routes is at least 1.20 m per 600 persons. According to this generalised proof, emergency routes with a total width of

$$250{,}000\ \text{pers}/600\ \text{persons} - 1.20\ \text{m} = 500\ \text{m}$$

. It has been established that this total width cannot be provided in the inner city environment. As an alternative to the generalised proof, an evacuation analysis is prepared in accordance with the Guidelines for Microscopic Evacuation Analyses (RiMEA). This comes to the conclusion that people in individual sub-areas of the public areas can be evacuated to other sub-areas of the public areas in a reasonable amount of time.

Accordingly, the requirements of the state building regulations would be met and the event could be authorised and held on this basis.

Examination of the capacity of the public areas

The next step is to carry out technical testing on the capacity of the public areas, the capacity of the separating elements with security search points and the quality level of traffic flow on the sections of the pedestrian routes based on the information in these recommendations.

When determining the capacity of the public areas, consideration must be given to the fact that half of the areas are to be used dynamically by the moving spectators. Maintaining the momentum of the cargo bikes and the moving spectators around the circuit is imperative in order to deal with the ebb and flow of people arriving and departing and to facilitate access to and exit from the stage area. If everything comes to a halt, there is a risk that people arriving at the event will no longer be able to reach the public areas or will only be able to do so after having had to wait a long time. The "fear of missing out" upon arrival can lead to hazardous situations and personal injury if public areas experience prolonged periods of no movement. The aim is therefore to achieve a GREEN quality level of traffic flow with a maximum of 0.7 pers/m² in dynamically utilised public areas and on bidirectional pedestrian routes.

For the public areas, this results in a capacity of

$0.7\ \text{pers/m}^2 \cdot 62{,}500\ \text{m}^2 + 2.0\ \text{pers/m}^2 \cdot 62{,}500\ \text{m}^2 = 168{,}750\ \text{persons},$

provided that the volumes of people arriving at and departing from the public areas can be managed on the sections of the pedestrian routes and via the security search points.

Inspecting the traffic flow on key sections of the pedestrian routes

A GREEN quality level of traffic flow with a maximum specific volume of people according to Table 12 of 0.6 pers/(m - s) is also aimed for on the sections of the pedestrian routes. On the section with a usable width B = 20 m from and to the public areas – after deduction of edge distances – maximum two-way traffic of $q_{60,\ \text{arriving and departing}}$ = 100,000 pers/h is expected. Fluctuations in the volume of people are taken into account according to Table 14 with the conversion factor f_{60} = 0.06 from the 60-minute forecast interval to the 2-minute interval with the highest traffic load.

For the section, the design-relevant 2-minute interval results in

$q_{f,2} = f_{60} \cdot q_{60} = 0.06 \cdot 100{,}000\ \text{pers/h.} = 6{,}000\ \text{pers/2 min.}$

The specific volume of people $q_{s,2}$ for the 2-minute interval results in

$q_{s,2} = q_{f,2}/B = 6{,}000\ \text{pers/2min}/20\ \text{m} = 300\ \text{pers/(m} \cdot \text{2 min)}.$

The specific volume of people of q_s then results in

$q_s = q_{s,2}/120\ \text{s} = 300\ \text{pers/(m} \cdot \text{2 min)}/120\ \text{s} = 3.0\ \text{pers/(m} \cdot \text{s)}.$

For a specific volume of people q_s = 2.5 pers/(m - s), this results in a RED quality level of traffic flow. The section is far from suitable (by a factor of 2.5/0.6 = 4.2) for accommodating the forecast volume of pedestrians. Such a high specific flow of people cannot be achieved under any circumstances. To fulfil the premise, the section would have to have a minimum usable width (W) of 84 m.

Checking the number of security search points

The next step is to check whether the forecast volume of people can be managed by the security search points. For the planned random bag searches, an achievable volume of people or rate of passage of 660 pers/(turnstile hour) is assumed. The required number of turnstiles with an expected volume of people of 50,000 pers/h in the sum of both entrances is

$50{,}000\ \text{pers/h}/660\ \text{pers/(turnstile h)} = 76\ \text{turnstiles}.$

To cope with the expected volume of people with the planned searches, 76 instead of 40 turnstiles would have to be operated.

Result of the suitability test

As a result, it can be concluded that the event location is unsuitable – based on the consideration of unidirectional and bidirectional crowd flows alone and without taking multidirectional crowd flows into account. The sample calculation shows that less than a quarter of the people expected on the basis of the forecast and who are likely to be accommodated according to the requirements of the state building regulations will be able to reach the public areas.

Even if the number of people present at the same time were reduced to a maximum of around 50,000 instead of 250,000 – for example by allocating tickets with time slots, the number of people arriving, departing and present in the respective time intervals would be reduced to more than a quarter – backlogs would still occur at the two junctions of the 90-degree bend of the sections of the pedestrian routes and the transition between the pedestrian routes and the public areas, as intersecting and multidirectional crowd flows are still to be expected in the event of high utilisation rates. Since a constant dynamic is a basic prerequisite for the safe operation of the event location, a fundamentally different event concept or event location must be chosen.

C 2 Experience with traffic management at evaluated events

There are generally few specific figures available on events, both in terms of the number of spectators and, in particular, the modal split, catchment areas and experience with the management of traffic and crowd flows upon arrival and departure. To be able to base future sets of rules and further developments of the Recommendations for Traffic and Crowd Management for Events (EVC) on a broader data basis, it is requested that empirical values based on the examples described in this section be sent to the Road and Transportation Research Association (FGSV).

C 2.1 Experience with the 2013 Annakirmes fun fair in Düren

Key data

The "Annakirmes" fun fair is an annual 9-day event held at the end of July/beginning of August. Opening hours approx. 11 am - 12 am. Tuesday, 30.07.2013 (family day), 12 pm - 10 pm, Friday, 02.08.2013 (fireworks day), 2 pm - 12 am

The fun fair site is normally used as a P+R site.

Image 31: Annakirmes fun fair Düren (photo: Koppers)

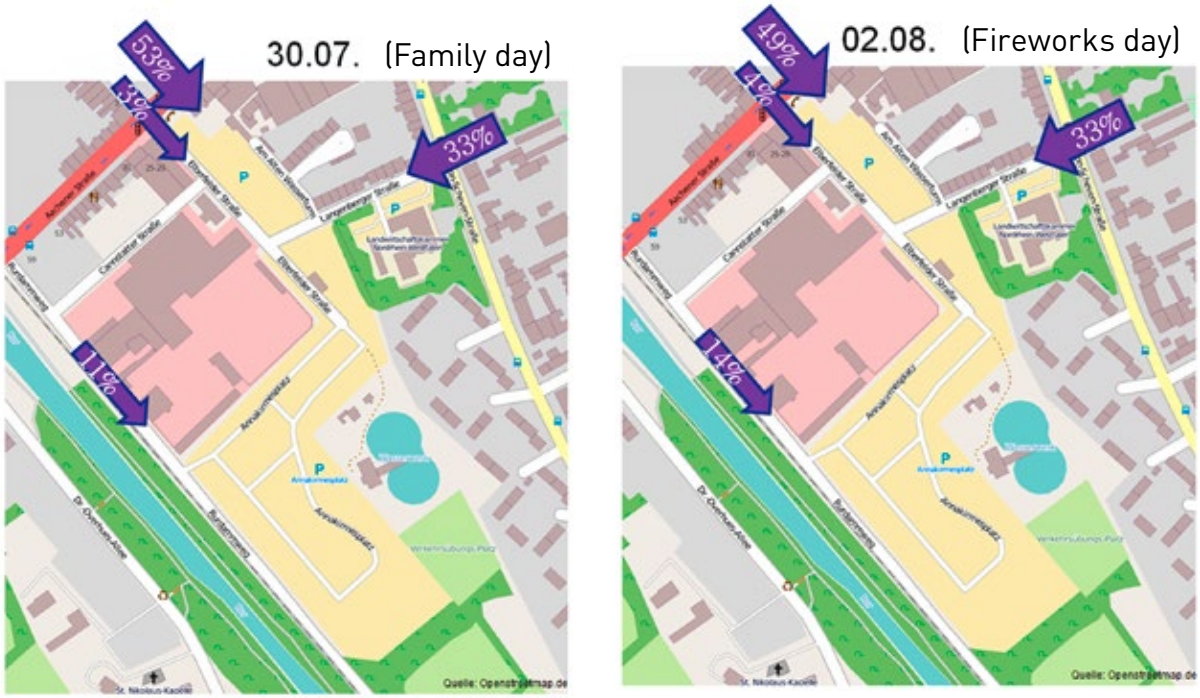

Image 32: Overview of the distribution of people travelling to the entrances (north: main entrance, east: side entrance, west: emergency exit) (base map: OpenStreetMap contributors)

Arrival/departure behaviour

Experience

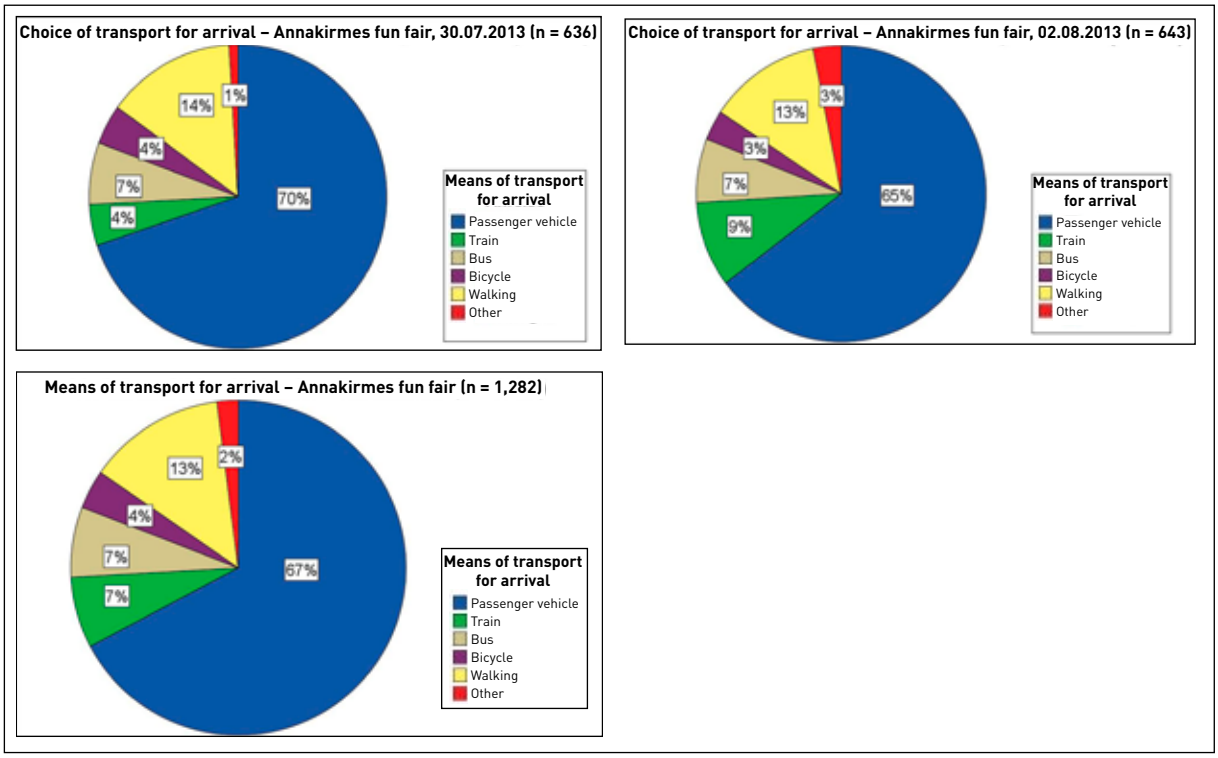

Image 33: Choice of transport when travelling to several Annakirmes fun fair events

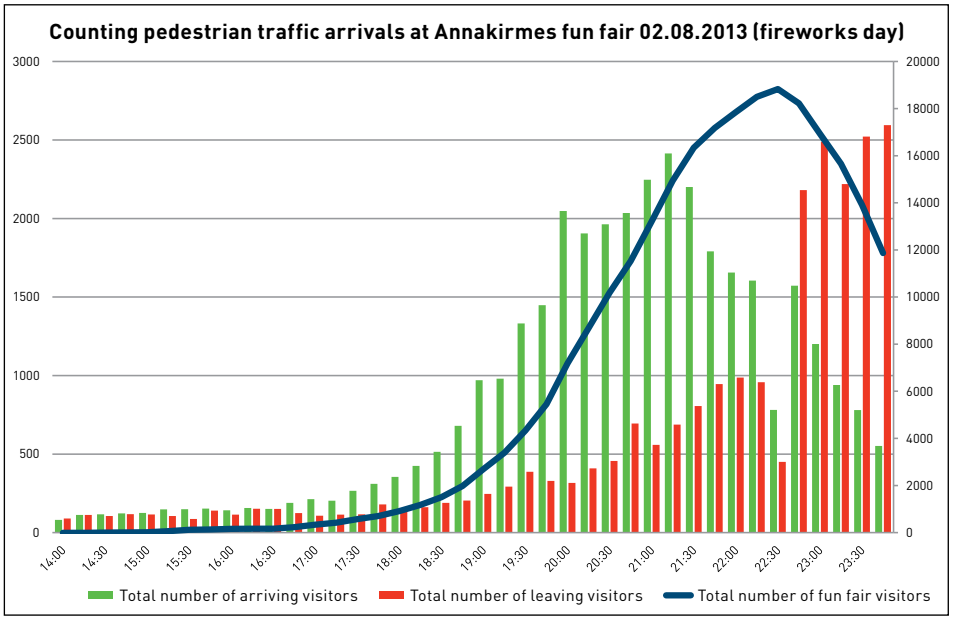

Image 34: Visitor count from 2 pm to 12 am in 15-minute intervals, total sum of people arriving at Annakirmes fun fair (fireworks day 2013), very hot summer's day (>36 °C), fireworks at approx. 10 pm

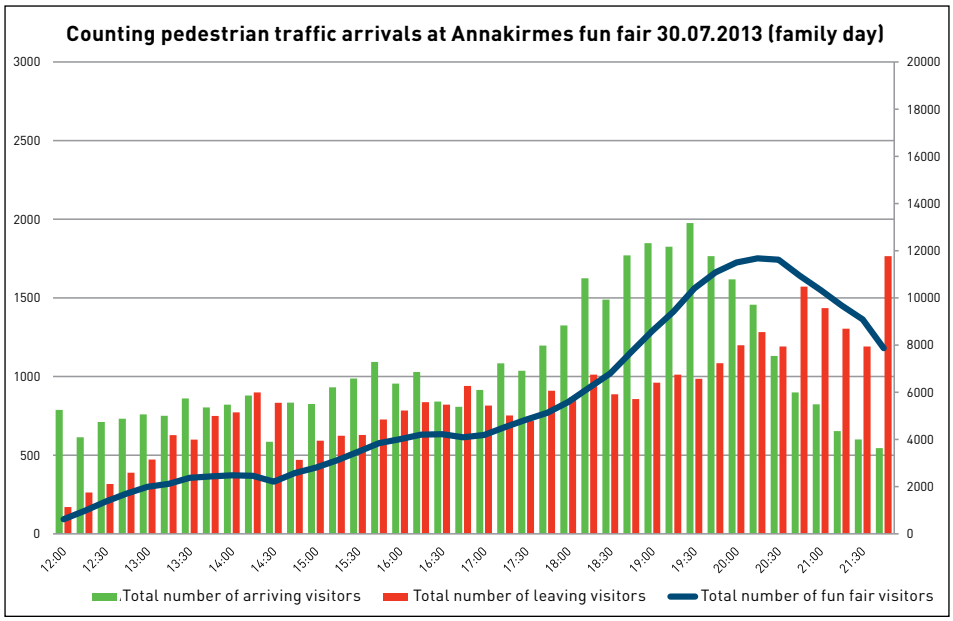

Image 35: Visitor count from 12 pm to 10 pm in 15-minute intervals, total sum of people arriving at Annakirmes fun fair (family day 2013), hot summer's day with rain showers

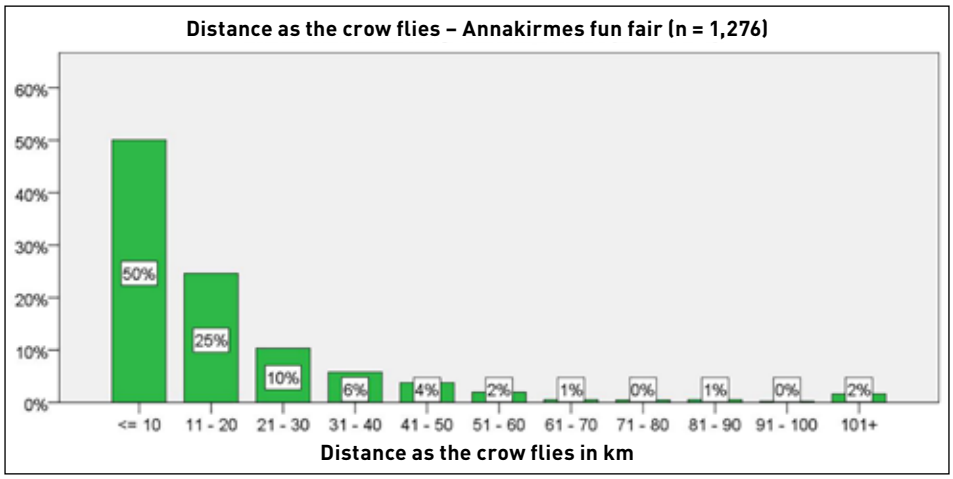

Image 36: Distance as the crow flies of people arriving at Annakirmes fun fair (in km)

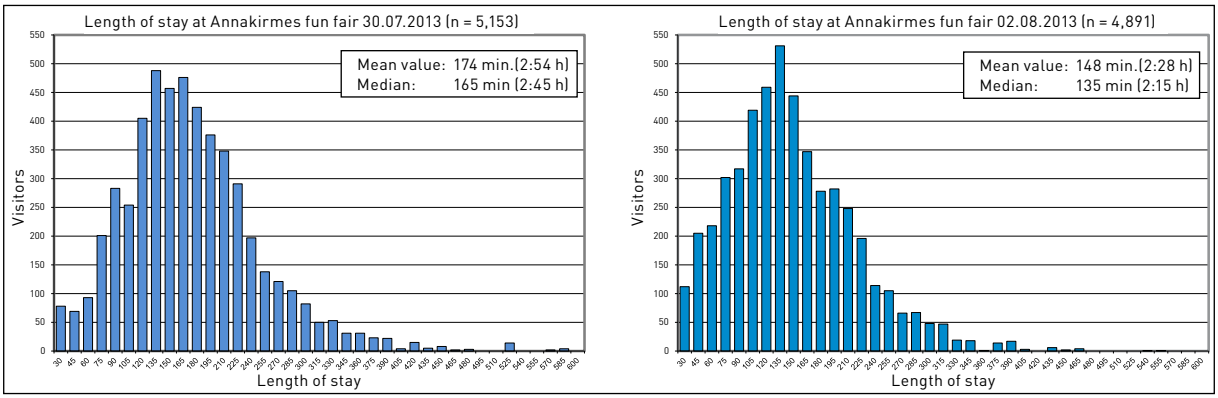

Image 37: Evaluation of the length of stay on family day (left), on fireworks day (right) using the OS-CAR method

Parking areas/parking facilities

Private areas are designated as parking areas and are not managed in a coordinated manner.

Experience

Due to a lack of systematic signposting, drivers spend a lot of time searching for parking spaces.

Image 38: Signage of the private event car parks, uncovered signposting to the Annakirmes fun fair P+R site

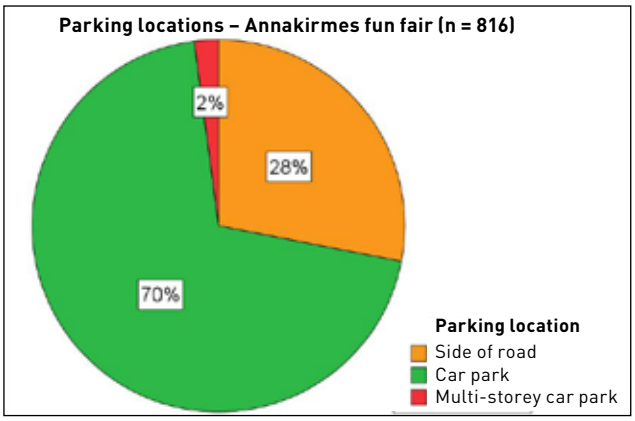

Image 39: Parking behaviour of car drivers

Routing of bicycle traffic, bike racks

Experience

Guarded parking facilities for the duration of the event are well accepted, but do not completely prevent bikes being locked to barriers and fencing.

Image 40: Bike station

Image 41: Incorrectly parked bikes

Emergency exits

A road (Rurdammweg) was used as an emergency exit; it was not intended to be used as a normal entrance.

Experience

The emergency exit was nevertheless used as an entrance. The reason for this was that it was the closest access point to the site from the train station and was therefore frequently used by people travelling by train.

C 2.2 Planning and implementation of Paderborn football stadium (Benteler Arena)

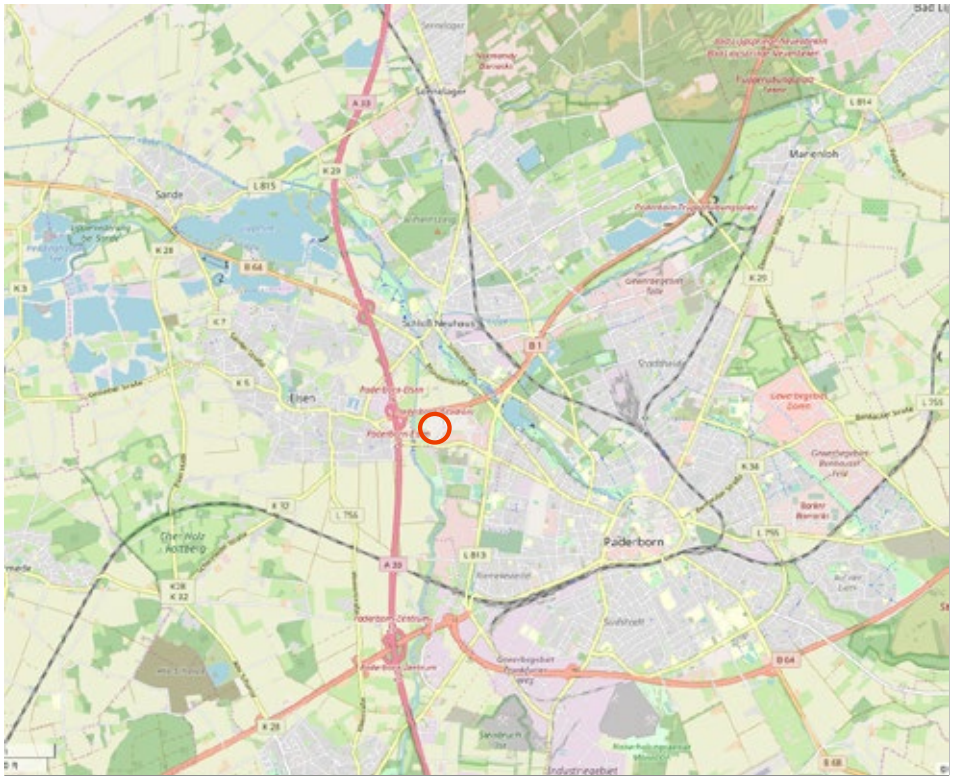

Image 42: Location of the Benteler Arena in Paderborn
(base map: OpenStreetMap contributors)

Challenges

Following complaints from local residents, ensuring sufficient parking bays for passenger vehicles to meet demand on match days. This is only partially possible in the immediate vicinity of the stadium, so an additional P+R service was created. A car park belonging to a local industrial business, 1.5 km from the stadium and secured under planning law for use by the club, is used as a P+R facility. To avoid noise from fans on foot, the P+R facility has been fenced off and a free shuttle is offered. A total of 15 stops laid out in three rows have been installed in front of the stadium, providing extensive shuttle service capacities at the end of the match.

Choice of transport and occupancy rate

The choice of transport behaviour was evaluated at a total of three matches:

Table 13: Choice of transport at the evaluated matches

Means of transport	Average ratio	Range
Passenger vehicle	60%	56.9 to 63.4%
Coach	3%	2.4 to 3.7%
Public transport	18.2%	15.4 to 20.9%
Bike	13.0%	5.4 to 20.6%
On foot	5.7%	4.8 to 6.6%

What is striking is the high ratio of pedestrian traffic for the less integrated location (the nearest residential areas are at least 1 km away) and the relatively high ratio of bicycle traffic for individual games. The latter was highly dependent on the weather. In bad weather, local public transport and passenger vehicles were used in roughly equal proportions as an alternative.

The occupancy rate for motorised individual traffic was between 2.5 and 2.9, with an average of 2.7.

Time allocation

For all matches, the journey to the stadium is focussed on the two hours before the start of the match. Both the second to last hour before kick-off and the last hour before kick-off accounted for 50% of destination traffic, with a variation range of between 43% and 56%. At 98%, originating traffic focussed on the first hour after the end of the match (variation range between 96 and 98%).

Experience

- The P+R service is predominantly only used when the car parks near the stadium are fully occupied, although there are tailbacks in the car parks near the stadium after the end of the match, while it is possible to leave the P+R car park without any problems.
- The demand for bicycle traffic was significantly underestimated when the stadium was built. Under pressure from the traffic expert, 2,000 bike parking spaces were installed in front of the stadium, which are often fully utilised (especially in the summer).
- There is such a large number of people walking away from the stadium after the end of matches that 4 m wide walkways are insufficient. In addition to their large number, pedestrians rarely stop at the traffic lights at the marked pedestrian crossing near the stadium, thus resulting in the regular the deployment of police resources.
- When communicating with people travelling to the stadium, it is crucial to state the address of the car parks and not that of the stadium, as otherwise their satellite navigation systems will direct them to streets that are closed off on match days and the car parks can only be reached by taking long detours.
- A concept for the protection of local residents has proven worthwhile and involves residential roads within a radius of approx. 1.2 km being closed off by stewards to prevent illegal parking. Local residents have been given resident parking permits. People travelling to the stadium tend to use local residential and industrial areas to park their vehicles even if the car parks near the stadium are not yet full, as they expect to get away faster after the match.
- Occasionally, stewards were not deployed in the P1 car park near the stadium, which has a capacity of 1,600 parking bays. Consequently, 30% of the parking bays remained unused, as drivers were unable to locate them despite exhaustive searches. In addition, the space between some parked vehicles was so large that it was impossible to park in adjacent spots. After the introduction of a row-by-row and an area-by-area parking system overseen by stewards, the utilisation rate increased to well over 90%.
- On the road (Paderborner Strasse) that runs past the stadium and is not part of the arrival/departure routes, there is a lot of drop-off and pick-up traffic and these vehicles tend to park on the verge or on the cycle path alongside the road. As a result, other vehicles are forced to veer into the oncoming lane and people and cyclists have to walk and ride on the road respectively. There are no drop-off or pick-up areas at the stadium.

C 2.3 Event "West German Broadcasting Corporation (WDR 2 für eine Stadt)", Remscheid

Key data

"WDR 2 für eine Stadt" was a live radio and music event (36,000 spectators) that was held on Saturday, 6 September 2014 in Remscheid. It took place at several locations (see map) dotted around Remscheid city centre:

1. "WDR 2 für Remscheid – Das Konzert" (3 pm – 10.30 pm)
2. "WDR 2 Montalk" (2 pm – 4 pm)
3. "WDR 2 Zugabe" (10.30 pm – 12 am)
4. "WDR 2 für eine Stadt – Live aus Remscheid" (11.00 am – 3 pm)
5. "WDR 2 Tooor für Deutschland" (2 pm – 3.30 pm)
6. "WDR 2 Einfach Gote Show" (4 pm – 5.15 pm).

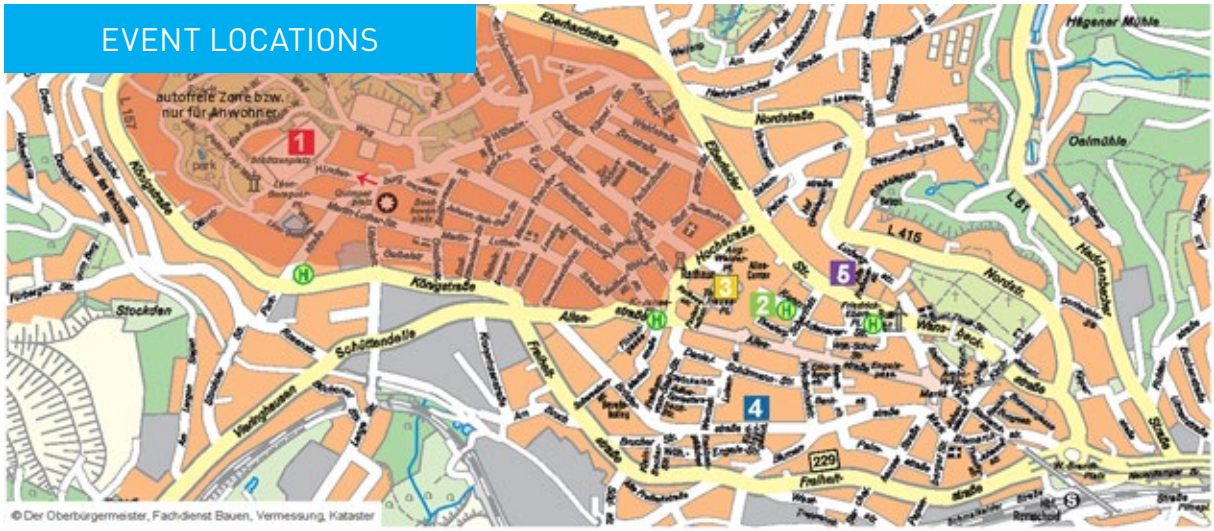

Image 43: Event locations (source: WDR2feS event flyer)

Challenges

- Escape routes from the concert site
- Management of everyday traffic, ensuring accessibility for local residents/delivery traffic in the city centre and around the concert site (surrounding area: local residential area)
- Difficult to calculate the number of attendees, especially at the Schützenplatz concert site (free admission concerts by Jupiter Jones, Element of Crime, Christina Stürmer, Mando Diao plus many more)
- Varied topography and complex landscape (considerable difference in altitude between the train station and event locations).

Organisation of the planning

A working group was formed to plan the traffic issues, which met weekly during the preparation of the traffic concept/coordination phase and then as required. The members of the "Traffic" working group were the fire service, police, Remscheid municipal utilities, Remscheid technical operations, the regulatory agency, city marketing, the specialist department for public order, safety and law and the "WDR 2-Tag" project group of the West German Broadcasting Corporation.

Experience

Thanks to good networking, many aspects could be clarified quickly.

Planning aspects

- Creation of a traffic plan for 36,000 people travelling to and from the event
- Establishment of buffer zones for the concert site, as demand was almost impossible to calculate
- Parking facility capacity/parking facilities
- Attractive public transport services (suburban trains and buses)
- Footpaths and waiting zones
- Taxi services, event logistics
- Special use of public traffic areas and its impact on motorised individual traffic and local public transport
- Protection of local residents, deliveries, care services, supply and disposal
- Event logistics.

Arrival/departure behaviour

Experience

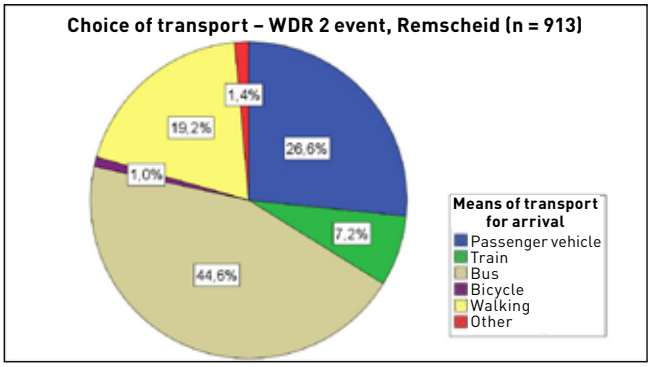

Image 44: Choice of transport for the journey

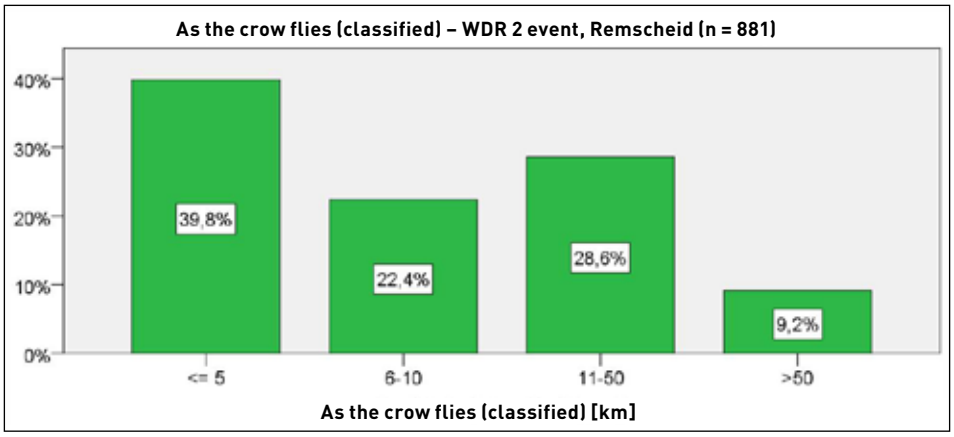

Image 45: Distance as the crow flies to the event (in km), classified

Parking bays/parking facilities

- The target figure from previous experience was a capacity of 2,000 parking bays.
- It was assumed that 500 of the 2,500 controlled parking bays in the city centre would be available for the event, due to an overlap with shopping traffic; existing parking guidance system.
- Additional P+R car parks in private and public areas with event-specific parking guidance system
- Parking fee: €5, free shuttle service
- Outdoor car parks 1-5 and public or private car parks with an access road
- Car parks 6 and 7 on pavement parking spaces and smaller areas
- Separate car park for people with limited mobility within the car-free zone
- The local media drew attention to the expected increase in traffic and advised people not to use their passenger vehicles to enter the city centre but to use public transport instead.

Image 46: Overview of event-specific parking options (source: WDR2feS event flyer)

Experience

- Thanks to intensive communication, many people travelled into the city centre on public transport
- The P+R car parks were well received
- Multi-storey car park occupancy in the city centre was below the capacity of a normal Saturday
- P6 (approx. 50 parking bays): fully occupied from approx. 10.30 am.
- P7 (approx. 310 parking bays): Allowed access up to approx. 4.30 pm/5 pm, after which all car parks were almost full.

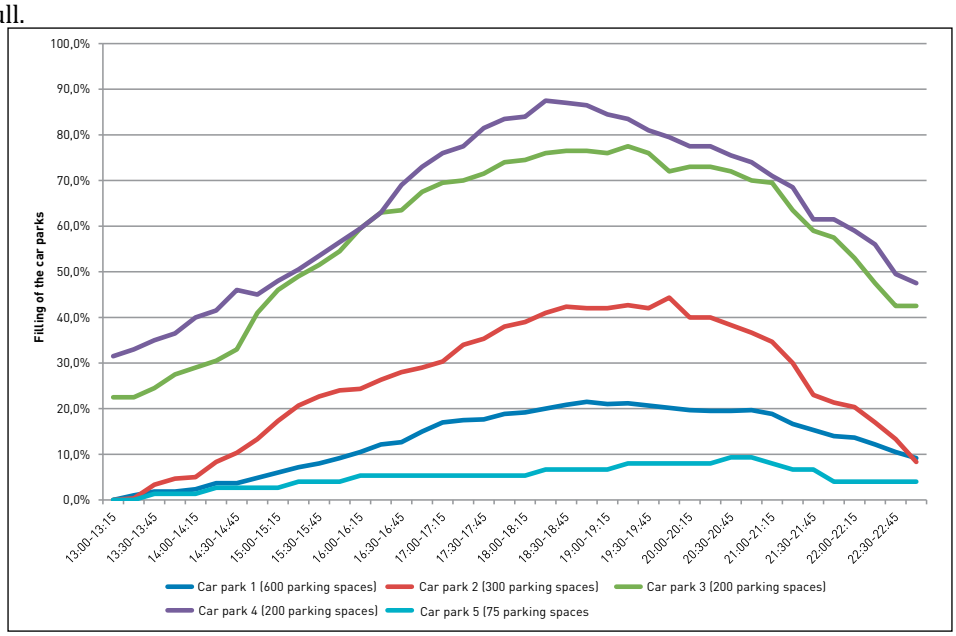

Image 47: Utilisation of car parks 1 to 5

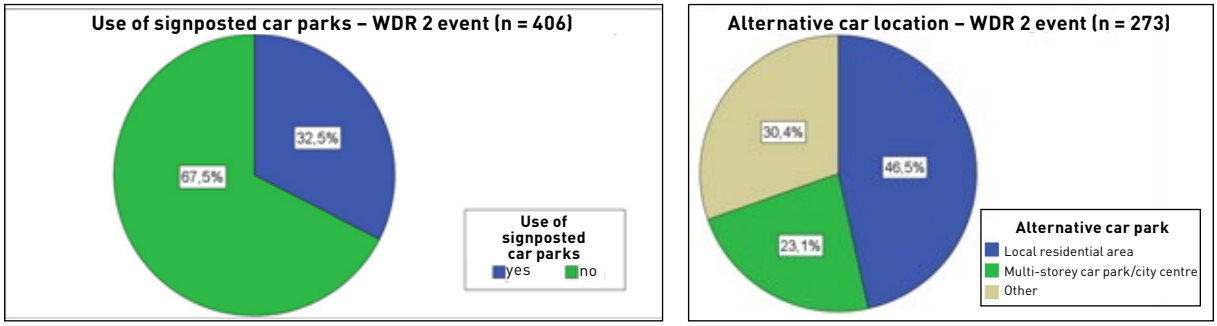

Image 48: Survey on car park utilisation by car drivers

Public transport services and demand, fare structure

- Routing of shuttle buses from the P+R via the train station and the city centre to the concert site
- Additional buses after the end of the concert
- Free public transport in Remscheid all day from 10 am
- Additional staff at the central stops
- Rail connection to Solingen was replaced by rail replacement services at that time.

Experience

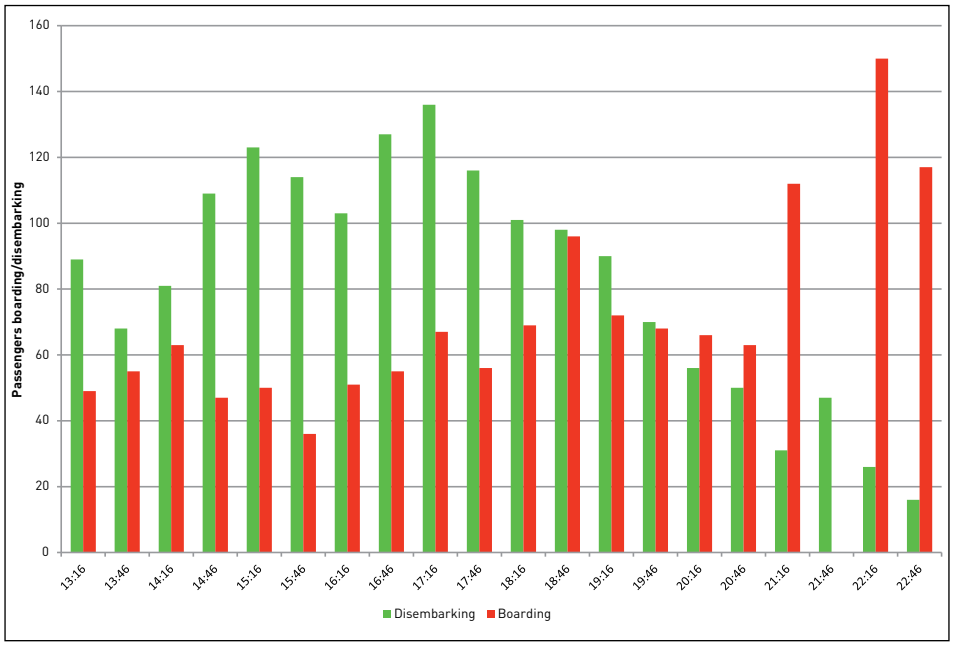

Image 49: Passenger survey S7 Remscheid main station (at the time of the event, traffic only from/to Wuppertal)

Routing of bicycle traffic, bike racks

Bicycle traffic was not considered separately due to the relatively low use of bikes in Remscheid.

Experience

Occasionally, bikes were locked to trees or similar in front of the concert site, but this did not significantly impair access.

Image 50: Incorrectly parked bikes near the concert site

Guidance of pedestrian traffic

Pedestrian traffic destinations were signposted by the event organiser.

Image 51: Signposting at the bus stop (left) and at the train stop (right)

Experience

- Thanks to the buffer zones set up, concertgoers were able to get from their vehicles to the concert site without any major disruptions.
- The admission situation was not critical at any time.
- Numerous families with younger children left the grounds at about 8.40 pm while the stage re-set.
- New spectators arrived later on for the main act, Mando Diao, but the arrival traffic was less than the departure traffic, meaning the capacity of the concert site was sufficient.

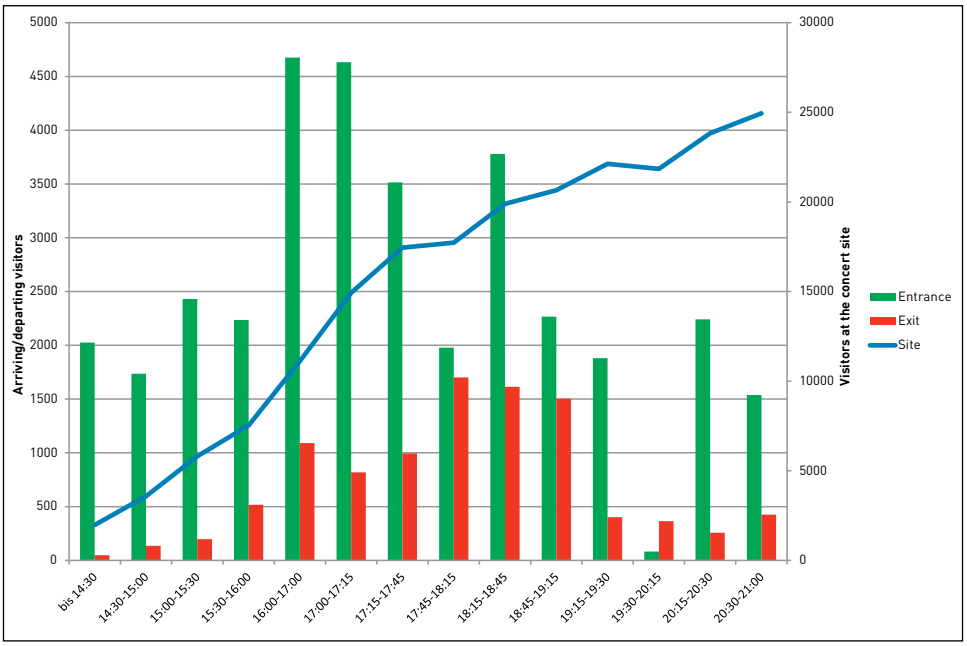

Image 52: Count at the concert site (source: WDR mediagroup GmbH, own chart)

Special use of public traffic areas

- Establishment of the local resident zone (red) and a car-free zone (yellow/green) to provide sufficient space for pedestrian traffic and as buffer zones in the event of tailbacks in front of the concert site
- Closures and diversions at 10 junctions around the concert site zone
- Various diversions to ensure accessibility (also for the fire service).

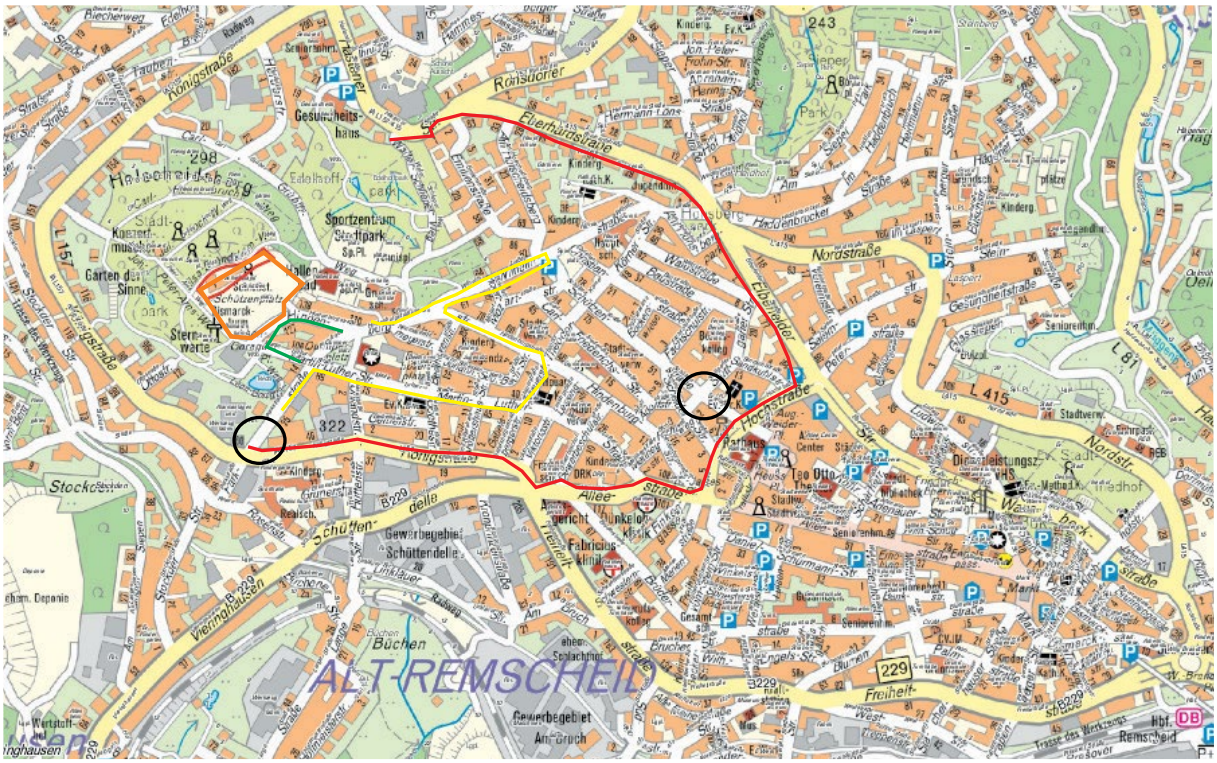

Image 53: Establishment of buffer zones around the concert site (source: City of Remscheid)**.**
Orange: concert site,
Black: search points,
Green: core area (no access for vehicles),
Yellow: 1st buffer zone (no access for vehicles, except emergency services and event logistics)

Experience

- Closures must be clearly communicated to local residents and people travelling to and from the venue
- Draft of comprehensible information plans, information put out via local radio, television, daily newspapers, programme booklets and websites
- Local residents must also be informed personally in advance (flyers)
- Acceptance of closures and obstructions was high among local residents.

C 2.4 Romantic Christmas market Lüntenbeck, 2013

Key data

The Christmas market took place on Saturday and Sunday from 11 am. to 7 pm on two weekends leading up to Christmas. Surveys and traffic surveys were carried out on the Sundays (8 and 15 December 2013). On 15 December 2013, there were some light rain showers in the morning, after which it cleared up. This was also reflected in the number of people arriving.

Image 54: View of the Christmas market in the castle grounds (left and right)

Image 55: Event location and surroundings

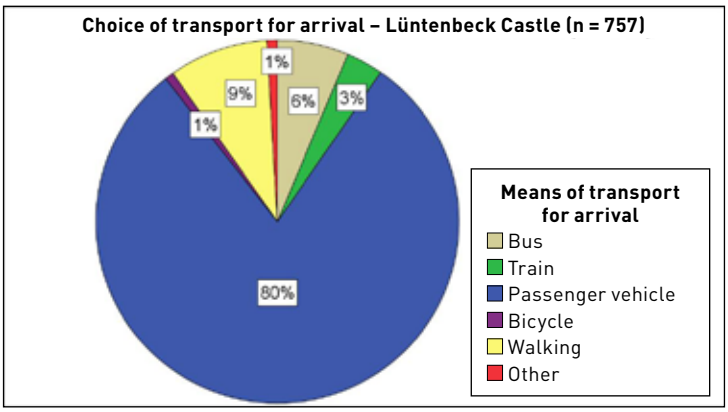

Image 56: Survey on the choice of transport, 8/15 December 2013

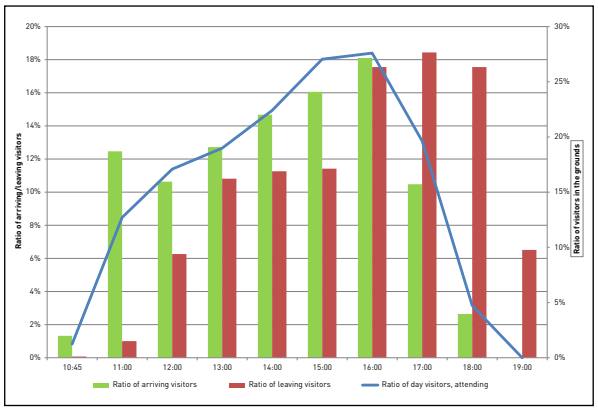

Image 57: Daily load curve, all entrances, 8 December 2013

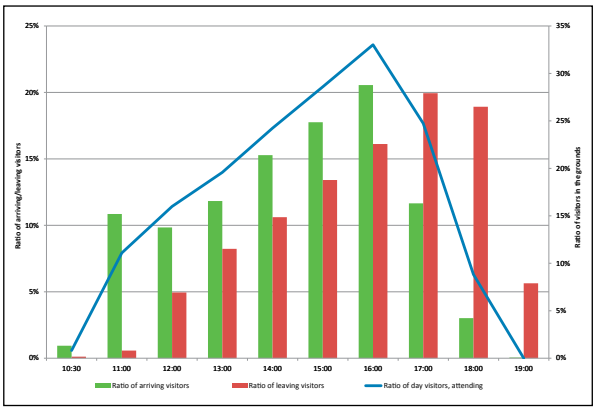

Image 58: Daily load curve, all entrances, 15 December 2013

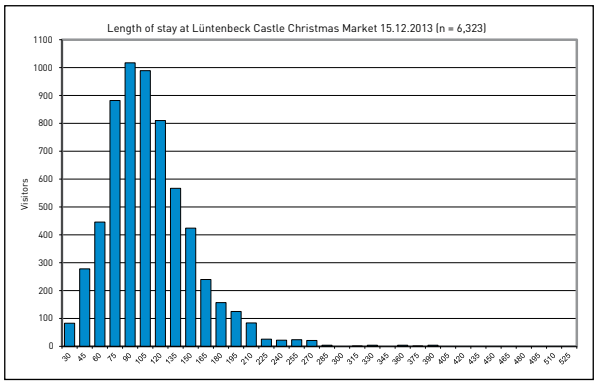

Image 59: Length of stay at Lüntenbeck Castle Christmas market, OS-CAR method, 8 December 2013

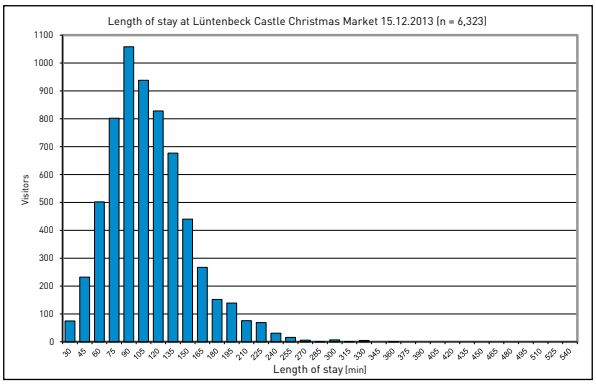

Image 60: Length of stay at Lüntenbeck Castle Christmas market, OS-CAR method, 15 December 2013

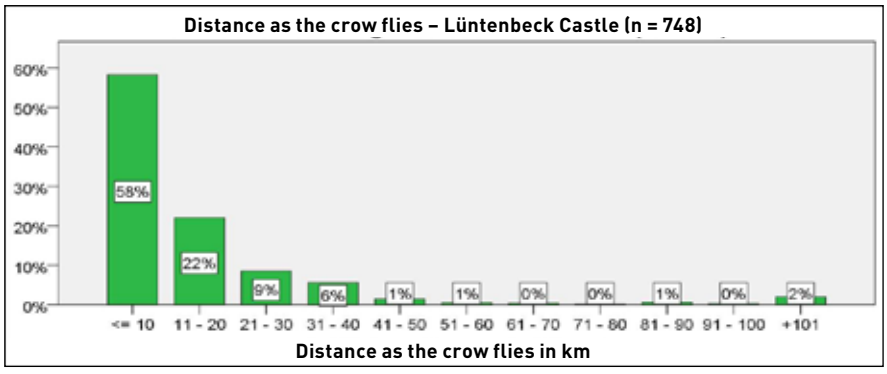

Image 61: Distance as the crow flies from survey to place of residence, 8/15 December 2013

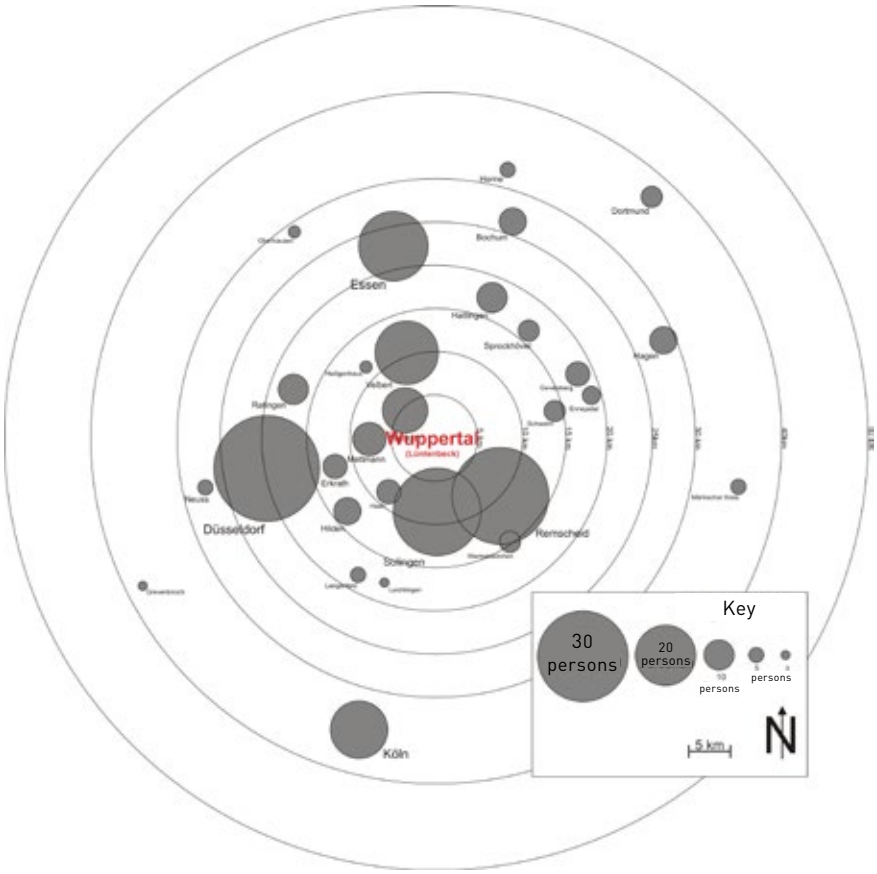

Image 62: Regional allocation of people travelling to the market (n = 740, n (town/ district) > 3, excluding Wuppertal – n = 372), from survey, 8/15 December 2013

Challenges

Relocation of the established event car park to a site approx. 1 km away from the event location.

Organisation of the planning

- Signs indicating the car park at the access route from the main road
- Closure of access road to the castle/surrounding residential area from the main road.

Parking bays/parking facilities

- Business premises used as an official car park
- Other companies take the opportunity to manage their parking areas without consultation with the organiser.

Image 63: Access to the car park and car park area

Image 64: Sign and access road to the car park

Experience

- Car park signs were removed overnight by unknown persons
- Car park was well accepted despite being further away from the event
- Some people travelling to the event had problems finding the car park
- 34.9 m² were required per vehicle, meaning it was possible to accommodate 2.87 vehicles per 100 m² of space.

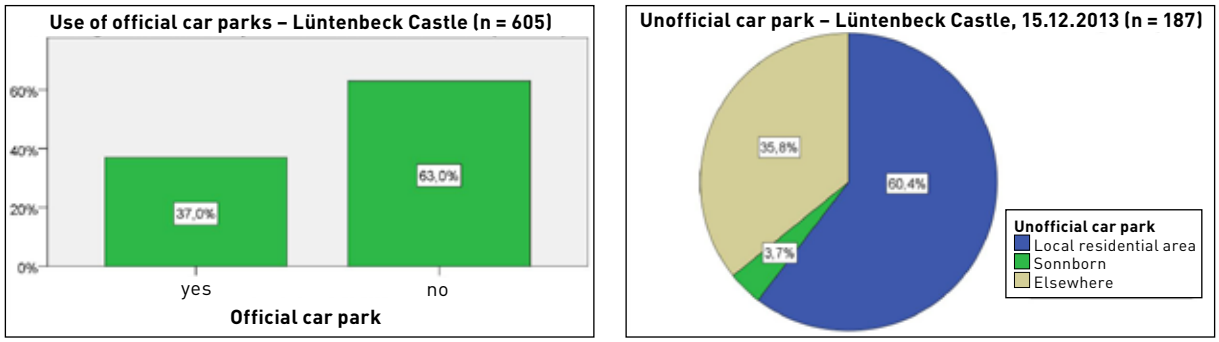

Image 65: Use of official car park (left) and unofficial parking facilities (right) from survey, 8/15 December 2013

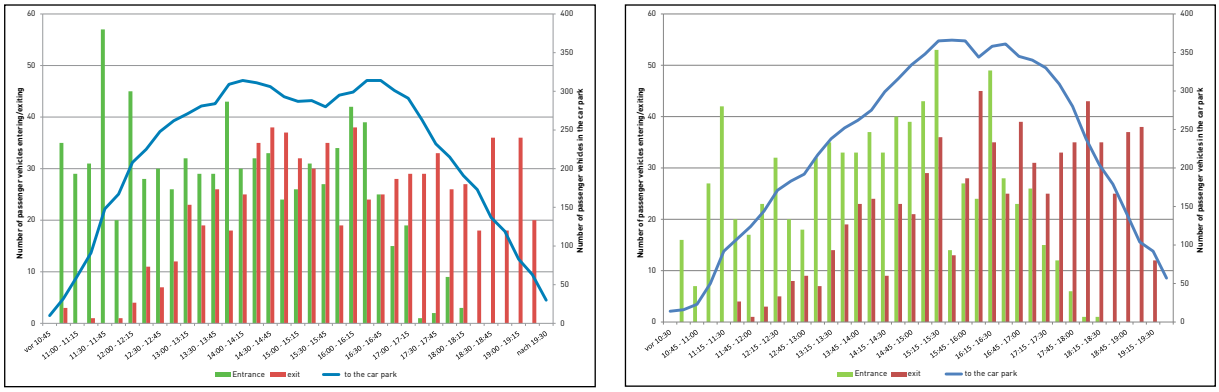

Image 66: Load curve for event car park, 8 (left) and 15 December 2013 (right)

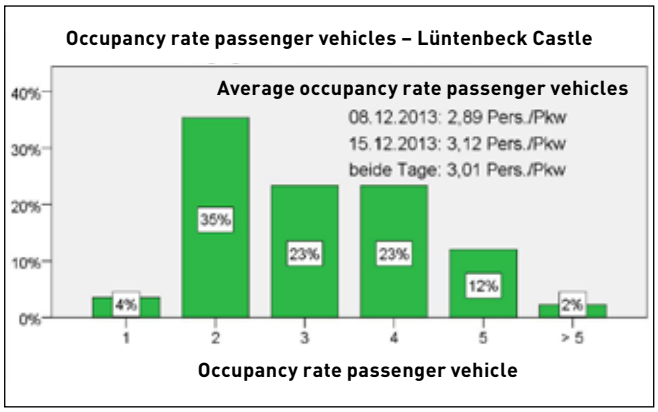

Image 67: Occupancy rate of passenger vehicles from survey

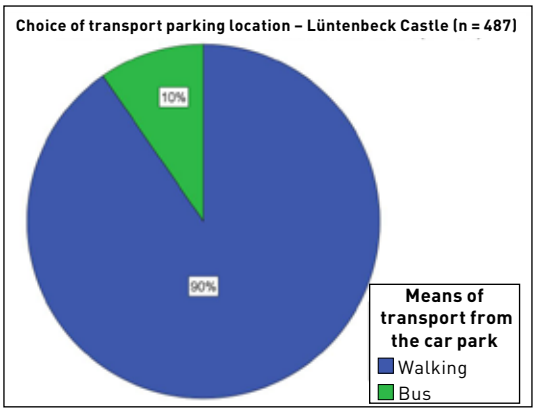

Image 68: Choice of transport from the official car park to the event site from survey, 8/15 December 2013

Public transport services and demand, fare structure

- Sale of combined tickets via online ticket centre (admission and use of public transport included) as an innovative development
- Additional buses on the regular bus route (connection to the nearest local district and car park).

Experience

The capacity utilisation of bus route 629, which ran unscheduled between Sonnborn and Lüntenbeck every 15 minutes, fluctuated greatly. Overall, however, the bus route was well received. However, some departing passengers had difficulty finding the departure stop after leaving the Christmas market, as this was not the same as the arrival stop and could not be seen from the arrival stop. There was no signposting available.

The bus route ran until 7 pm (official end of the event). As a timetable was only displayed at the special stop on the second weekend, many people leaving were unaware of the time of the last bus, which meant that some people who left the Christmas market at the very end or shortly afterwards were left waiting for a bus that was no longer running. The bus ran approximately every 15 minutes, but the departure times according to the timetable were rarely adhered to.

Guidance of pedestrian traffic

There were two possible routes from the car park to the Christmas market: through Nordbahntrasse or via the former landfill site. The routes were well signposted and lit, especially on the second weekend, although the signposting was not particularly rich in contrast due to the dark green signage.

Image 69: Signposting from the car park (left 8 December, centre/right 15 December)

Image 70: Hazard point at tunnel in Nordbahntrasse (left), footpath to the castle (right)

Image 71: Additional stop at the car park (left) and departure stop at Lüntenbeck Castle (centre, right)

C 2.5 Experiences from the planning and previous implementation of the Wildpark football stadium in Karlsruhe

Background

The plan is to rebuild Wildpark Stadium in Karlsruhe on the same site, and a traffic plan was prepared as part of the planning process. This process involved carrying out numerous traffic surveys and gaining knowledge and experience from other stadiums. The key findings are to be made available here for comparable planning. Concert events, for example, are seen as comparable in terms of traffic planning, as they take place over a similar period of time, with spectators travelling to the stadium over a period of several hours and departing over a very short period of time.

Key data

- Stadium for 30,000 people
- Location close to the city centre
- Not directly accessible by motorway or rail-based public transport
- Construction of large car parks is not an option due to restrictions (forest). In practice, parking is permitted on neighbouring roads and tolerated on numerous forest paths.

Image 72: Location Wildparkstadion (base map: OpenStreetMap contributors)

Planning process

All relevant administrative departments were represented in the planning team. Joint meetings were held frequently, often together with external stakeholders such as the executive committee of the football club, fan group representatives and local councillors. The discussions were controversial but constructive. Joint excursions to other stadiums, for example, were also organised. This created mutual trust, which ultimately led to a constructive planning process.

Planning process experience

Most participants agree that this working atmosphere contributed more to a consensus-based result than purely technical work.

Parking

- Permitted parking is free of charge and can be found in the immediate vicinity of the stadium.
- At most match days, the motorised individual traffic ratio was around 70%.
- The occupancy rate is 2.1 – 2.2 pers/passenger vehicle.

Experience with parking

- Car park management increases the occupancy rate: In comparable stadiums with controlled car parks, the rate is 2.8. The amount of space required for parking can thus be reduced.
- Communicated shortage of parking areas influences the choice of means of transport: It is well known that parking is particularly scarce during matches against FC Kaiserslautern, which are always well attended. Even without further measures, the motorised individual traffic ratio for these matches was only 43%, with an occupancy rate of 2.3.

Traffic flow at the end of the match

The control of pedestrian and motorised traffic after the end of matches is a challenge for the police and road construction and maintenance authorities. The peak is particularly pronounced in motorised traffic, as the car parks are located in the immediate vicinity of the stadium and therefore many spectators get back to their vehicles and drive off at the same time. In stadiums with directly adjacent car parks, it also takes longer for car parks to empty.

Experiences with the traffic flow after the end of the match

In addition to a (communicated) shortage of parking areas, a decentralised organisation of the offer contributes to a temporal decrease in peak traffic after matches: Spectators take different lengths of time to reach car parks at varying distances from the stadium, and the outflowing motorised traffic is distributed over a longer period of time.

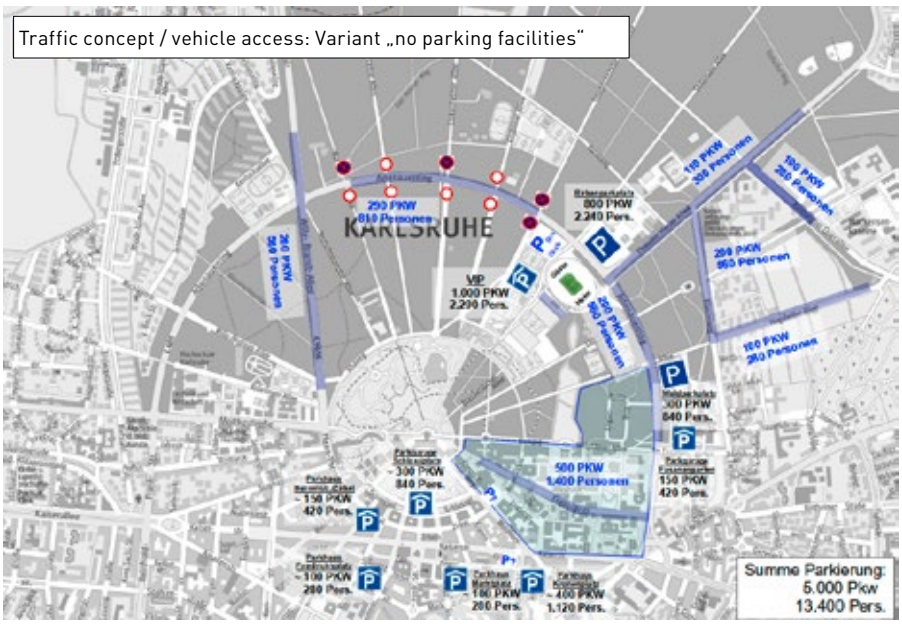

Image 73: Decentralised parking concept (source: City of Karlsruhe)

Public transport

A regular criticism of Wildpark Stadium is that it does not have a separate rail public transport link. This is true insofar as the nearest stop, which is served by almost all metropolitan rail services, is almost 1 km away. In comparison, the Allianz Arena in Munich is considered to be well linked to the public transport system. However, the nearest stop at the Allianz Arena is a 1.3 km walk from the stadium exit.

Experience of local public transport

Especially after matches, fans may have an increased potential for aggression. Public transport vehicles that pick up passengers directly in front of the stadium are often severely damaged by them. For example, the stop nearest to the stadium in Mainz is roughly 900 metres from the exit for this reason.

C 2.6 Day of German Unity, Frankfurt am Main, 2015

Source: Planning of transport measures
Client: traffiQ Lokale Nahverkehrsgesellschaft Frankfurt am Main mbH
Contractor: AS+P Albert Speer + Partner GmbH

Key data

- Friday, 2 October to Sunday, 4 October 2015 in Frankfurt am Main
- 25th anniversary
- Event location: the entire city centre of Frankfurt
- Ländermeile (state mile) and citizens festival
- Interfaith service in the cathedral
- Ceremony in the Alte Oper
- Evening production on the Main/on a bridge over the River Main
- Concert stages at Opernplatz and at Hauptwache
- Sunday shopping
- Expectation: 1.4 million visitors, 700,000 of them on 3 October.

Challenges

- Long set-up and dismantling phases with closures of important traffic routes (24 days in total)
- Management of everyday traffic, securing deliveries in the city centre, diversion of local public transport even during the set-up and dismantling phases
- Time overlap during the set-up phase with a large-scale trade fair event (International Motor Show (IAA)) and a professional football match
- An incalculable number of attendees, especially at the FFH stage in front of the Alte Oper (free admission concerts by CRO, Sarah Connor, Roger Cicero plus many more)
- Extremely high number of attendees, especially on Saturday night for the evening production on the River Main
- Service in the cathedral and ceremony in the Alte Oper with a large number of attendees.

Organisation of the planning

Two working groups were formed to plan the transport issues, which met once a fortnight.

The members of "IV" working group were

- Hessian State Chancellery (and commissioned event agency Roth&Lorenz)
- State police
- Public order office
- Fire planning authority
- Road traffic office
- Office for Road Construction and Development
- traffiQ (local public transport company Frankfurt am Main), "Transport" coordination centre.

The members of the "Public Transport" working group were:

- State police
- German federal police
- Rhine-Main Transport Association (RMV)
- DEUTSCHE BAHN AG
- Frankfurt am Main Traffic Company (VGF)
- traffiQ (here dual function as local public transport company and as "Transport" coordination centre).

Experience

- All parties involved must be fully involved at an early stage.
- There needs to be a central coordination centre that is, if possible, set aside from day-to-day business for this task and that in any case has good contacts within the administration.

Planning aspects

- No demand-orientated traffic concept, not least because demand was almost impossible to calculate. Instead: supply-oriented concept with a focus on optimising the organisation of public transport in particular
- Special use of public traffic areas and its impact on motorised individual traffic and public transport
- Long-lasting closure of important transport axes
- Parking facility capacity/parking facilities
- Public transport services (regional trains, suburban trains, underground trains, trams and buses) and attractive fares
- Routing of bicycle traffic, bike racks
- Footpaths and waiting zones
- Taxi services, coach traffic, event logistics
- Protection of local residents, deliveries, care services, supply and disposal.

Experience

- Close networking of topics, some overlaps; interfaces have to be observed.
- In addition, close links with the following aspects:
  - Escape and emergency routes, evacuation areas, set-up areas for emergency services
  - Safety zones, closures of traffic areas, underground stations and car parks due to the large number of people that need to be protected
  - Communication concept
  - Ongoing road construction measures by the city.

Parking bays/parking facilities

- In the immediate vicinity: up to 8,800 parking bays in public car parks
- In the wider area: 2,900 parking bays in public car parks
- Multi-storey car park at the trade fair centre: 4,500 parking bays (open on all three days, additional bus route 50, daily fare: €12),
- P+R sites: 2,000 parking bays in the region
- Parking areas for security staff
- Note: Car parks partially inaccessible, car parks partially closed for safety reasons, which had to be communicated via the parking guidance system, among other things.
- Coordination of routing on the motorway network with Hessen Mobil.

Experience

- Through intensive communication, most people travelled by local public transport; multi-storey car park occupancy in the city centre was only 50% – 80%
- Multi-storey car park at the trade fair was only used by 300 passenger vehicles; the fees for multi-storey car park usage and the need to switch to local public transport were apparently too unattractive.

Public transport services and demand, fare structure

- Discounted Rhine-Main Transport Association RMV event ticket (three days for the price of one)
- Intensive promotion of the use of public transport "via all media channels"
- Additional transport of all routes, also in the evening and at night
- Additional stewards and security staff.

The following had to be taken into account:

- Underground stations partially closed for security reasons
- Tram lines ("Altstadt route") out of service due to "red carpet" around St Paul's Church and the cathedral
- Diversions of bus and night bus services due to the city centre closures.

Experience

- Very high ratio of attendees travelling by bus and train due to intensive promotion of regional rail transport and local public transport
- Particularly high demand for the evening production on the River Main.

Routing of bicycle traffic, bike racks

- Five additional bike parking spaces around the event areas with approx. 700 parking spots at mobile parking facilities
- Intensive communication (event booklet, various websites, app, German Cyclists Association (ADFC)), but no additional signage/guidance.

Experience

- Bike parking facilities were accepted to varying degrees, cyclists are not prepared to take even slightest of detours to the nearest parking facility.
- The incorrect parking of bikes, especially in escape routes, was largely prevented.

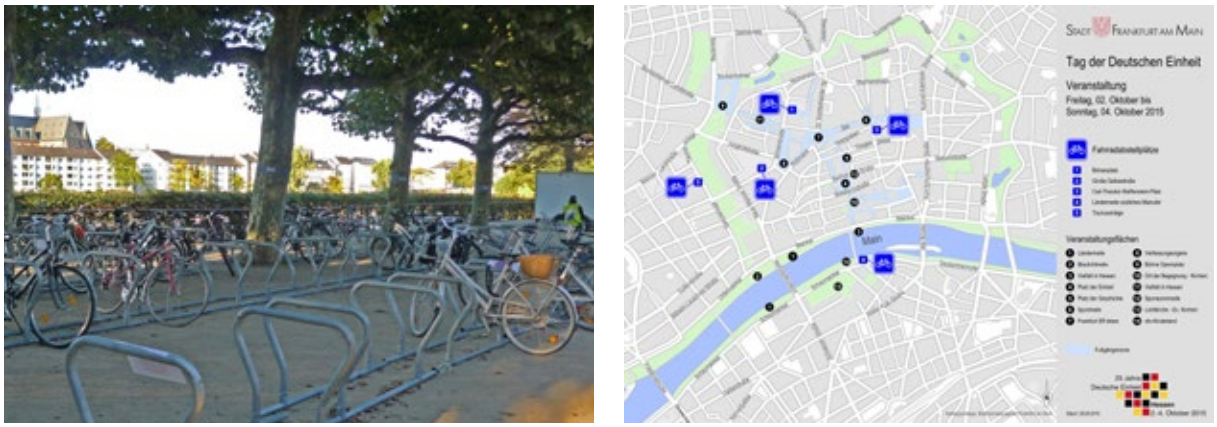

Image 74: Bike racks (photo: AS+P, Site plan: traffiQ/AS+P)

Guidance of pedestrian traffic

- Pedestrian destinations were signposted by the event organiser
- Numerous guides provided information
- 40 "Frankfurt ambassadors" from the administration were trained and deployed
- Bridges are notorious bottlenecks, crowd flow management.

Experience

- Overcrowding of concerts was prevented by instant app messages; therefore no impact on neighbouring streets beyond the barriers that were installed anyway
- The guidance of pedestrian traffic at Eisener Steg bridge was helpful, nevertheless: Bridge exits were overloaded due those arriving or departing stopping and not walking.

Image 75: Guidance of pedestrian traffic (photos: AS&P)

Taxi services

- Taxi ranks located within the event or logistics areas could not be accessed
- Maximum possible expansion of existing taxi ranks not affected by the event.

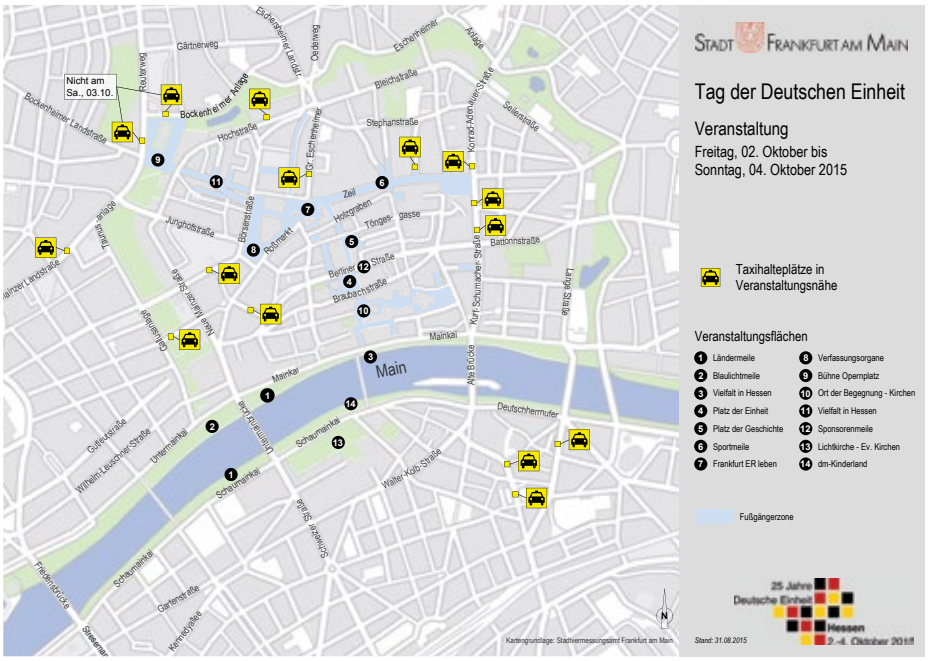

Image 76: Taxi services (site plan: traffiQ/AS+P)

Experience

There were no complaints, neither on the part of the taxi association nor on the part of arriving or departing pers/taxi customers.

Coach traffic

- 250 special parking bays for coaches at the Eissporthalle festival site (motorway connection and underground railway connection, fees: €50/coach/day)
- Continuous signposting to the car park already from the motorway
- In addition to coaches travelling to the event, approx. 80 "normal" tourist coaches are also expected in Frankfurt at weekends; most of their usual drop-off/pick-up zones could not be accessed.

Experience

- Poor utilisation of the special parking bays for coaches (five coaches in three days); it is unknown how and where the coaches were organised and allocated
- There were no known traffic obstructions due to coaches stopping, parking or turning.

Image 77: Signposting to parking facilities
(graphic: trafficQ/AS+P)

Delivery traffic and event logistics

- Due to the extensive closures, delivery traffic in Frankfurt city centre was severely impacted
- Parking areas for approx. 100 trucks during the entire set-up and dismantling period on the outskirts of the city centre.

Experience

- Limited time flexibility for deliveries to shops due to very limited storage space, i.e. many city centre shops are dependent on almost daily deliveries
- Access for parcel services difficult or even impossible at times
- Logistics for local residents and the event must be well planned, e.g. fixed delivery windows, compliance with which is also monitored
- City centre shops and service providers must be informed in advance (e.g. via the Chamber of Industry and Commerce/Chamber of Crafts).

Special use of public traffic areas

- Parts of the city centre and an important bridge over the River Main were closed for up to 24 days due to the extensive set-up and dismantling phases
- Checklists to document the planning status
- Closure plans for five different set-up and dismantling phases
- Additional closure plans for five different event phases
- 48 city centre junctions were impacted by the closures
- A road closure and signage plan was drawn up for each junction in addition to the documentation, including effects on traffic lights.

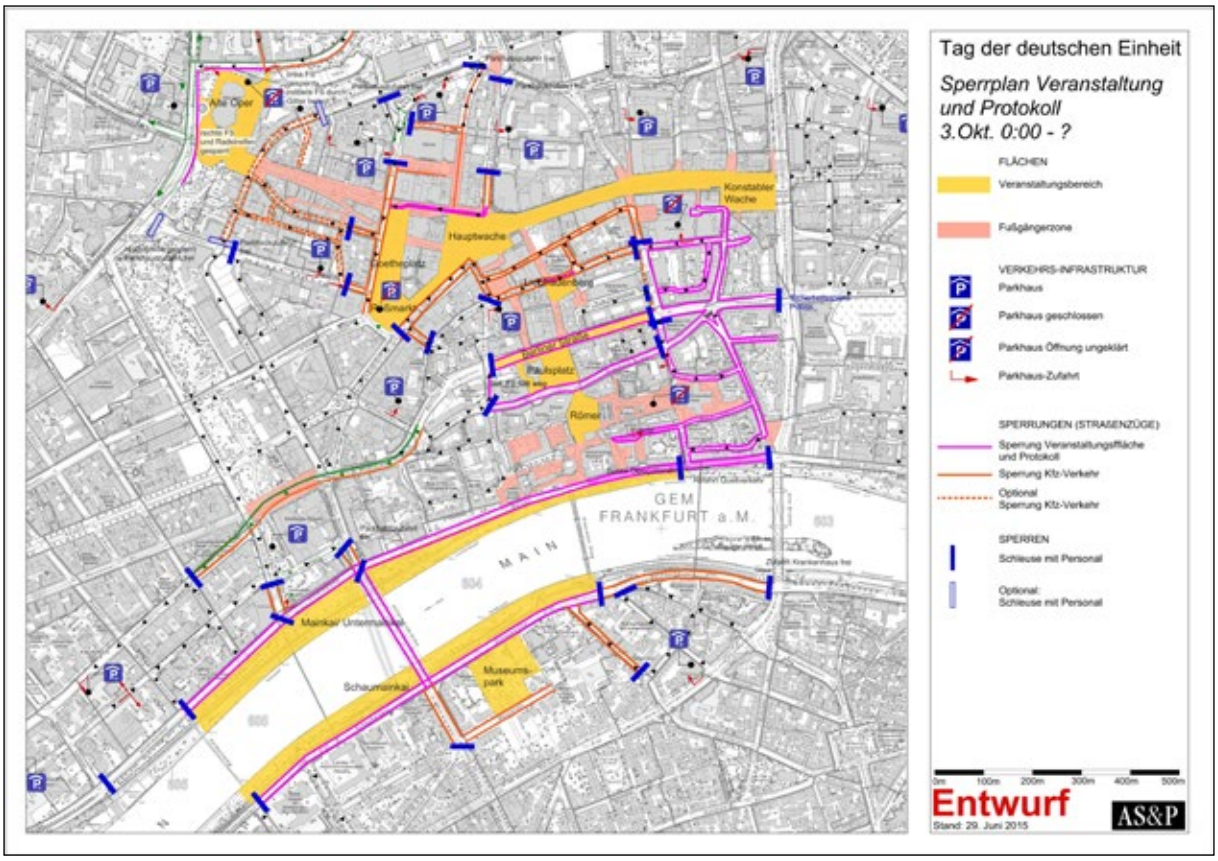

Image 78: Closure plan (graphic: traffiQ/AS+P)

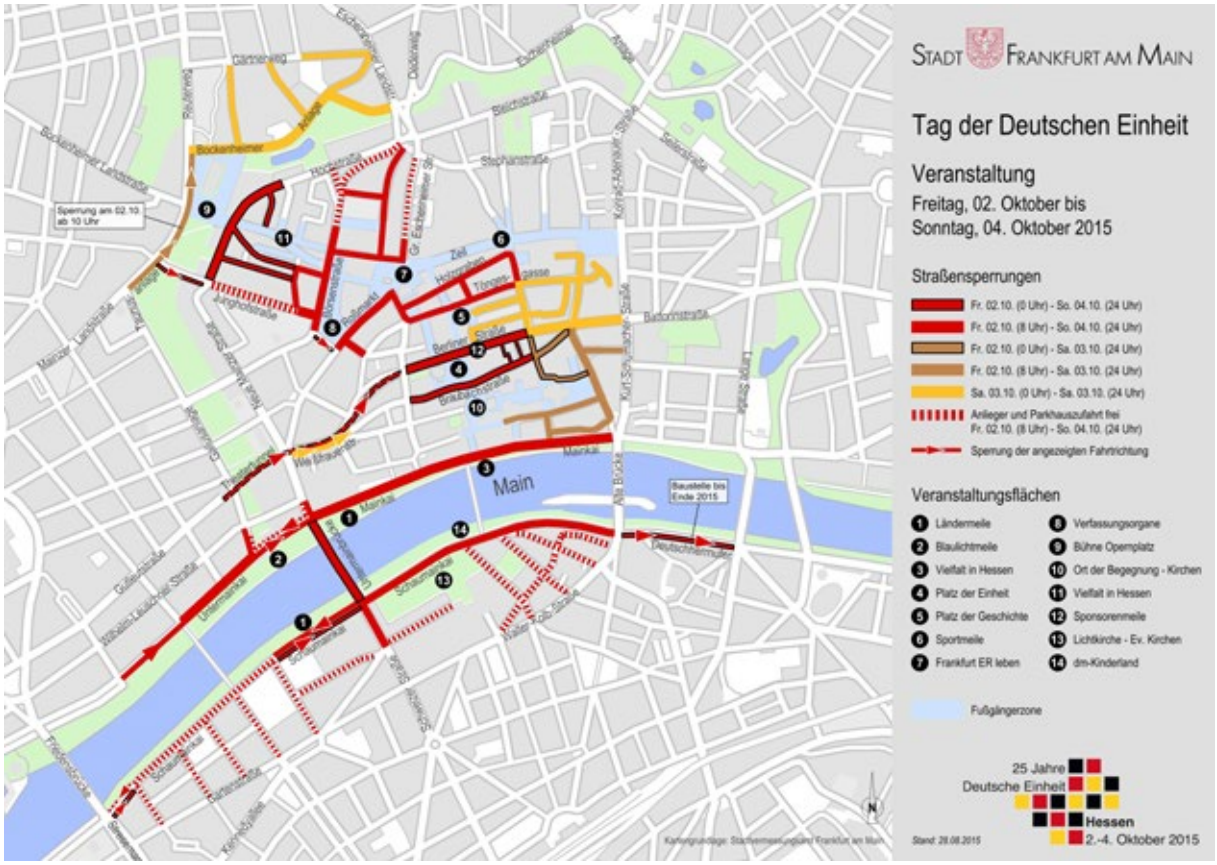

Image 79: Event areas (graphic: traffiQ/AS+P)

Experience

- Precise planning of the set-up and dismantling work was carried out at relatively short notice and was frequently changed afterwards, 13 revisions of the road closure plans were needed in total
- Large-scale utilisation of road space
- Extensive, detailed coordination with the Hessian State Chancellery, among others
- Closure plans and checklists were urgently required to maintain an overview and to document agreements
- Concept: As little additional signage as possible, no diversion signage as there are too many different destinations and routes
- Different closure phases must be clearly communicated to local residents and people travelling to and from the event
- Important: Draft of comprehensible information plans, information put out via local radio, television, daily newspapers, programme booklets, websites and app)
- Local residents must also be informed personally in advance (flyers, info box on the Zeil)
- Acceptance of closures and obstructions was high, very few complaints
- Consider dynamic security situations (e.g. demonstrations).

Experience from operations

- Stewards are required at all road closures, sometimes 24 hours a day
- Although stewards are to be provided by the event organiser, support from state police and/or municipal traffic police is essential at important junctions
- Clear regulations for special cases at the closures must be defined in advance (e.g. removal vans, care staff, deliveries, market operations)
- It is better to close off more generously in terms of space and time ...
  ... in order to have to communicate as few different closures as possible
  ... to have a buffer for unforeseen area utilisation and
  ... to have room for manoeuvre with regard to safety measures.

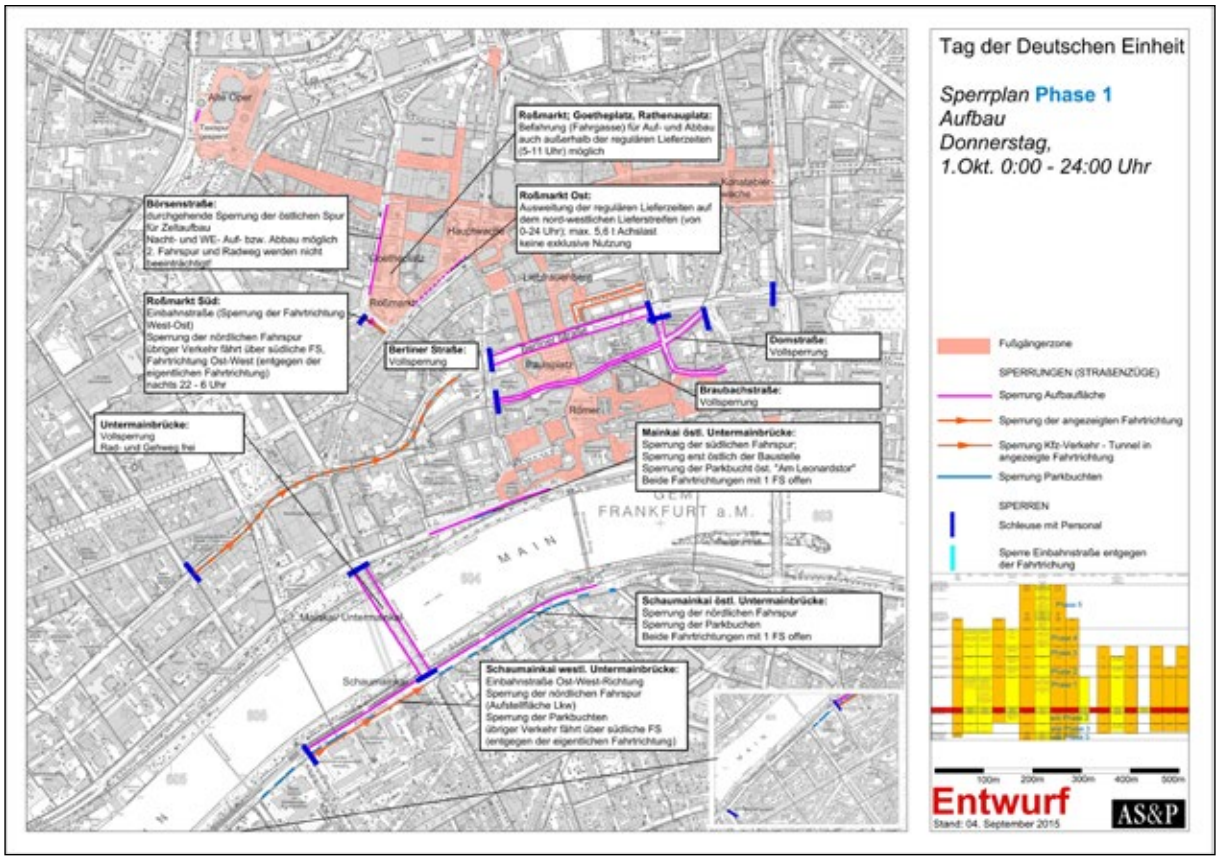

Image 80: Layout plan for barriers (graphic: traffiQ/AS+P)

C 3 Experience with crowd management

C 3.1 Crowd management and avoiding high crowd densities inside a multifunctional arena

Task

The interior of a multifunctional arena where music events are to take place should be divided into two sub-areas. The front area near the stage, in which a catwalk was integrated, was separated from the rear area by a barrier line. The standing areas at the front were more expensive and sold out. Separate security search points had to be set up for the front area. The regular entrances to the interior were located halfway along the length of the hall (Figure 81). It should be possible to fill both areas of the interior in a reasonable amount of time.

Image 81: Entrances to the interior (source: Bernd Belka, Special Security Services Deutschland)

Problem situation

The barrier line narrowed the entrances to the interior. Conducting security searches and checking the two types of ticket at or just behind the entrances would likely result in long waiting times, significant tailbacks and blockages (see Figure 82).

Image 82: Examples of barriers at entrances to the front area of an interior (left) and to the interior (right) (source: Bernd Belka, Special Security Services Deutschland)

Solutions

The problem was successfully overcome by segregating the respective crowd flows to the front and rear areas, thus separating them in advance of the entrances.

For this purpose, a 1-m-wide safety aisle was installed on the side walls of the interior in the rear area of the interior (see Figure 83, marked in red). The boundaries of the safety aisle were marked on the hall floor with contrasting adhesive tape.

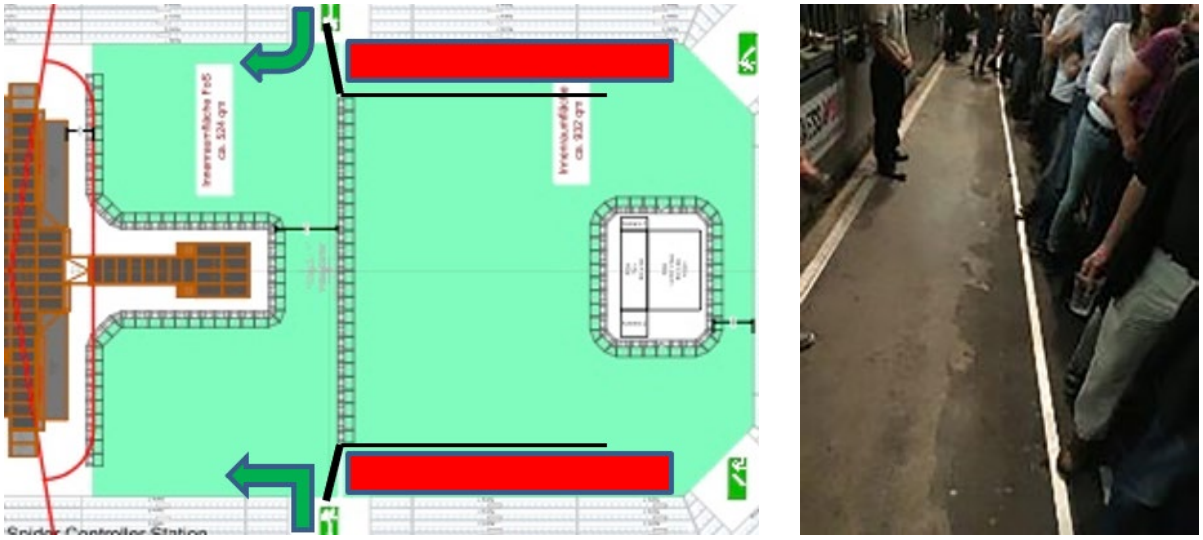

Image 83: Security aisle at the rear area of the interior (source: Bernd Belka, Special Security Services Deutschland)

The security aisles became movement areas or transfer routes where people were not allowed to stand. Stewards used the floor markings to guide people through the hall, ensured that the safety aisles were kept clear, explained the system and provided assistance if anything was unclear.

A one-way system was then set up to fill the rear area (see Figure 84). The circulation aisles in front of the entrance doors to the interior were used for this purpose. Stewards were deployed at the interior doors and only authorised persons were admitted to the area near the stage by means of a ticket check. People with tickets for the rear area were diverted. People in the rear area were allowed to leave this area via the security corridor that had been set up.

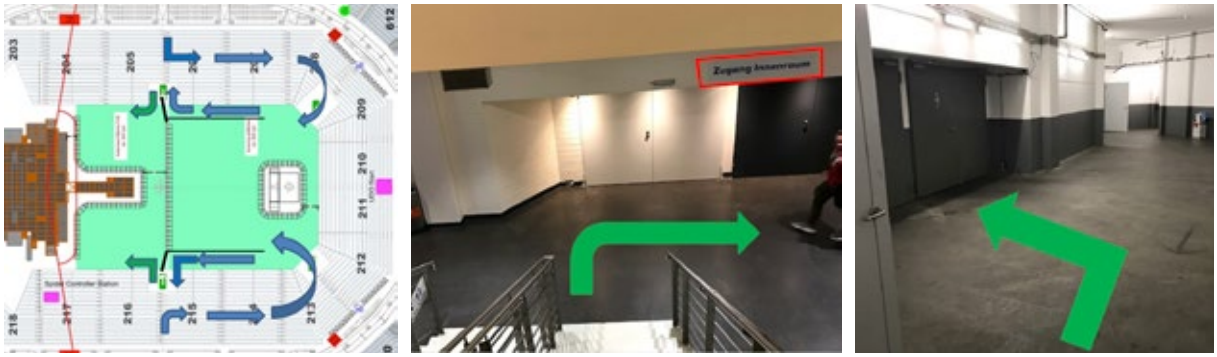

Image 84: One-way system for the rear area of the interior and segregation of the security search points (source: Bernd Belka, Special Security Services Deutschland)

Result

As a result, all entrances remained free of tailbacks at all times. All emergency exits were usable at all times. Figure 85 gives an impression of the situation in the interior during the event.

Image 85: Situation in the interior during the event (source: Bernd Belka, Special Security Services Deutschland)

C 3.2 Guidance of arriving persons with "early entry" access authorisation to specially assigned public areas

Task

At events, groups of people may gain earlier access to the public areas than other people. This allows them to occupy a better position, especially at events with public areas in front of stages or stage areas, because they are closer to this stage area.

This access authorisation - known as "early entry" - is limited to a set number of guests by the event organiser and offered as a separate access authorisation. Early entry access authorisations are usually expensive and are usually purchased by highly motivated fans of the artist.

The number can range from a few to several hundred people.

With the purchase, people usually receive a meeting time and a rendezvous point in the outdoor area of the event. From there, they should then be guided into the event area at a set time.

The high level of motivation can also lead to high dynamics and hazards in small groups of people. In this respect, the persons authorised to enter must be guided and accompanied to the areas assigned to them.

Solutions

The guidance of authorised persons must be planned in detail in advance. The planning includes

a) the selection of the rendezvous point and the meeting time,

b) the material design of the waiting zone at the rendezvous point,

c) personal care and management by stewards,

d) detailed information on the procedure for admission to the public areas,

e) the detailed routing to the target area.

Planned and implemented measures are discussed below using an example (event: Depeche Mode; event location: Gelsenkirchen, Veltins-Arena; number of people with "early entry" access authorisation: 180)

About a): Individuals with access authorisation were directed to a designated ticket office near the arena at a specified time

About b): After a positive ticket check, the individuals with access authorisation were directed to a crowd guidance system. For this purpose, a narrow, approx. 1.50 m wide waiting zone (Figure 87) was created in the form of a linear queueing system.

About c): A sufficient number of stewards were recruited and deployed with sufficient advance notice.

About d): Detailed information and instructions for action were given to all stewards involved and to those waiting.

About e): The securing of the route to the assigned area and the timely positioning of the material used was planned in advance (Figures 86 to 91).

On the day of the event, it is important that the crowd guidance speed is determined by the stewards to counteract the high dynamics that would otherwise arise. A narrow width of the waiting zone and the crowd guidance system offers good control mechanisms.

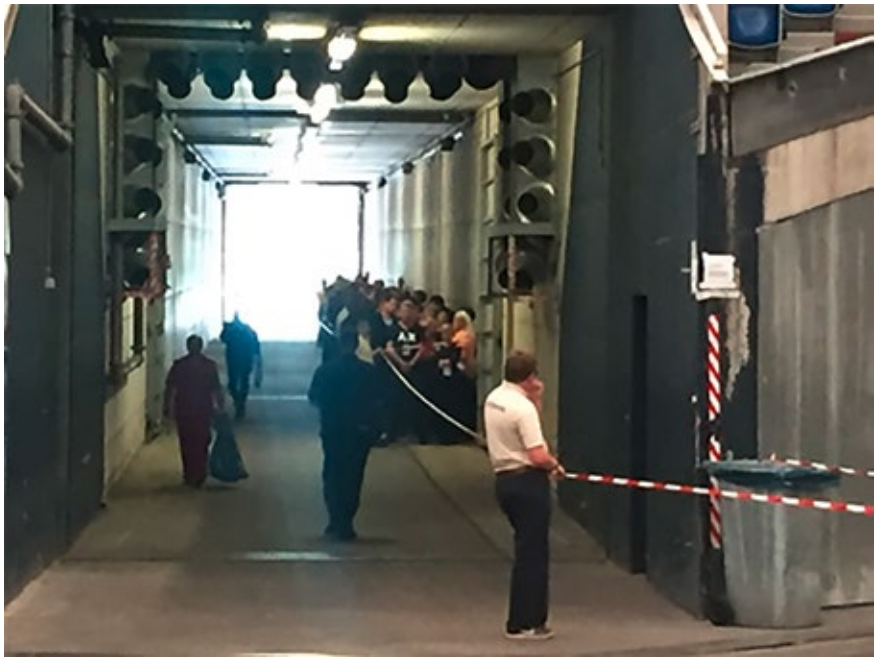

Image 86: Waiting zone for authorised persons ("early entry")
(source: Bernd Belka, Special Security Services Deutschland)

The material used was barrier tape as a spatial boundary, which was held in place by stewards. Stewards also provided those waiting with suitable and sufficient information to help ensure their health and safety.

Image 87: People waiting in the waiting zone cordoned off by barrier tape and stewards (source: Bernd Belka, Special Security Services Deutschland)

From a predetermined time agreed with all those involved, the waiting fans were guided in a controlled manner via a demarcated crowd guidance system to the designated area of the public area.

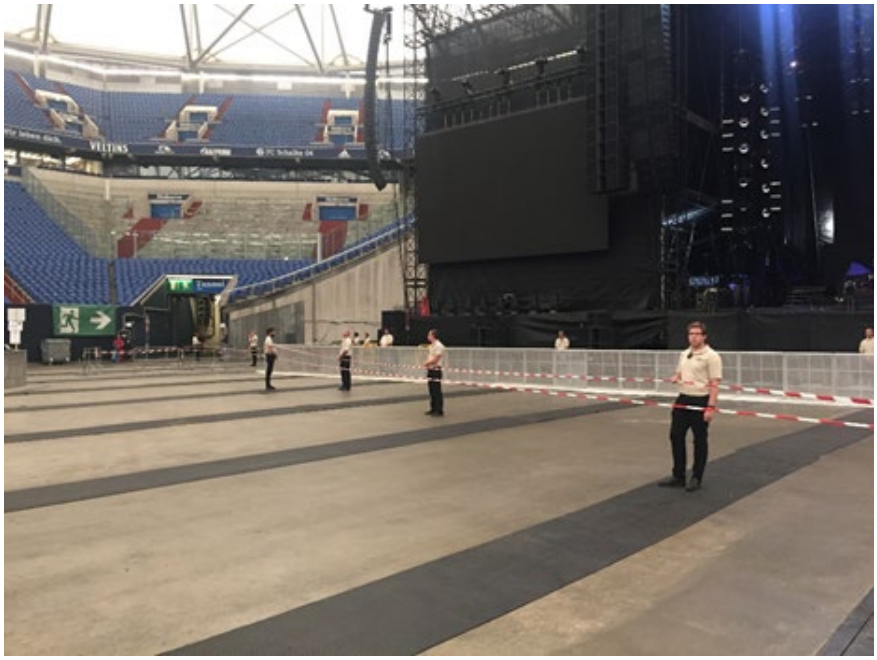

Image 88: Crowd guidance system cordoned off by barrier tape and stewards
(source: Bernd Belka, Special Security Services Deutschland)

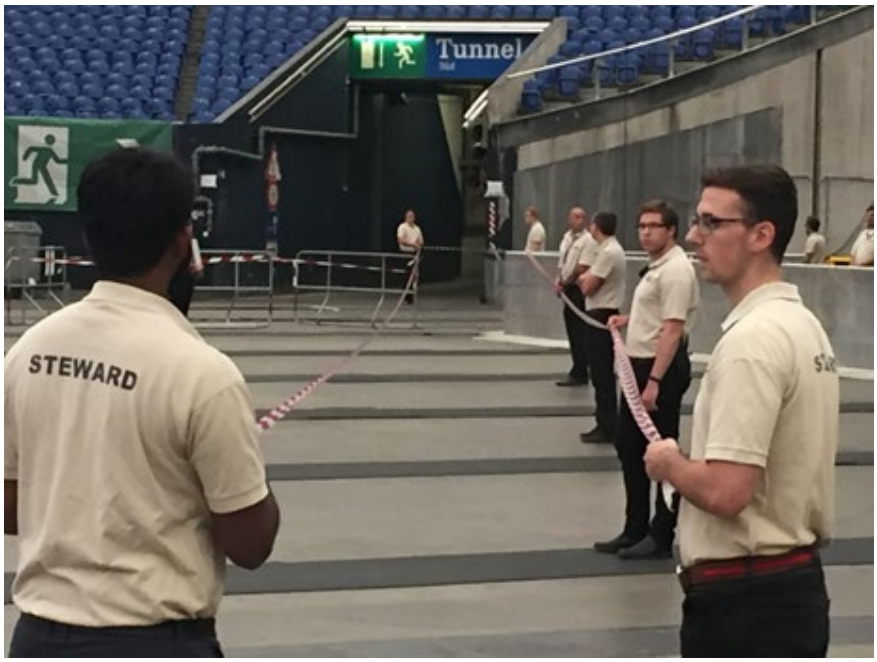

Image 89: Crowd guidance system cordoned off by barrier tape and stewards
(source: Bernd Belka, Special Security Services Deutschland)

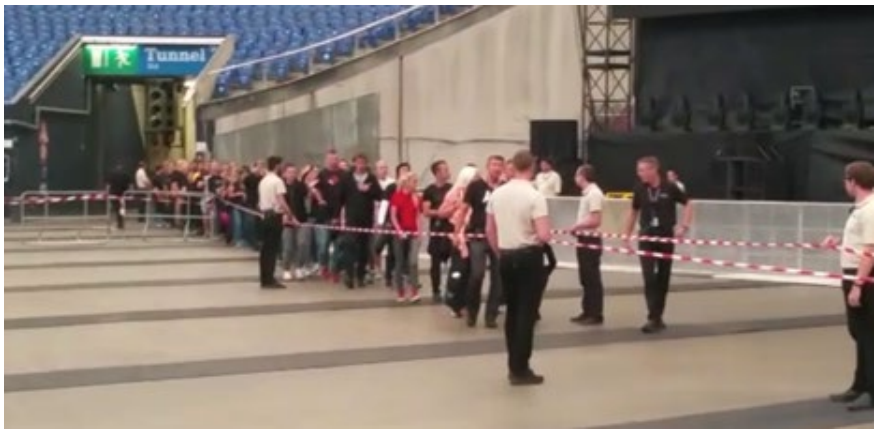

Image 90: Controlled guidance of people via a cordoned off crowd guidance system to the designated area in the public area
(source: Bernd Belka, Special Security Services Deutschland)

After leaving the crowd guidance system, the guests were able to find an ideal spot in the stage area.

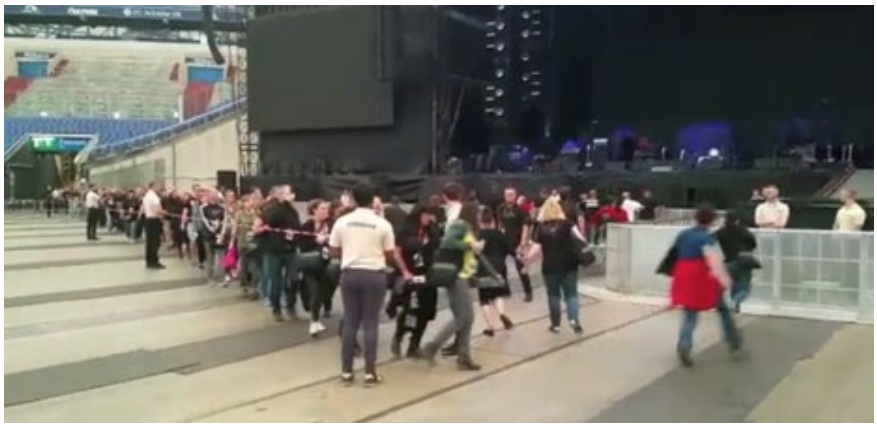

Image 91: People finding their spot at the end of the crowd guidance system in the front-of-stage area
(source: Bernd Belka, Special Security Services Deutschland)

C 3.3 Checking capacity by counting individuals and tagging individuals in non-seated public areas

Task

In non-seated areas of the event, it may be necessary to carry out capacity checks to ensure that the number of people attending at the same time in segregated public areas is not exceeded. In large areas in particular, high crowd densities should be avoided through the subdivision of spectators into several separate areas, for each of which the number of attendees must be determined individually. For events with ticket sales, the capacities of the individual areas are limited by the corresponding number of tickets available per area.

Solutions

When entering a segregated area of a public area, tickets are checked and admission to the area is granted if the result is positive.

To avoid high crowd densities, large areas without seating are divided into individual areas using barrier systems.

There are several options available to ensure compliance with authorised capacities.

In the event of a numerical check of individual areas, people are counted manually. This involves manually counting the number of arrivals at all access points upon initials access (Figure 92) and comparing the total number with the total capacity.

Image 92: Manual counting by stewards
(source: Bernd Belka, Special Security Services Deutschland)

Another option is to check tickets (Figure 93) if individual areas are sold separately and assigned to individual ticket holders. In this case, tickets are checked at all access points. If the check is successful, the ticket holder is allowed to enter the respective area.

Image 93: Tickets being checked by stewards for separately sold areas
(source: Bernd Belka, Special Security Services Deutschland)

When checking tickets or means of admission control in highly dynamic access situations to restricted areas – for example, shortly after admission begins – people should be asked to hold their tickets or means of admission control above head height. This desired behaviour should be clearly and loudly announced and demanded by stewards.

This has the advantages of

- better recognisability of the tickets/means of admission control and
- better control of pressure development due to the more unstable posture of the people.

Individuals wishing to exit the area for the first time after entry will be tagged to allow re-entry. The tag must be checked by stewards upon re-entry. Untagged individuals will be directed to a designated point before exiting the area for the first time. They may then leave the area.

The following can be used for tagging individuals

- stamps (different symbols for different areas) or
- wristbands (different colours for different areas)

.

For access checks at the entrance, a means of admission control in the defined colour should be kept ready for each person for each limited area.

Wristbands and stamps should be picked up at a reasonable distance from the entrance to the area. This ensures that access is not blocked by people queuing to pick up a wristband.

The following should be taken into account when applying wristbands as means of admission control:

- recount the wristbands upon receipt,
- compare the number of wristbands with the capacity of the area,
- the type of wristband (paper, plastic, fabric) should be demonstrated and staff instructed on correct use of the wristbands,
- wristbands should be worn on a defined wrist (facilitates checks, Figure 94).

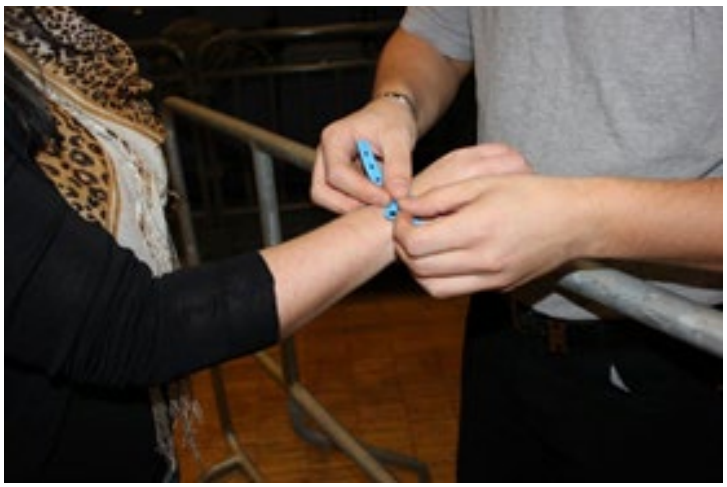

Image 94: A steward fitting a wristband
(source: Bernd Belka, Special Security Services Deutschland)

Image 95: Marked ticket after receiving a means of admission control
(source: Bernd Belka, Special Security Services Deutschland)

In exceptional cases, wristbands can also be issued to people as a means of admission control without having to be worn. However, this should only be the case if it would be too disadvantageous to have stewards carry out this task.

Disadvantages or prerequisites could be

- excessively long queues at pick-up points,
- insufficient staff issuing wristbands,
- an excessive absolute number of wristbands to be issued.

As a way to control capacity, tickets should be marked accordingly when issuing a means of admission control to prevent misuse (Figure 95). This stops area tickets being collected and given to someone else outside the area.

From the moment the first person leaves the area, each person's wristband must be checked upon entering the area. Persons who have a wristband may no longer be counted, as otherwise the segregated areas may theoretically become overcrowded even though full capacity has not yet been reached.

Once full capacity of the area has been reached, only persons with correctly coloured wristbands will be admitted.

In ticket-controlled areas, there may be a delay in filling the area. In this case, persons have a basic access authorisation and can enter the capacity-limited area for the entire duration of the event.

The positions and instructions for action for the capacity check are shown below in the form of sketches (Figures 96 to 99). All the steward positions are labelled with the direction of work. Arrivals are indicated as a "guest" with the direction of movement shown as a green arrow.

The following tasks are assigned to steward positions:

Position 1: Counting/Checking tickets
Position 2: Checking means of admission control
Position 3: Securing closure
Position 4: Issuing means admission control

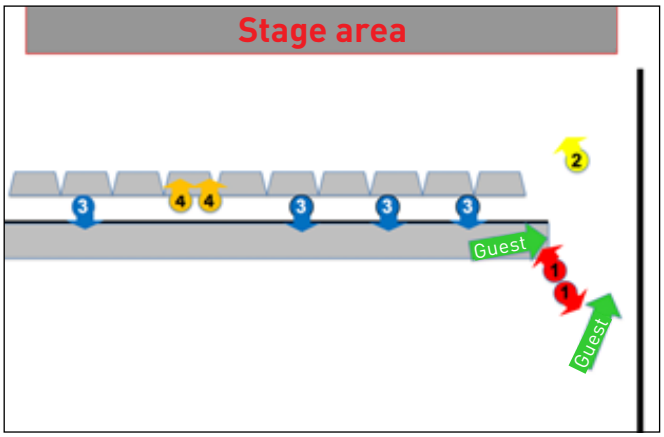

Image 96: Counting guests entering the area for the first time
(source: Bernd Belka, Special Security Services Deutschland)

Position 1: Counting people or checking tickets. The "back-to-back position" prevents double counting.

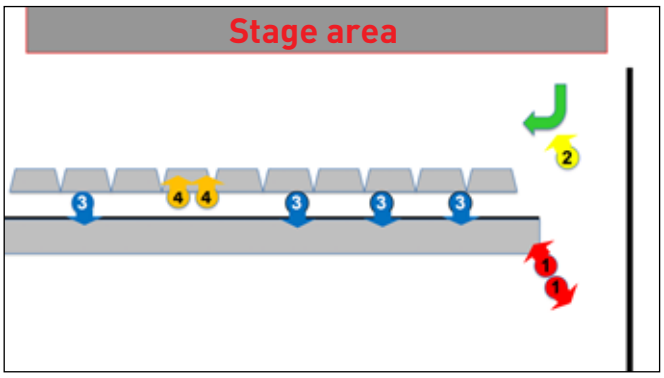

Image 97: People leaving segregated areas
(source: Bernd Belka, Special Security Services Deutschland)

People (green arrow) want to leave the segregated area and are asked to pass through position 2 to the pick-up point for the means of admission control, position 4.

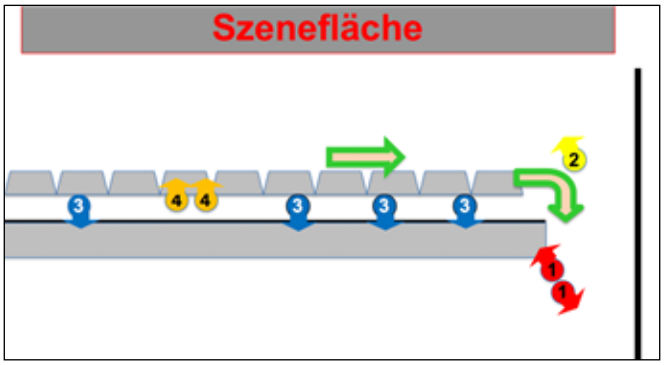

Image 98: Person has received a means of admission control
(source: Bernd Belka, Special Security Services Deutschland)

One person (green-beige arrow) has received a means of admission control at position 4 and can leave the segregated area.

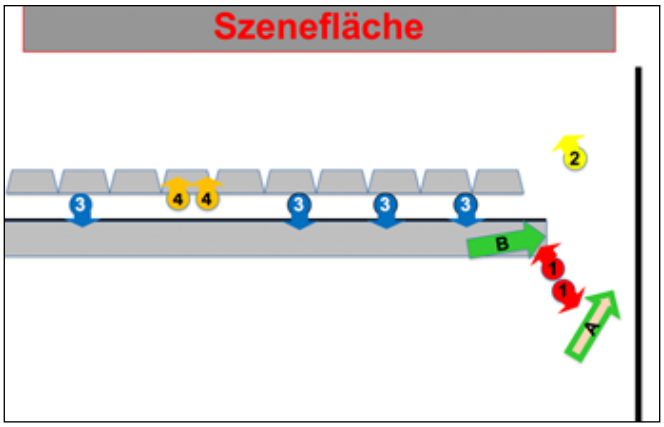

Image 99: Counting only people who have not yet left the segregated area
(source: Bernd Belka, Special Security Services Deutschland)

The tagged person (A) can re-enter the area and is not counted. The as yet untagged person (B) is counted.

C 3.4 Temporary barriers along routes for special flows (in this case: for a slow cycling-in by racing teams through public areas)

Task

For special crowd flows, such as artists or athletes, it may be necessary to make predetermined routes temporarily available without disruption. For this purpose, it may be necessary to temporarily block public routes.

Solutions (using the example of the Tour de France 2017 in Düsseldorf)

For the opening of the Tour de France 2017 in Düsseldorf, all 22 participating teams were to be presented to the public on a stage at Burgplatz in the centre of Düsseldorf. Team presentations were to take place at intervals of around 10 minutes.

After the team presentations, they were to ride through a temporarily cordoned-off route through large parts of Düsseldorf's old town at a slow pace to an agreed destination (Apollo-Platz). The designated route for the teams (Figure 100) was approx. 2.5 m wide and controlled using suitable barriers.

Image 100: Specified route of the slow cycling-in of the teams at the 2017 Tour de France with the direction of travel
(source: City of Düsseldorf)

Closure of the route and the introduction of the materials into highly frequented public areas could result in massive restrictions on the individual mobility of people in the affected areas. To mitigate this, the following measures were put in place:

a) Definition of crossing points as temporary junctions along reduced speed sections and public paths connections,

b) Signposting of these crossing points,

c) Placement of instructed stewards at the crossing points,

d) Installation of a team of stewards for opening and closing crossing points.

About a): When setting up the crossing points, the general flow directions and volumes of people in the areas concerned were taken into account. These crossing points were designed sufficiently wide enough to allow easy access when open.

About b): The crossing points were labelled alphabetically and signposted accordingly (Figures 101 and 102).

Image 101: Alphabetically labelled and signposted crossing points
(source: Bernd Belka, Special Security Services Deutschland)

Image 102: Fixed crossing points with alphabetical labelling
(source: Bernd Belka, Special Security Services Deutschland)

About c): Each crossing point was manned by three stewards.

About d): Each opening in the barriers was manned by one steward. A third steward was in charge of opening and closing the crossing point (Figure 103).

When opening the crossing point, i.e. when opening the path connection for pedestrians, the stewards placed at the openings held a barrier tape attached to their barrier position and moved to the opposite side of the path to allow people to pass through. As such, they opened their side of the crossing point and at the same time blocked off the reduced speed section with the barrier tape they were holding.

When the slowly approaching team was sighted, an acoustic signal whistle sounded and the path connection was closed (Figure 104). To do so, the stewards returned to their original position and used the barrier tape to close off the public path connection to allow the slow-moving cyclists to pass by.

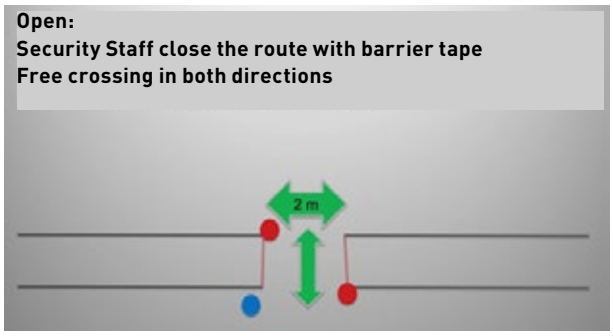

Image 103: Position of stewards when the public area crossing points were open for pedestrians
(source: Bernd Belka, Special Security Services Deutschland)

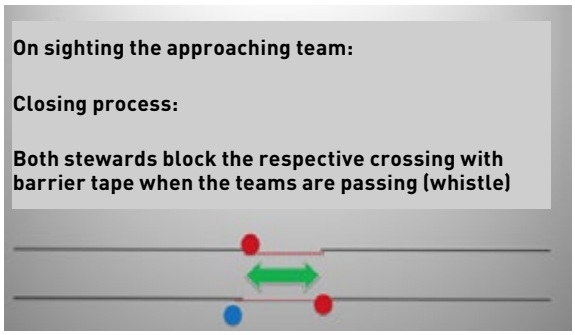

Image 104: Position of stewards when the public area crossing points were closed to enable slow-moving cyclists to pass by
(source: Bernd Belka, Special Security Services Deutschland)

Annex D

Interrelationships between densities, speeds and volume of traffic of motor vehicle and pedestrian traffic

The following section explains the interrelationships that are relevant when considering capacity, achievable volumes of traffic and their underlying speeds. The explanations form the basis for planning and designing traffic facilities at an event site and for assessing situations along routes and in areas of arrival and departure routes as well as in public areas.

The capacity of a traffic facility is defined as the maximum volume of traffic that a flow of traffic can achieve under given conditions. This definition generally applies to all traffic facilities, i.e. facilities featuring both motor vehicle and pedestrian traffic. The capacity can be achieved in individual cases under optimum conditions, such as optimum speed, optimum density, dry weather, good light conditions and a level surface. To determine the respective capacity, numerous surveys have been carried out in the past on a wide variety of traffic facilities. The findings have been incorporated into the Road and Transportation Research Association's (FGSV) "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015]. Based on these findings, the "Handbook for the Design of Road Traffic Facilities" (HBS) defines criteria for assessing the traffic flow on a six-level scale of quality of traffic from A to E, depending on the capacity of the respective traffic facility. In other publications [e.g. Fruin 1971, Weidmann 1993 for pedestrian traffic], scales of a level of service (LOS) are also given, which basically corresponds to the procedure according to the "Handbook for the Design of Road Traffic Facilities" (HBS). The quality of traffic or level of service is classified using manual calculations or simulation models.

The basis for classification and assessment is formed by interrelationships between volumes of traffic or specific flows, average speeds and densities. The physical relationship q (volume of traffic, or specific flow) = v (average speed) k (traffic or crowd density) applies to all movement processes. Analyses of a cross section or a route section of traffic facilities over several time intervals result in scatter plots, which form the basis for deriving a regression curve or a regression range. Figure 105 illustrates these interrelationships in a fundamental diagram with scatter plots and a regression curve derived from surveys of individual states in specified time intervals.

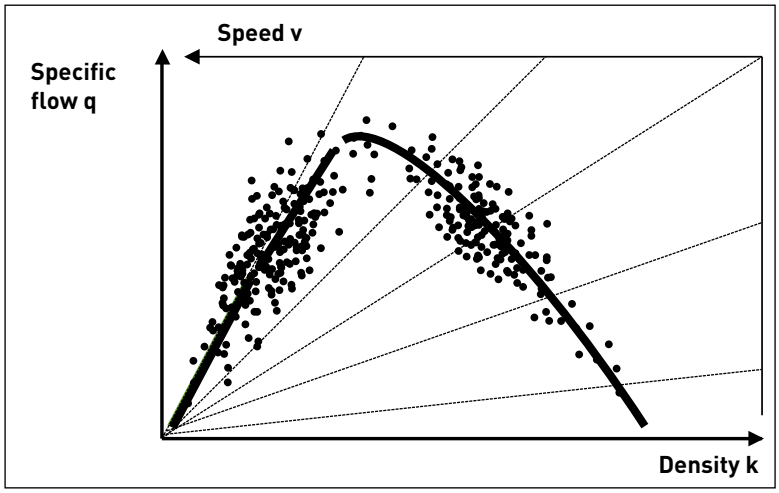

Image 105: Interrelationships between volume of traffic or specific flow q, speed v and traffic density k, illustrated using a fundamental diagram

The fundamental diagram is used, among other things, to derive the capacity of a traffic facility (see Figure

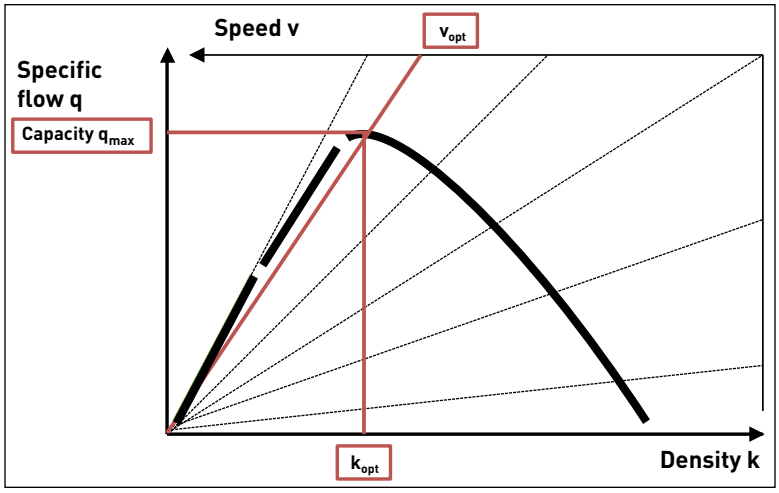

Image 106: Capacity q_{max} at optimum speed v_{opt} and optimum density k_{opt}

106).

The capacity is not an absolute value up to which a stable traffic flow is given. Congestion, which is associated with an approval of the volume of traffic in the cross section and thus with a serious loss of performance, rather occurs depending on individual behaviour at volumes of traffic that are usually well below the capacity limit. In contrast, an optimum state with full utilisation of the capacity is rarely achieved (see exemplary scatter plots in Figure 105).

At lower traffic densities than k_{opt}, higher speeds are possible with a stable traffic flow, while the achievable volume of traffic or the achievable specific flow decreases. At higher traffic densities than k_{opt}, hold-ups and congestion with lower average speeds and lower achievable volumes of traffic or rates of passage are recorded. The scatter plots are nevertheless predominantly well below capacity, so that a transition from moving traffic to congested traffic can be observed even at lower volumes of traffic and lower traffic densities. The causes are individual behaviour that deviate from a homogeneous behaviour with an optimal traffic flow. Braking by a car driver or tripping or jostling by someone in pedestrian traffic can lead to congestion at high densities that are far below the theoretically achievable densities.

Figure 107 shows an example of a possible sequence of successive traffic situations. Here, too, it can be seen that the transition from moving traffic to congestion can be rather random and far below the possible volume of traffic or the possible specific flow at the respective capacity. If there is congestion, the achievable volume of traffic or the specific flow is low. Congested traffic conditions can last for a long time and only recover slowly and gradually and only if the volume of traffic to be recorded is lower than the achievable volume of traffic in the congested state. It takes a correspondingly long time and a period of reduced volumes of traffic before stable traffic conditions with higher achievable volumes of traffic can be recorded again.

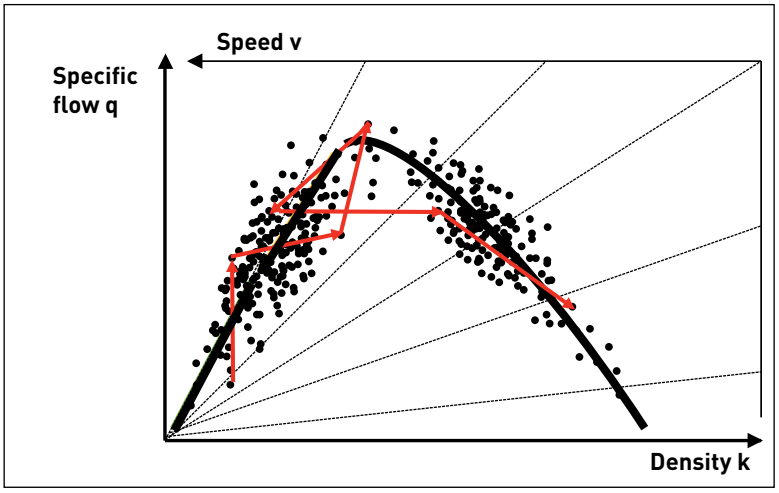

Image 107: Hysteresis of an sample course of successive traffic situations

These interrelationships justify the principle laid down in the "Handbook for the Design of Road Traffic Facilities" (HBS) of not designing traffic facilities close to capacity, but at the limit of a probably still stable traffic flow (see Figure 108). With levels of service A to C, congestion due to overloading is rather rare, so that the volumes of traffic used as a basis are achievable, while serious drops in performance are likely when designing above the limit between D and E. In this respect, congestion is already likely at volumes of traffic close to capacity and, in the event of fluctuations in the volumes of traffic or individual behaviour, even if a quality level D is demonstrated. If traffic facilities are designed at the capacity limit between E and F, congestion is almost certainly to be expected, which in turn will very quickly lead to a serious loss of performance.

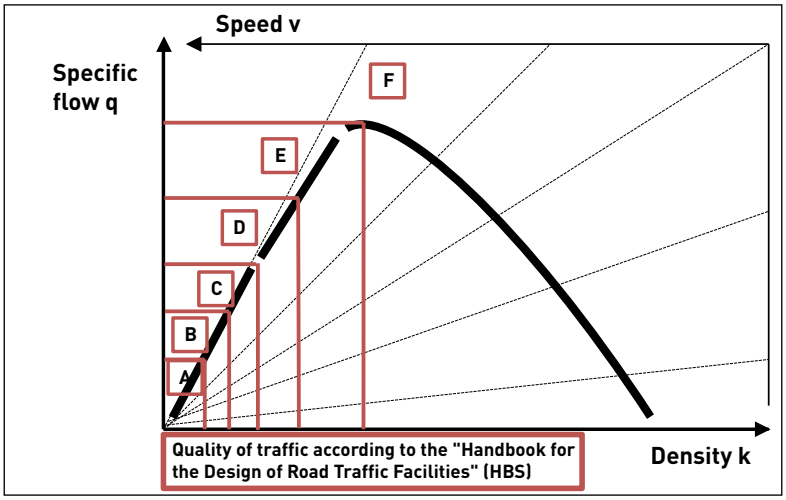

Image 108: Sample traffic conditions in the range of the quality levels A to F according to the "Handbook for the Design of Road Traffic Facilities" (HBS)

Waiting and loss times due to congestion increase progressively with increasing volumes of traffic close to the capacity limit, i.e. particularly in situations that are to be assessed with the quality level E according to the "Handbook for the Design of Road Traffic Facilities" (HBS). Volumes of traffic close to capacity should therefore be avoided – overloading, i.e. volumes of traffic above capacity, which are to be assessed as quality level F according to the "Handbook for the Design of Road Traffic Facilities" (HBS), must be avoided at all costs, at least on arrival, as the resulting lengths of tailbacks and waiting times can take on dimensions that can hardly be realistically calculated and that can hardly be reduced. Such congestion in motorised or pedestrian traffic can have a significant impact on comfort during arrival and departure and, in particular, on safety during arrival by increasing the motivation to reach the destination on the "last mile" ("fear of missing out").

The "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV) 2015] contains information and procedures for assessing the quality of traffic of a wide range of traffic facilities and for determining the expected quality level. They can and should be used to design and check all traffic facilities for travelling to and from events by public transport. For pedestrian traffic and for facilities in the course of pedestrian routes to and from public areas and in public areas, Sections 8 and 9 in conjunction with this Annex D and the following Annex E contain information and procedures that have been adapted to current knowledge and for use in planning, approving and putting on events. These are to be used for the planning and control of crowds of people at events instead of the procedure stipulated in the "Handbook for the Design of Road Traffic Facilities" (HBS).

The scientific literature contains a wide range of publications on fundamental diagrams based on observations, experiments and their analyses. The publications by Predtetschenski and Milinski [Predtetschenski; Milinski 1969], Fruin [Fruin 1971], Weidmann [Weidmann 1993] and Nelson and Mowrer [Nelson; Mowrer 2002] have been widely cited. Some of the publications show a considerable scatter range of data, which can be attributed, among other things, to different basic parameters, such as the instruction to push and jostle, sometimes with personal assistance. The data and procedures listed here are based on interrelationships between volumes of people or specific flows, average speeds and crowd densities, which were derived from current and extensive experiments and can be verified [Holl 2016]. The fundamental diagrams for one-way traffic (Figure 109) and two-way traffic (Figure 110) show the conditions to be observed or expected at events for situations in which people walk quickly on level footpaths and do not push and jostle. Regression ranges derived from numerous experiments with corridors of varying widths are shown. The interrelationships are similar to the findings presented in [Weidmann 1993], which form the basis of the procedure stipulated in the "Handbook for the Design of Road Traffic Facilities" (HBS), wherein more differentiated information for one-way traffic and two-

way traffic is given here instead of information for one-way traffic with a conversion factor for two-way traffic in the "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015]. In addition, any edge distances to be deducted according to the procedure stipulated in the "Handbook for the Design of Road Traffic Facilities" (HBS) for determining the usable width are already taken into account in the information in Figures 109 and 110, thus ensuring that no deduction of edge distances is required in the method according to Annex E. A three-stage scale (GREEN, YELLOW, RED, see Annex E) is used for assessment.

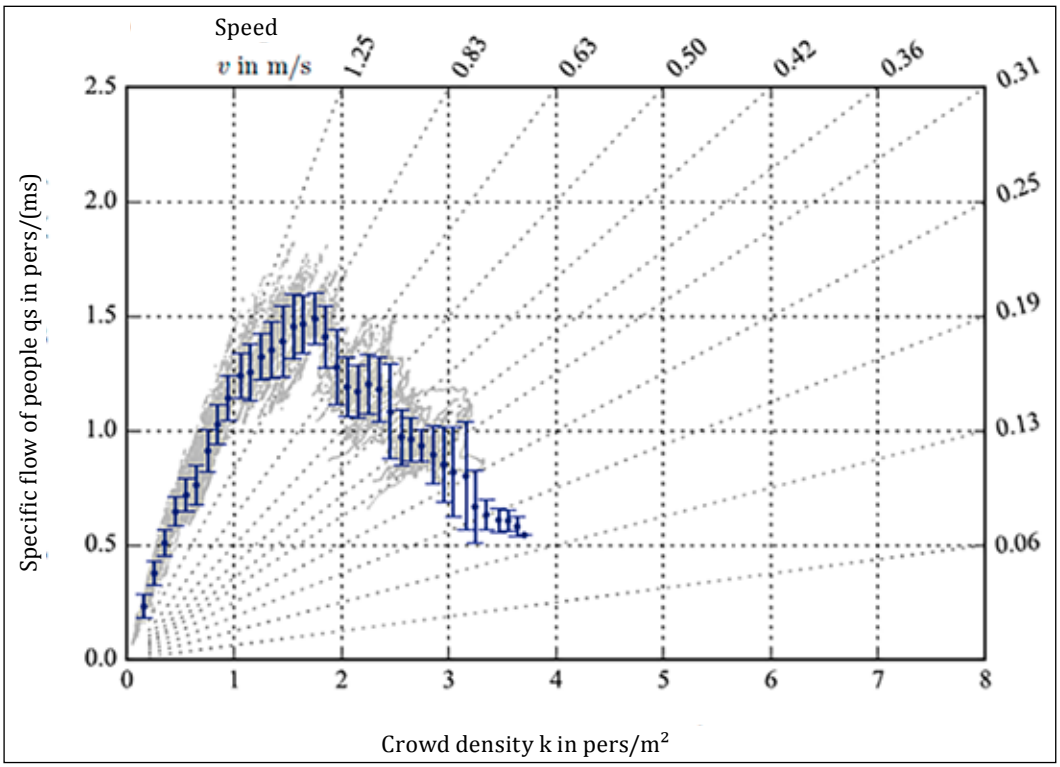

Image 109: Fundamental diagram for level footpaths, one-way traffic [Holl 2016]

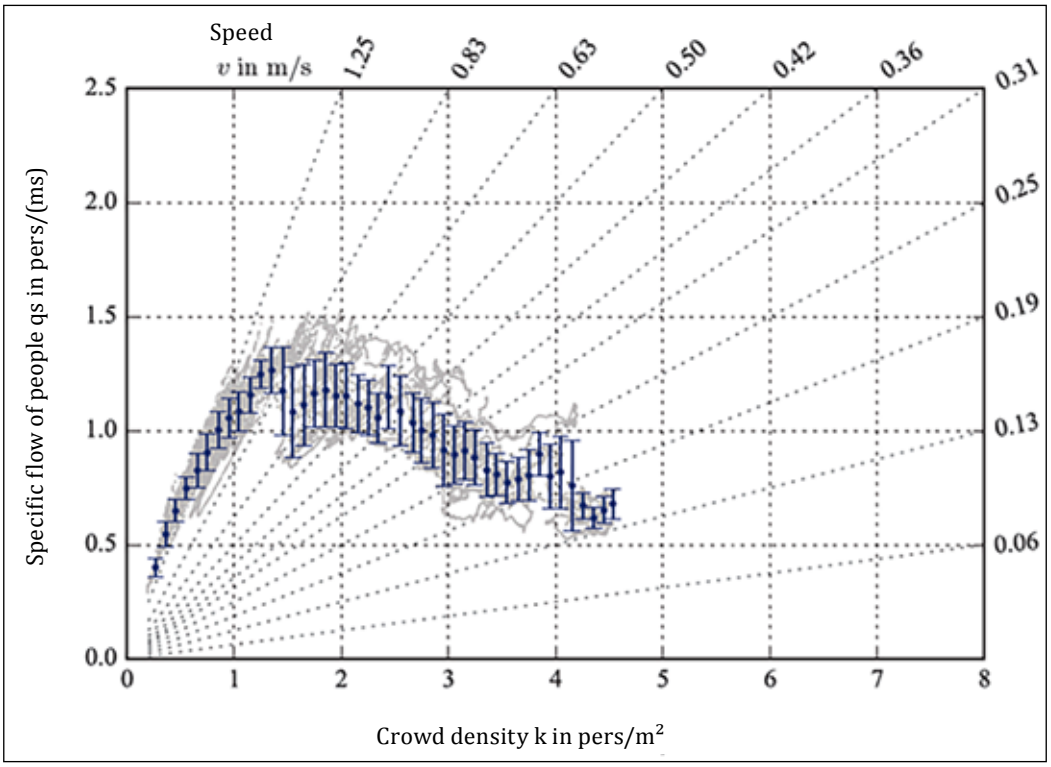

Image 110: Fundamental diagram for level footpaths, two-way traffic [Holl 2016]

An optimal condition with maximum possible volume of people for one-way traffic on the level is therefore reached at around 1.3 pers//(m · s) to 1.6 pers/(m · s). This capacity limit is reached at a crowd density of around 1.75 pers/m² and a walking speed of around 0.70 m/s to 0.90 m/s, at which point there is already pushing and jostling and an individual speed can no longer be freely selected. The higher the crowd density increases from this point onwards, the lower the speed and the achievable volume of people or rate of passage.

A free choice of speed or movement without pushing and jostling is possible with crowd flow densities of less than around 0.80 pers/m² based on one-way traffic. In situations with crowd flow densities of between around 0.8 pers/m² and 1.60 pers/m², there is a high risk of a transition from a stable situation with mainly people walking to an unstable situation with pushing and jostling and backed-up crowds of people. From a crowd flow density of around 1.60 pers/m², an unstable situation with pushing and jostling and backed-up crowds of people is almost certain to occur. At 0.8 pers/m², the achievable volume of people is approximately 0.7 pers/(m · s) or 40 to 45 pers/(m · min).

Volumes of people in the order of magnitude of the capacity values at around 75 to 95 pers/(m · min) can be observed over short periods of one or several seconds, ideally possibly over periods of a few minutes with disciplined behaviour. In crowd flows, disruptions caused by individual behaviour deviating from optimal behaviour, for example by reduced speeds of individual persons, are common, meaning such high volumes of people can only be recorded for short periods and only in the case of ideal behaviour.

An unstable condition in a moving crowd flow with pushing and jostling and backed-up crowds of people, which can be observed at densities of between approximately 1.60 and 5.50 pers/m², can harbour no or high risks (see Figure 111). As with a predominantly standing crowd, the hazard situation is determined not only by the crowd flow density but also by the mood and motivation of the people in the respective cluster when walking. It must be taken into account that the higher the crowd density, the lower the achievable volume of people or rate of passage. For example, with a crowd density of 3 pers/m², the achievable volume of people in one-way traffic is approximately 48 pers/(m · min), and of 4 pers/m² approximately 30 pers/(m · min), provided that the average speeds specified in the fundamental diagram (see Figure 109) are achieved in the respective cluster. If people stop or choose speeds below the possible speeds, the achievable volume of people drops significantly.

Image 111: Situation in an unstable, congested state with a crowd flow density of 2.5 pers/m² without a hazard situation
(source: Dr Dirk Oberhagemann, vfdb TB 13-01)

Congestion in pedestrian traffic can cause hazards, especially on arrival, but also on departure and during attendance in public areas. The situation in a crowd of people cannot be determined solely by parameters such as the average density over a large area or the average speed at a cross section. Rather, the determining factor is situations in small clusters of people, which can lead to potentially dangerous conditions in just four to five rows of people – depending on the mood and motivation of the people in this cluster. One of the reasons for this is that it is no longer possible to communicate across this number of rows – there is no "front-to-back communication". For any pressure loads that a person in a crowd may be exposed to, it is therefore not decisive whether there are 100 or 10,000 people in a pushing and jostling situation, for example.

With a density of between 5.5 and 6.6 pers/m² in a cluster of people, independent movement is no longer possible without pushing, shoving or using force. People stand in the crowd and follow any movements in the crowd. It should be noted that people who walk, run or climb stairs require more space than people who stand. This is due on the one hand to the length of the stride, which increases the space projected onto the surface, and on the other hand to the freedom of movement required for walking – to avoid tripping. In this respect, the conditions and requirements for walking must be differentiated from those for standing. Accordingly, the crowd density of a moving crowd flow must be differentiated from the crowd density in areas with standing areas. Different requirements must be placed on areas that are predominantly used dynamically than on areas that are predominantly used by standing people. From a density of 3 to 3.5 pers/m2 and upwards in a cluster of standing people, physical contact cannot be avoided. It should be noted that getting through a cluster of standing people with a density of around 2 pers/m² is fraught with difficulties and delays, for example in a rescue situation. Nevertheless, high densities are not uncommon at events in clusters of standing people – e.g. up to 8 pers/m² in crowds of young people in waiting zones or in front of stages – which do not necessarily result in hazards (see Figure 112). In addition to the crowd density, the hazard situation is determined by the mood and motivation of the people in the respective cluster.

Image 112: Crowd densities of 4 pers/m² in a waiting situation without a hazard situation
(source: Dr Dirk Oberhagemann, vfdb TB 13-01)

The question of in which areas and at what times high crowd densities, pushing and jostling and congestion can be expected can be estimated using manual calculations (see Annex E). The use of simulation models is recommended in order to estimate the extent and duration of congestion situations and the expected crowd density in a pushing and jostling situation. The results must be interpreted and assessed taking into account the specific basic parameters. For example, expected waiting and congestion situations long before the start of an event can be considered acceptable if these are reduced during the arrival time and all people travelling to the event can reach the public areas in good time before the event begins. If, on the other hand, it is to be expected that some of the people travelling to the event might miss part of the event due to excessive loss times, this can lead to high risks. Situations in which congestion is possible, probable, almost certainly to be expected or likely to occur on the day of the event require closer examination, observation and, in many cases, the use of hazard prevention measures. Further information can be found in Sections 8 to 10 and the associated annexes.

Annex E

Procedure for the design of pedestrian routes and verification of the quality of traffic on pedestrian routes on arrival and departure and in dynamically used public areas

E 1 Introduction, terms and abbreviations

The procedure for designing and assessing the quality of traffic serves to prove that the expected traffic demand can be handled as safely as possible and with the desired quality on pedestrian routes and in dynamically used public areas. The procedure is based on Section S-9 "Facilities for pedestrian traffic" of the "Handbook for the Design of Road Traffic Facilities" (HBS) of the Road and Transportation Research Association (FGSV), whereby the procedure and the qualities to be aimed for are adapted to the conditions of an event, to current knowledge and to the different areas of a site.

The procedure applies to unidirectional and bidirectional routes on pedestrian routes for arrivals and departures as well as in public areas such as walkways, ramps, entrances/exits, corridors, stairs, bridges, marked pedestrian crossings and overpasses as well as paths between market stalls or similar. It does not apply to facilities that are not used in a linear fashion (e.g. footpaths with intersecting crowd flows, platforms or areas with non-directional traffic, such as public areas with standing spaces).

The procedure only evaluates the influence of the width of routes on the quality of traffic of pedestrian traffic. Other impairments to pedestrian traffic, such as poor walkway surfaces or disruptions caused by other types of traffic or disruptive behaviour by groups of people, are not taken into account in this procedure and may have to be considered elsewhere. Furthermore, the influences of people with limited mobility, such as people with wheelchairs, wheeled walkers, prams or long sticks, are not taken into account.

The "Terminology Relating to Road and Transport" of the Road and Transportation Research Association (FGSV) (2020) and the terms defined here apply:

Volume of people; (also referred to as: flow)	=	Number of people per unit of time at a cross section
Volume of people, specific	=	Volume of people, related to a width unit of the cross section
Footpath	=	Linearly used route of a pedestrian route of arrival and departure or dynamically used public area
Corridor	=	Footpath with fixed boundaries on both sides
B	=	Usable width of the footpath [m]
B_b	=	Actual width of the footpath [m]
B_f	=	Width of marked pedestrian crossing [m]
B_h	=	Width of a point obstruction [m]
B_s	=	Non-usable width [m]
k	=	Notional crowd flow density that would occur on a usable width [pers/m²]
q_2	=	Design volume of traffic for the 2-minute interval [pers/2 min]
$q_{f,2}$	=	Notional volume of people of both walking directions together for the 2-minute interval [pers/2 min]
$q_{s,2}$	=	Relevant specific volume of people [pers/(m · 2 min)]
q_s	=	Specific volume of people [pers/(m · s)]
pers	=	Person (also as a unit)
QSV	=	Quality level of traffic flow
v	=	Walking speed (horizontal) [m/s]

E 2 Measure for assessing the quality of traffic

The procedure described here is used to assess the quality of traffic on routes used on a regular basis. The main criterion for the quality of traffic at events is the safety of crowd flows and the probability of congestion. The criterion for the quality of traffic flow on footpaths is a notional crowd flow density k in persons per square metre in conjunction with a specific volume of people in persons per metre and second.

The notional crowd flow density on footpaths is determined by the specific volume of people, which refers to a width of 1 m, and the walking speed:

$$k = q_s / v$$

where
k = notional crowd flow density [pers/m²]
q_s = specific volume of people [pers/(m · s)]
v = walking speed (horizontal) [m/s]

The quality of traffic is evaluated for each relevant part and time range of a pedestrian route and a dynamically used public area. Instead of the six quality levels of the "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015] based on the level of service concept according to Fruin [Fruin 1971], a concept with three quality levels of traffic flow (GREEN, YELLOW, RED) is used for events:

- **Quality level of traffic flow (QSV) GREEN:**

Mutual interference between people can occur, but the free choice of walking speed is not significantly affected. The traffic flow remains largely stable, with no congestion is to be expected as a result of the situation in the section in question.

- **Quality level of traffic flow (QSV) YELLOW:**

People are often forced to change their speed and direction. Individual behaviour can lead to congestion as a result of the situation in the section in question.

- **Quality level of traffic flow (QSV) RED:**

As a result of the high volume of traffic, there are considerable obstructions. The situation in the section in question will almost certainly result in congestion.

Table 14 shows the parameters of the specific volume of people q_s and the notional crowd flow density k to be used to assess the situations.

Table 14: Limit values of the GREEN, YELLOW and RED levels of quality

Type of traffic or facility	Quality level of traffic flow (QSV) with expected specific volume of people and expected specific crowd density of moving persons on the level*)		
	GREEN	YELLOW	RED**)
One-way traffic	$q_s \leq 0.7 \frac{pers}{ms}$ $k \leq 0.8 \frac{pers}{m^2}$	$q_s \leq 1.3 \frac{pers}{ms}$ $k \leq 1.6 \frac{pers}{m^2}$	$q_s > 1.3 \frac{pers}{ms}$ $k > 1.6 \frac{pers}{m^2}$
Two-way traffic	$q_s \leq 0.6 \frac{pers}{ms}$ $k \leq 0.7 \frac{pers}{m^2}$	$q_s \leq 1.0 \frac{pers}{ms}$ $k \leq 1.3 \frac{pers}{m^2}$	$q_s > 1.0 \frac{pers}{ms}$ $k > 1.3 \frac{pers}{m^2}$

*) For stairs and routes with a gradient of more than 6% or with a gradient of less than - 6%, these values must be halved
**) In mathematical terms, specific volumes of people of well over 1.3 pers/(m · s) can be calculated using this method, which cannot be achieved in reality

The classifications of the levels of quality are derived from the fundamental diagram (see Annex D) on the safe side and shown in Figures 109 and 110 .

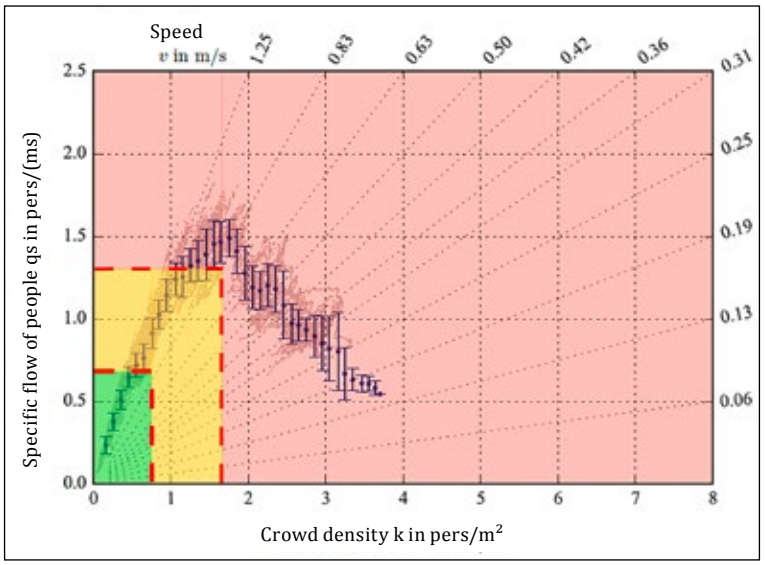

Image 113: Illustration of the quality levels of traffic flow (QSV) GREEN, YELLOW, RED for one-way traffic

E 3 Basics of the procedure

Influencing variables

Type of footpath

The type of footpath has an effect on use. For this reason, a distinction is made in the procedures between walkways, corridors, ramps, stairs, marked pedestrian crossings and crossings. Paths between market and fun fair stalls or similar are to be treated as walkways, bridges as ramps.

Function of footpaths

Footpaths usually serve several purposes: In addition to primarily being used for moving from place to place, it is also common to find people standing on footpaths, e.g., in front of shop displays and stalls or when waiting for other people in a group, an opportunity to cross the road or a public transport service. This can result in restrictions on freedom of movement and, as a result, a reduction in walking speed and an increase in crowd flow density for people walking. These different utilisations of footpaths can be partially taken into account in the procedure by determining the usable width of the footpath, wherein influences due to group formation, waiting, people with limited mobility or disturbances can lead to deviating conditions.

Volume of people

The volume of people is the main influencing factor.

The decisive volume of traffic is the number of people moving through the cross section during the 2-minute interval with the highest traffic load. It is specified in the unit of persons per 2 minutes for both directions together.

If a footpath is predominantly used in one direction only, higher walking speeds are generally achieved with high volumes of traffic than with approximately equal flows of traffic in both directions. This is taken into account in the procedure.

Defining routes and sections and determining the usable width of footpaths

The procedure applies to sections of footpaths. In the case of pedestrian routes along roads, these routes may be limited by junctions where people have to wait before crossing a carriageway. Corridors and tunnels, ramps, stairs, marked pedestrian crossings and zebra crossings always form a separate route. A further subdivision into sections is generally not necessary here.

The factors listed above influence the quality of traffic. The routes of footpaths are only subdivided into sections where the volume of people changes significantly (e.g. crowd flow intersections).

A further subdivision of a section formed in this way due to different dimensions of the footpaths is not necessary, however, because the point with the smallest usable width of the footpath B is decisive for the assessment of the quality of traffic on a section. It is therefore sufficient to determine this smallest usable width of footpath B and to use it for the assessment of a section formed due to different volumes of traffic.

If turnstiles, doors or gates narrow the distances of footpaths, the respective width of the turnstile, door or gate is to be used as the smallest usable width.

As footpaths cannot be used at every point, the usable width of the footpath must be determined. Restrictions due to fixed obstructions and waiting zones in front of stalls or in the area of marked pedestrian crossings or at stops as well as due to installations must be taken into account. The usable width B of a footpath results from the actual width of the footpath B_b reduced by the unusable width B_s. The unusable width B_s includes the width of fixed obstructions in the footpath B_h. For marked pedestrian crossings and crossings, the actual width B_b can be used as the usable width B. Installations include, for example, switch and mailboxes, display cases, ticket/parking ticket machines, rubbish bins, planters, lighting masts or bollards.

The actual width B_b must be reduced by 0.30 m in corners and for narrow changes of direction (changes of direction with radii < 15 m) of corridors, ramps or stairs.

In the area of waiting zones, the width of the footpath can be restricted by standing persons. The "Handbook for the Design of Road Traffic Facilities" (HBS) [FGSV 2015] contains information on determining the usable widths of footpaths to be used in this case, which are not described in more detail here. The "Handbook for the Design of Road Traffic Facilities" (HBS) should be applied in the event that pedestrian routes for arrivals and departures with significant sections at events are routed along such waiting zones.

The smallest usable width of footpath B in a section is decisive. The usable width B of a footpath can be made up of several usable partial widths.

Determining the design volumes of traffic

The design and review of pedestrian routes for arrivals and departures and in public areas is based on a time interval of two minutes.

Within 60, 30 or 15-minute intervals, fluctuations and pronounced peak traffic can occur. To take these fluctuations into account, the volume of people (unit: persons per two minutes) is used as the basis for the design volume of traffic on the basis of the 2-minute interval with the highest traffic load.

The forecast volume of people is converted to 60, 30 or 15-minute intervals for the design of narrow sections in pedestrian routes, doors and gates, stairs, tunnels and ramps on arrival and departure routes as well as for footpaths in public areas between market stalls or similar, not linearly to two minutes, but with factors. The factors include safety margins for the occurrence of fluctuations and peak traffic. The factors are to be applied above all if a throng-like arrival is expected, e.g. via train stations and stops, which can lead to short-term peak volumes of traffic. Figure 114 shows an example of a load curve with fluctuations in the volume of people and the hourly volume of traffic and 2-minute volume of traffic determined using the factors.

The 2-minute volume of traffic can only be determined linearly if a consistently high volume of people is expected in the respective time intervals. In addition, the dimensioning of security search systems can be carried out with linear calculation of the 2-minute volume of traffic, as homogeneous processes can generally be achieved in these areas through the use of stewards.

Annex C contains examples for determining the design volumes of traffic.

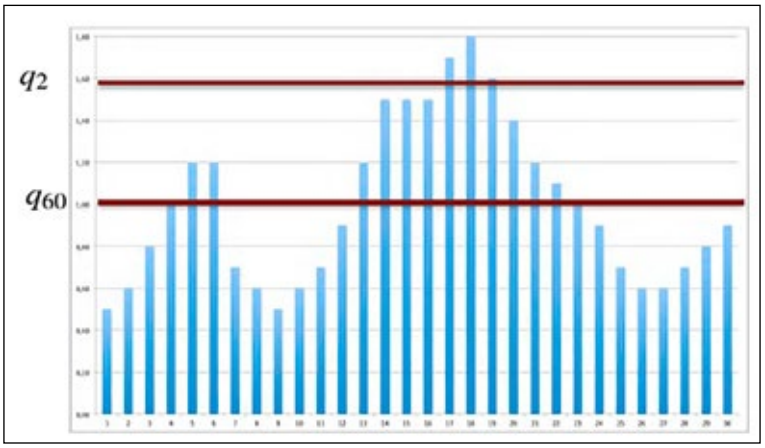

Image 114: Load curve with fluctuations in the volume of people (example) (source: Holl)

If the forecast volume of people is available in 60, 30 or 15-minute intervals, the design volume of traffic for a section is calculated using the following equation:

$$q_2 = f_t \cdot q_t$$

where q_2 = design volume of traffic at 2-minute intervals [pers/2 min]
$_{ft}$ = Conversion factor for different forecast intervals according to Table 15
q_t = volume of traffic in the forecast interval of duration t

Table 15: Factors for the conversion to 2-minute intervals

Forecast interval of duration t [min]	**Conversion factor$_{ft}$** [t min/2 min]
60	0.06
30	0.10
15	0.18

E 4 Assessing the quality of traffic

Procedure

The quality of traffic is assessed separately for each footpath.

The following calculation steps are required for each section in which the smallest usable width is decisive:

1. Determination of the notional volume of people.
2. Determination of the specific volume of people.
3. Evaluation of the specific volume of people by assigning it to a quality level of traffic flow.

Finally, the quality of traffic is assessed for all routes.

Assessing a section

For the assessment of the quality of traffic on a linear footpath, the relevant notional volume of people $q_{f,2}$ must be determined for the 2-minute interval – for bidirectional routes used in both walking directions together. This results in the specific volume of people $q_{s,2}$ for the 2-minute interval based on a width of 1 m, from which the specific volume of people q_s is then calculated.

The specific volume of people $q_{s,2}$ for the 2-minute interval is calculated according to the following equation:

$$q_{s,2} = q_{f,2}/B$$

where $q_{s,2}$ = notional volume of people for the 2-minute interval [pers/(m - 2 min)]
$q_{f,2}$ = notional volume of people of both walking directions together for the 2-minute interval [pers/2 min]
B = smallest usable width of the footpath [m]

The specific volume of people qs is then calculated according to the following equation

$$q_s = q_{s,2}/120$$

where qs = specific volume of people [pers/(m · s)]
qs,2 = notional volume of people of both walking directions together for the 2-minute interval [pers/(m · 2 min)]

As the assessment of the quality of traffic of a section is based on the smallest usable width of a footpath in addition to fixed obstructions and waiting zones, the worst quality of traffic of a section is decisive for the quality level of the traffic flow of a section consisting of several sections.

Finally, the specific volume of people q_s is used to determine the quality levels of traffic flow (QSV) GREEN, YELLOW or RED in accordance with Table 12 .

The results are evaluated depending on the route under consideration in accordance with the explanations in Section 8.

Annex F

Scenarios, special requirements and possible solutions or measures

Possible scenario/ special requirement	Solutions/measures
Need to increase parking area capacity or reduce demand	– Optimisation of parking density (e.g. deployment of more stewards, barrier tape or marking of parking rows, more restrictive behaviour of stewards so that vehicles are parked closer together) – Paving of parking areas (which cannot be used in wet weather) – Lighting (in order to be able to park in remote peripheral areas) – Designation of further parking areas in the vicinity of the event – Inclusion of P+R facilities (if they are actually available at weekends, for example) – Inclusion of private parking areas in the vicinity (e.g. car parks belonging to retail outlets or companies) – Measures to increase the occupancy rate of vehicles (e.g. increasing parking fees or staggering parking fees depending on the number of vehicle occupants, advertising for ride sharing) – Measures to change the modal split in favour of public transport (e.g. combined ticket, expansion of public transport services)
Requirement to provide parking areas for certain target groups	– Determining demand as precisely as possible – Target group-specific signposting to the event location and in particular back to the parking areas – (Control) measures to enforce the provision of parking areas for specific target groups – Early communication with the target groups
Need to optimise the loading of parking areas	– Clearly visible signposting to the parking areas (so that there are no delays on the access routes) – Clearly visible signposting back to the public road network (to avoid "wrong turns" in the car park) – Widening of car park entrances or exits and/or additional entrances or exits – Checking and, if necessary, correcting the sequence access checks > payment > vehicle parking – Deployment of a sufficient number of trained car park attendants
Need to improve the efficiency of the access routes to the car parks and the departure routes or to reduce motorised individual traffic	– Expansion of the infrastructure, paving or expansion of access roads or paths – No roadworks on public roads in the vicinity of the car parks during the event – Traffic-dependent and special temporary signal controls to speed up arrivals and departures – Installation or expansion of a car park guidance system/temporary event signposting/dynamic signposting/variable signposting – Temporary one-way traffic regulations – Modification of the allocation of lanes – Closure of road sections for through traffic – Change in the target group-specific parking area allocation – (Temporal and spatial) relocation of non-event-related traffic, including the associated communication and public relations work

Possible scenario/ special requirement	Solutions/measures
Continuation: Need to improve the efficiency of the access routes to the car parks and the departure routes or to reduce motorised individual traffic	– Extension of the arrival and departure period (e.g. through pre-events and post-events at the event site, including the associated communication) – Segregation of departures (e.g. by "intentionally" making the walk from the event site to the parking area longer) – Shifting attendee traffic to public transport (e.g. combined ticket, expansion of public transport services) – Shifting attendee traffic to bikes/expanding bike parking spaces – Establishment of a shuttle transport service
Need to set up a drop-off/pick-up zone	– Determining the demand as precisely as possible – "Legalisation" and use of "established" areas is preferable to setting up new locations – Signposting to the drop-off zone – Communicating at an early stage for which groups of people only such areas or driveways are available – Clear regulations (e.g. access checks, maximum standing time, re-admission of spectators at the end of the event only after prior request via radio or mobile phone), communication of these rules and consistent implementation of these rules during the event – Deployment of stewards – Signposting from the drop-off zone to the entrance of the event site and back to the pick-up zone
Need to increase public transport capacity or relieve the burden on public transport	– Increasing the frequency of services, extending operating times and/ or night-time traffic, special traffic, additional stops for scheduled train services or route extensions, including the associated communication and public relations work – Supplementing shuttle bus services (provided this does not hinder public transport) – Establishment of public transport prioritisation at junctions and/or establishment of bus lanes – Extension of the arrival and departure period (e.g. through pre-events and post-events at the event site) – If different means of public transport lead to the event, shift to the most efficient means of public transport if possible (e.g. shift from tram to suburban trains) – Segregation of departures (e.g. by "intentionally" walking longer distances from the event site back to the stops and stations) – Shifting attendee traffic to motorised individual traffic/expanding the number of parking areas available – Shifting attendee traffic to bikes/expanding bike parking spaces

Possible scenario/ special requirement	Solutions/measures
Need to relieve (critical) transfer points and stops	– Adequate frequency of transport services – Shifting non-event-related traffic to other public transport services or stops and/or, if possible, to other time slots, including the associated communication and public relations work – Shifting transfers for arrivals and departures to other stops, including the associated communication – Relocation of stops, if necessary temporary cancellation of a stop that does not have the necessary capacity – Additional temporary stops where sufficient space is available – Ensuring free and fast movement away from public transport stops – Expansion measures at public transport stops, including traffic lights, in particular to speed up movement away from stops – Timely completion of all possible construction work at stops/no construction site equipment at stops during the event – First security search points for access to an event only at a sufficient distance from a stop so that any congestion does not extend as far as the stop – Operational regulations (e.g. slow entry to stops, order to drive through without stopping) – Temporary closure of access to the stop or platform ("dividing up" passengers depending on the capacity of the vehicles) or setting up a queuing system, especially for departures – Deployment of passenger assistance staff and, if necessary, the (federal) police – Extension of the arrival and departure period (e.g. through pre-events and post-events at the event site) – Segregation of departures (e.g. by "intentionally" taking a longer walk from the event site to the stop)
Need or desire to change the modal split in favour of public transport	– Combined ticket, including offensive advertising, for the use of the combined ticket – Adequate, attractive public transport services (e.g. frequent services, night-time traffic), including the associated communication – Appropriate, attractive equipment of the stops – Cleanliness at the stops (if necessary, cleaning during the event after the arrivals) – Services (e.g. deployment of passenger assistance staff, luggage storage) – Special design of the ticket ("collector's value") can contribute to the actual use of the ticket – Organisation of the arrival and departure as a special part of the event (e.g. use of special trains, combination of timetable design and tourism advertising and campaigns) – Shortage of parking areas and/or high parking fees to discourage the use of passenger vehicles

Possible scenario/ special requirement	Solutions/measures
Need to set up shuttle bus transport services	– Shared use of public transport stops for shuttle buses, while at the same time ensuring free access for scheduled public transport – Setting up additional shuttle bus stops/driveways, including setting up separate waiting zones and queuing-up spaces – Early communication of which buses only have access to such areas or driveways – Clear regulations (e.g. access checks, re-admission of spectators at the end of the event only after prior request via radio or mobile phone, maximum standing time), communication of these regulations and consistent implementation of these rules during the event – Deployment of stewards – Signposting from the shuttle bus to the entrance of the event site and in particular back to the pick-up zone
Need or desire to increase the ratio of bicycle traffic	– Making the existing cycle paths alongside roads more attractive (e.g. paving, lighting) – Changing the cycle path routing/shortening the journey/eliminating possible points of conflict with pedestrians and/or motorised individual traffic – New planning and construction of cycle paths alongside roads – Installation/completion of signposting to the event site and signposting at the event site back to the bike parking spaces – Installation of new and/or expansion of existing bike racks – Improving the equipment of existing bike racks (also: lighting) – Establishment of special services at the bike racks, including the associated communication – Free bike and travel option on public transport services
Need or desire to increase the ratio of pedestrian traffic	– Making existing footpaths more attractive (e.g. paving, lighting) – Modification of footpath routing/shortening of footpaths – New planning and construction of footpaths – Installation/completion of signposting to the event site and signposting back from the event site
Need to relieve (critical) waiting zones and common areas used by people travelling to and from the event site and those attending the event site	– Ultima ratio: Relocation of the event location – Changing the event concept – Reduction in the number of persons allowed or reduction in ticket sales – Relocation of excessively small waiting zones – Reducing the crowd flow towards a waiting zone or common area: • Change the access routes/set up a one-way system if necessary • Segregate arrivals in terms of time or space (e.g. earlier opening of the event site) • Change/intensify the crowd flows (actively by addressing/passively by signposting) – Increase the flow capacity at entrances: • Review/increase the efficiency of access checks • Create additional search points • Increase the deployment of staff at search points

Possible scenario/ special requirement	Solutions/measures
Continuation: Need to relieve (critical) waiting zones and common areas used by people travelling to and from the event site and those attending the event site	– Segregation/extension of the arrival period, e.g. by offering a pre-programme – Setting up buffer or waiting zones, possibly with their own catering and entertainment installations – Queue management for relief at entrances – Closure of the entrance and/or already the access routes when the allowed number of people has been reached: • Note that closures can create new hazards due to a high crowd density and/or due to a "changed" mood • Only carry out closures in places where people can still be redirected or diverted away • Provide suitable and sufficient material needed for closure • Provide sufficient and trained staff • Inform the waiting/accumulating attendees about the situation and possible alternatives or options • Develop strategies in advance for dealing with waiting attendees or those refused entry or ejected from the event • Develop an area plan, including possible relief zones for the respective closure point in advance – Signposting, information and/or addressing people in the waiting zone before access checks to ensure people can leave the entrance area quickly after access checks have been carried out – Changes to the time sequences to improve the distribution of crowd flows – Changing the utilisation of space and rooms to improve the allocation of attendees – Optimisation of areas (e.g. changing the arrangement of event-related infrastructure, installing a privacy screen) – Relocation of a special attraction to another part of the event area – Relocation of a contact point that may be heavily frequented (e.g. catering, toilets, but also tents or shelters in the event of bad weather) – Extension of a waiting zone or common area: • Reduce other space requirements • Add further/adjacent areas • Remove superstructures, fixtures or obstructions • Pave areas, that could not be used in wet weather • Lighting (so that remote peripheral areas are also used) • If expansion is not possible, create/keep clear possible relief zones – Increased deployment of stewards (also for continuous monitoring of crowd flows) – Providing opportunities to address people waiting or backing up – Opening of reserved/retained relief zones if a critical crowd density is reached – Segregation of departures in terms of time and/or space to relieve congestion in the exit areas or the pedestrian routes and/or public transport stops behind them

Possible scenario/ special requirement	Solutions/measures
Continuation: Need to relieve (critical) waiting zones and common areas used by people travelling to and from the event site and those attending the event site	– Accepting the risk and improving deployment options in the event of overcrowding (e.g. prepared safety announcements, preparation for opening relief zones, more accident assistance points, additional fire safety departments, more emergency exits) – Never take measures uncoordinated, always check possible measures with regard to the consequences for the entire event and – if not foreseen and planned – only initiate them after consultation with all those involved.
Dealing with (problematic) taxi services	– Make existing taxi ranks more attractive, so that they are used and taxis do not let their passengers get in and out "recklessly" and obstruct traffic – Reorganisation of operational procedures at taxi ranks, including any necessary controls – Expansion of existing taxi ranks – Relocation of taxi ranks as close as possible to entrances/exits – Installation/completion of signposting, especially back to the taxi rank at the end of the event – Special traffic routing for taxis – Extension of the arrival and departure period (e.g. through pre-events and post-events at the event site) – Shifting attendee traffic to public transport (e.g. combined ticket, expansion of public transport services)
Dealing with the use of public areas	– Modification of the event concept or reduction of external area utilisation – Re-distribution of area utilisation/use of alternative areas – Provision of additional logistics or service areas in the wider neighbourhood – Closure and diversion of motorised individual traffic, including the associated communication and public relations work – Diversion routes for public transport, including the associated communication and public relations work – Closure and diversion of flows of pedestrian traffic, including the associated communication and public relations work – Provision of alternative parking areas for residents and neighbours – Avoiding further, additional area utilisation (e.g. no construction sites on public roads in the vicinity of the event)
Dealing with the protection of residents	– Minimising the motorised individual traffic ratio for arrivals and departures – Temporary closures for through traffic/(controlled) access for residents only – A sufficient number of parking areas directly at the event location so that there is no person searching for a parking area in neighbouring streets – Changing the motorised individual traffic routing concept for the event – Changing the event-related footpath routing – Street cleaning during and after the event – Communication with local residents

Remarks on the system of technical publications of the FGSV

R stands for regulations:

These publications either specify the technical design or realization (R1) or give recommendations on the technical design or realization (R2).

W stands for information documents:

These publications represent the current state-of-the-art knowledge and define how a technical issue shall be practicably dealt with or has already been successfully dealt with.

Category R1 indicates 1st category regulations:

R1-publications contain the contractual basis (Additional Technical Conditions of Contract and Directives, Technical Delivery Forms and Technical Testing Regulations) as well as guidelines. They are always coordinated within the FGSV. R1-publications – in particular if agreed on as integral part of the contract – have a high binding force.

Category R2 indicates 2nd category regulations:

R2-publications contain information sheets and recommendations. They are always coordinated within the FGSV. Their application as state-of-the-art technology is recommended by the FGSV.

Category W1 indicates 1st category documents of knowledge:

W1-publications contain notes. They are always coordinated within the FGSV but not with external parties. They represent current state-of-the-art knowledge within the respective responsible boards of the FGSV.

Category W2 indicates 2nd category documents of knowledge:

W2-publications contain working papers. These may include preliminary results, supplementary information and guidance. They are not coordinated within the FGSV and represent the conception of an individual board of the FGSV.

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