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Key Crowd Safety Issues in the Design of Public Venues

Conception des lieux de réunion et critères de sécurité

Konzeption von Versammlungsstätten Sicherheitskriterien

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SUMMARY

This paper concentrates on the hazards that can arise from crowd behaviour and their implications on venue design requirements. It also argues that there are benefits in adopting a systematic approach to the assessments of risks during the design stage of a development project. A proposed approach to crowd safety risk assessment is briefly described. This paper is based on a major research project on crowd safety completed by the authors for the UK Health and Safety Executive. The results of the research form the basis for guidance on crowd safety planning in the UK.

RÉSUMÉ

L'article expose la valeur d'une méthode systématique d'évaluation des risques dans une phase d'étude initiale, relative aux dangers résultant du comportement des foules et qu'il faut prendre en compte lors du projet de lieux de rassemblement. La réflexion méthodique ainsi présentée se base sur un projet de recherche de grande envergure entrepris par les autorités britanniques de la santé et de la sécurité et dont les résultats ont d'ailleurs été utilisés pour établir des recommandations nationales en la matière.

ZUSAMMENFASSUNG

In Betrachtung der Gefahren, die aus dem Verhalten von Menschenmassen erwachsen und beim Entwurf von Versammlungsstätten zu berücksichtigen sind, wird der Wert einer systematischen Vorgehensweise bei der Risikobeurteilung in einem frühen Planungsstadium aufgezeigt. Die vorgestellte Betrachtungsweise basiert auf einem grösseren Forschungsprojekt der britischen Behörde für Gesundheit und Sicherheit, dessen Resultate in einschlägige nationale Empfehlungen Eingang fanden.

1. INTRODUCTION

Public venues refer to permanent as well as temporary places where members of the public assemble. They include transport venues, sport stadia, shopping malls, leisure complexes, concert arenas and fairgrounds. Large crowds are a normal and desirable part of the operations in many of these venues. However, the presence of large numbers of people can give rise to a variety of safety hazards. These can result from unsafe venue features, crowding problems or the existence of one or more physical threats (e.g. fire) in an emergency. Appropriate design and effective crowd management are the keys to ensuring crowd safety in public venues. The focus of this paper is on the first of these aspects. Management issues have been discussed elsewhere (References 1 & 2).

2. VENUE DESIGN REQUIREMENTS

At a general level, the most important design requirements are:

(i) To ensure that the venue provides sufficient space, access and appropriate layout to cater for the needs and activities of the crowds during normal operations and in an emergency situation.

(ii) To ensure that the structures are sufficient to accommodate the static and dynamic loadings that can occur through the above.

Adequate venue design involves more than just elimination of unsafe design features (e.g. inadequate stair design or unsafe floor surfaces), removing of obstructions, minimisation of pinch points, and creating enough space for people to stay or move around. Whilst these are important design requirements, the emphasis should be on how to cater for the needs and activities of the crowds as described in (i) above. To achieve this, the design team must carefully consider the likely crowd flows, distribution, and behaviour in their specific venue. Crowd behaviour is particularly important since it can have a substantial influence on flows and on visitor activities, which in turn determines venue design requirements. The rest of this paper discusses the implications crowd behaviour can have on crowd safety and venue design. It also outlines a systematic approach to the assessment of crowd safety risks during the design phase of a development project.

3. CROWD BEHAVIOUR

3.1 Understanding Crowd Behaviour

The ways people behave in a public venue is influenced by a large number of diverse factors. Some of them are directly related to venue design, others are either due to specific circumstances or associated with the individuals themselves. Nevertheless, most of these can have implications for venue design. Therefore, it is very important for the design team to identify such factors and understand their influences.

Figure 1 shows a model of the factors affecting people's behaviour in public venues. It was developed as a framework for describing the influences of various factors on crowd behaviour. The model is structured around a human response flow diagram which consists of four main stages that an individual may cycle through. The four stages are:

(i) To sense - the stage at which the individual obtains information from the surroundings.

(ii) To interpret - the stage at which the individual considers the meaning of the information.

(iii) To decide - the stage at which the individual decides upon the response required to the interpreted situation.

(iv) To act - the stage at which the individual physically carries out the plan/decision.

3.2 Factors Affecting Crowd Behaviour

Factors affecting behaviour are listed adjacent to the human response flow diagram. They are grouped in accordance with the ways in which they may affect behaviour. It is impossible to describe and discuss in detail the influence of each factor in this paper. Therefore, the rest of this section focuses on some of the more important factors and discusses the implications they may have on venue design.

3.2.1 Goals and Objectives

The reasons for attending a venue, any dominating desires or immediate needs that people have is often the primary factor in determining their activities, movement and distribution. For example, in a venue designed to hold events where there is a centre of attention (e.g. outdoor concerts, sports fixtures, racing), the primary goal of those attending is to gain a suitable vantage point in order to watch the attraction. The crowd density and hence the loading in these vantage points are therefore likely to be significantly higher than in other parts of the venue. Similarly, the access routes leading directly to these vantage points are likely to be in greater demand. In a pop concert, for example, people tend to gather as close to the stage as possible, whereas a position adjacent to the finishing line is a primary vantage point in a race meeting. Furthermore, there may be some incentive in climbing up venue features such as fences, towers (e.g. for lighting), walls and other similar structures to obtain a better view. These structures should, therefore, be able to withstand the extra loading imposed or suitably designed to prevent or discourage such behaviour.

Apart from the centre of attention, there are often other places in the venue which tend to 'attract' a large number of people. Such places include refreshment and toilet facilities. Access to and from these facilities are likely to be heavily used and should be designed accordingly. Consideration needs to be given to the location of such facilities in relation to accommodation/circulation areas, exit/entrance capacity and the physical design of the fixtures and structures in such areas.

Similarly, in transport venues where the main goal is to catch the train, plane, etc., the main 'attractions' tend to be the area in front of the departure board and the check-in area where static crowds mingle with dynamic crowds. An open area is therefore required to cater for such activities. Large number of pillars and columns can restrict movement and create crowding problems. The positioning of departure information has to also be considered to prevent unwanted localised crowding problems. In some other venues such as shopping malls and show/fairgrounds, the 'attractions' are spread across the venue and particular attention needs to be paid to crowd flows.

3.2.2 Mental Condition and Emotion

People's mental state such as aggressiveness, jubilation and emotional fever can significantly influence their activities in some venues and therefore have to be taken into consideration at the design stage. Aggressiveness can lead to confrontation between rival groups. Jubilation and emotional fever can easily lead to people jumping up and down, swaying and surging, and other similar activities (e.g. 'Mexican Waves'). These activities obviously put extra loading on the structure underneath and may pose a direct threat to crowd safety through crushing with appropriate seggregation or barrier design.

3.2.3 Knowledge, Experience and Expectations

It is important to bear in mind that people behave in accordance to their perceived environment which does not necessarily correspond to the real environment. People tend to interpret what they see, hear, etc. based upon the knowledge, experience and expectations they have developed from everyday life and past visits to similar venues. Incorrect perceptions of the layout of the venue and of the situation can result in tragic consequences, especially during an emergency (eg. the King's Cross fire in 1989). However, the layout of some public venues is so complex and confusing that way finding is difficult for people even during normal operation. Venue layout and the detailed venue features can also influence crowd distribution. For example, where there is more than one access route to a particular area, people who are unfamiliar with the venue tend to use the more obvious route. Those who know the venue well tend to use the most direct route. A potential consequence of such behaviour is overcrowding on one route whilst the others remain quiet. Inadequate consideration of flow patterns and user habits cannot necessarily be overcome by improved signage.

3.2.4 The Characteristics of the Venue

The layout of the venue, design of circulation routes, and the design and location of facilities can have a fundamental influence on behaviour and crowd flow. Physical features of a venue can be used to enhance or restrict certain behaviour, choice of routes or actions. Depending on the particular situation, this can have both positive and negative consequences and in many instances may have a knock-on effect in other parts of the venue. For example turnstiles could be useful in limiting and controlling the flow of people into an area but may result in dangerous crowd build-up outside. Similarly, barriers or fences may be positioned to segregate crowd flows or to prevent access to restricted areas, but if used inappropriately, could from part of a trap where the movement of the crowd is undesirably restricted or channelled. Other design features which could introduce negative effects on crowd safety include pinch points or bottle necks, funnelling effects, convergence of several routes into one area with limited space, dead ends, and popular places/facilities/attractions too close to each other or next to a busy junction/crossroads.

4. A SYSTEMATIC APPROACH TO ASSESS RISKS

4.1 The Need for a Systematic Approach

The previous section was intended to give a general impression of how various factors may influence people's behaviour and consequently venue design requirements. In practice, however, there can be a different combination of factors involved in a venue at different times and under different circumstances. The effect of each factor on behaviour can also vary, resulting in widely differing behaviour. It is impossible to produce a set of rules on behaviour and venue design which are general enough to suit all types of public venues and yet specific enough to be useful.

A better alternative is to systematically assess the safety risks associated with the design. This is to ensure that the venue does not pose any major safety hazards and that it is as safe as is reasonably practicable during both normal operation and in an emergency situation. Risk assessment at the design stage also helps to avoid costly modifications which may otherwise only be revealed after the venue is built.

4.2 An Overview of a Risk Assessment

The purposes of a risk assessment are as follows:

(i) To provide a systematic review of the safety risks within a venue.

(ii) To enable the hazards to be prioritised and subsequently to identify those aspects of the venue design that require the most needed modifications.

(iii) To focus attention on the design modifications required to minimise the risks to crowd safety.

In order to achieve the above, the risk assessment process generally consists of the following four main stages:

(i) Identification of hazards - This is to consider and identify the safety hazards that could exist due to inadequate design or lack of consideration to people's needs and activities. The aspects of the design which could contribute to the hazards are also identified at this stage.

(ii) Risk estimation - This is to estimate the risk level of each of the hazards identified. It involves determining, using expert judgement, the likelihood of each hazard to occur and the potential consequence should it occur. Rating scales such as those shown in Figures 2 and 3 can be used for this purpose. The risk level of each hazard can then be calculated by multiplying its likelihood and its consequence. It must be noted that the risk levels calculated at this stage are for ranking purposes only and should not be treated as an absolute measure of risk.

(iii) Risk Prioritisation - This is to compare the risk level of each of the hazards in order to determine their relative importance. In general, the higher the risk level, the more important the hazard is. Priority should usually be given to tackle hazards which are relatively more important.

(iv) Identification of measures to minimise risk - This is to identify the modifications required on the existing design in order to minimise risk in the venue.

More details on risk assessment and its applications to crowd safety can be found in References 1, 3 and 4. To maximise the benefits of risk assessment and to minimise the costs and effort involved in modifying the design, a brief risk assessment can be carried out at the end of the initial design stage on the general layout and on the main venue features. A more detailed assessment can be conducted at the final design stage on all aspects of the design.

5. CONCLUSIONS

A range of hazards can arise from the assembly of large crowds in public venues. Adequate venue design is vital to crowd safety. In general, venues should be designed to cater for the needs and activities of the crowds. In order to achieve this, careful consideration has to be given to crowd flows, crowd distribution and especially crowd behaviour. Crowd behaviour in public venues is influenced by a large number of diverse factors, many of which have some bearing on venue design. However, the ways these factors influence behaviour, and hence design requirements, varies across venues. There are clear benefits from carrying out a systematic review of the risks posed by a design. To do this at an early stage of a development project could minimise the costly safety modifications that may be required after the venue is built. It could also significantly reduce the costs and effort involved in crowd management when the venue is in use.

6. REFERENCES

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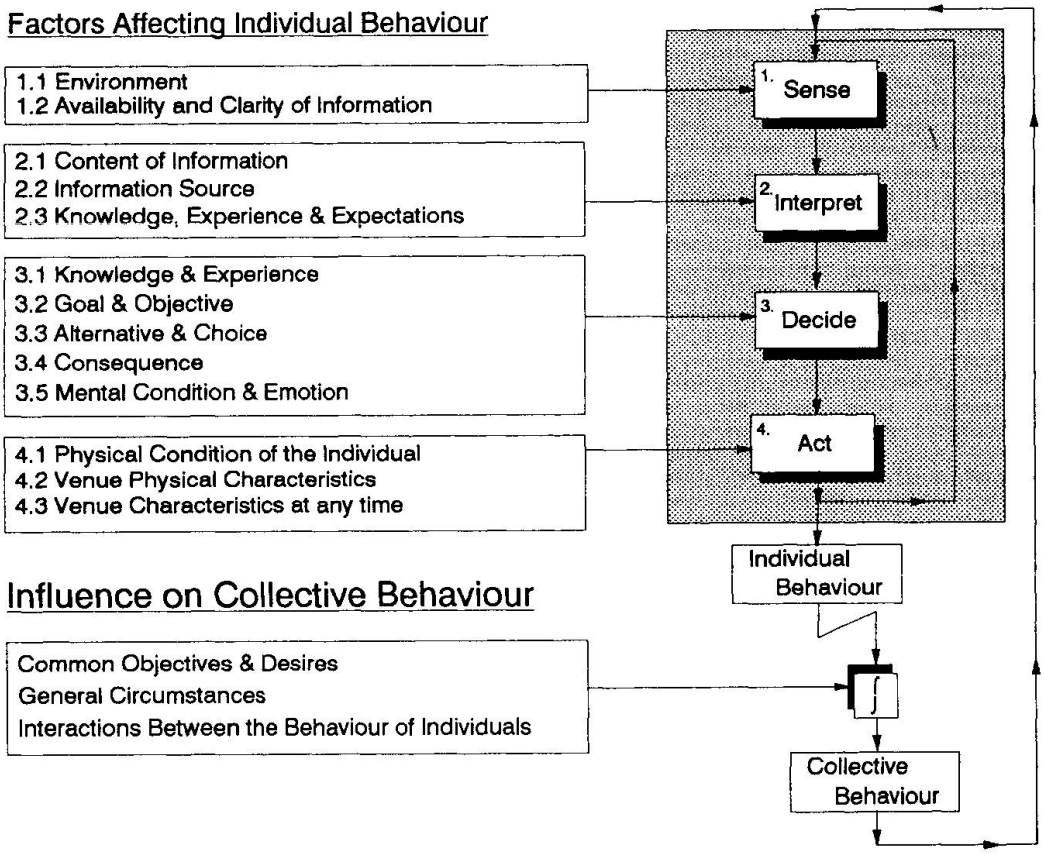

Figure 1 Factors Affecting People's Behaviour in Public Venues

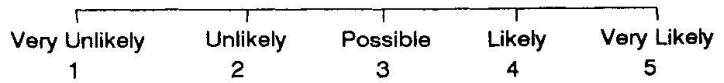

Figure 2 A 5-Point Scale for the Estimation of Likelihood

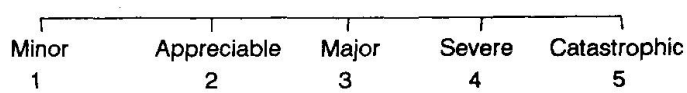

Figure 3 A 5-Point Scale for the Estimation of Severity of Consequences