

Spatial Changes after Public Safety Incidents

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Abstract. How to use space to regulate people's behaviour is one of today's key issues. The academic community for environmental behaviour research from the environmental determinism, gradually shifted to the interaction theory. Many studies have focused on the effects of human behavior on space and vice versa. However, research on the safety of specific workspaces is lacking. This paper delves into safety hazards within workspaces amid social tensions and public safety hazards, exploring how environmental enhancements can inversely impact human behavior. This paper compares the workspaces for bus drivers from different countries, analyses the advantages and disadvantages of each configuration, and concludes two key aspects in improving worker safety: establishing proper enclosure of physical space for the workers and maintaining a visual connection with the public. These two aspects are critical for other workspaces, such as doctor's offices and commercial kitchens as well. Through such spatial adjustment, designer can achieve the purpose of regulating the user behaviours. This paper also looks into the safety measures implemented after different types of natural disasters and confirms that substantial safety improvements are achievable through thoughtful design interventions.

Keywords: Social hot spot; public safety; workspace; spatial change; physical space.

1. Introduction

By analyzing the infamous public safety incidents and exploring the changes they had on human behaviour and redesigning of the spaces in which the incidents took place. This paper looks into the adaptation of the new design for physical and visual space to influence human behaviour. Currently, academic research has mostly focused on the revision of policy and design guidelines caused by societal trends and movements but not specific events. This preference in research topics overlooks the crucial aspect of the sum the major changes happening in this field. The next part of this paper will focus on both mass and natural event narratives, exploring how the design of physical and visual space can positively influence human behaviour during major events.

2. Reflections on workspace changes triggered by mass safety incidents

2.1. The changes of the workspace for bus drivers

Over the past ten years, there have been numerous cases of bus drivers being physically assaulted by passengers. Refer to Figure 1 for specific data [1]. According to statistics from Qingdao City in Shandong Province, China, there have been 30 such incidents in just a 10-month period [2]. The most tragic of these incidents happened on October 28th, 2018, when a bus in Chongqing plunged into a river. The cause of the accident was a passenger who demanded that the driver stop the bus immediately at a non-stop location when the driver refused, the passenger attacked him. This led to the bus crashing through a guardrail and falling into the river. Sadly, 13 people died and two others are still missing as a result of this incident [3]. To prevent the occurrence of such vicious incidents, the management of public transportation around the world has been upgraded. First of all, the way to conducting work has changed. According to Wang Jian, a professor at the School of Transportation and Communications of Chongqing Jiaotong University, when compared to bus drivers in other countries who only drive, drivers in China have additional responsibilities such as monitoring ticket evasion and passenger supply [4].

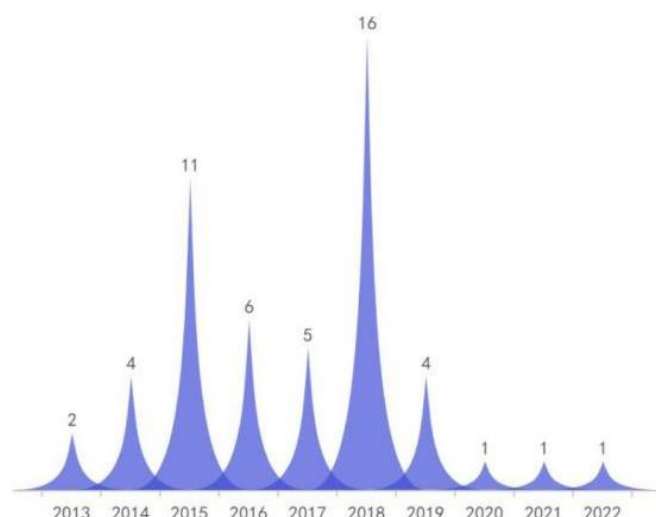


Fig 1. Number of Passenger-Driver Conflicts Filed in China, 2013-2022, self-created [1].

The many tasks assigned to drivers make it difficult to have a closed workspace. An open space at any time may cause safety hazards. Therefore, it is vital to optimize the driver's work responsibility, work method, and workspace to reduce the occurrence of such tragedies. The bus company retrofitted the buses with safety doors in accordance with the provisions of the *Technical Requirements for Special Safety Facilities for Urban Public Vehicles and Trams* set by China in 2019. At present, after the field investigation, in most of the cities in China's public transport companies in the driver's workspace has set up with safety isolation doors. This paper uses images to analyze the transformation of workspace in public transportation. China's driver workspace before and after the improvement of the difference is very obvious. The driver's workspace locates in the forefront of the vehicle. The rest of the space has almost no separation allowing the passengers to invade the driver's work area at any time. The driver is subject to a high degree of interference while driving and the safety measure is lacking. See Figure 2 for details [5]. The improved semi-closed workspace separates the driver's work area from the passenger area. The passengers cannot easily invade the driver's workspace, and this to make up for the shortcomings of the previous railing guardrail to a certain extent, it further isolates the drivers and blocks the distraction, optimizes the driver's performance, allowing increased driver's focus. See Figure 3 for details [6]. As a result, this change increases the safety of drivers and their passengers on the bus. However, the semi-enclosed space in the current Chinese public transportation system, puts their drivers at risk. The semi-enclosed space does not provide the drivers their autonomy to control how they communicate with the passenger, and the drivers' workspace is still vulnerable to passenger invasion. On December 14, 2020, a passenger took a Guangzhou 76 bus to the Dongping subway station near the bus stop. The passenger missed his stop. When he asked the driver to stop, the driver refused, and the passenger hopped over the guardrails to get to the driver and hit the driver with his shopping bag.



Fig 2. Driver's workspace in China - Before Improvement [5].



Fig 3. Driver's work space in China - Improved [6].

The occurrence of this vicious incident illustrates that the semi-enclosed workspace still permits the driver to be vulnerable. This paragraph analyzes the form of the safety barrier door itself through the collection of data from the United States, Russia, the United Kingdom, Germany, and China's public transportation interior photographs. See Figure 4 for details [7]. This paragraph analyzes the changes that safety gates have brought to the enclosure of the driving space and the relationship between the driving space and the passenger space. This paragraph compares the results of transformed bus spaces in different countries and finally summarizes the advantages of each space. Through the comparison of the bus driver's workspace in the above countries, this paper finds that in addition to China and the United States after the improvement of the driver's workspace is not completely separated from the passengers, the use of semi-enclosed, leaving the front end of the driving space is not fully enclosed, you can always supervise the evasion of the situation. The lower end of the unenclosed space is equipped with a ticket inspection device, which also makes it difficult for passengers to enter the driving area. In all other countries studied, the driver's workspace is enclosed from the public space used by passengers. For example, in Russia, the UK, and Germany, the driver's workspace is fully enclosed and exists as a separate workspace from the space used by passengers. Whether or not the space intersects with the passenger's space is entirely up to the driver. The design of the driver's workspace in the above three countries maximizes the driver's safety and reduces communication with the passenger to ensure the driver's concentration during work. Overall, the comparison shows that "the bus driver's workspace is more secure when it is fully enclosed".



Fig 4. Comparison of bus drivers' workspace by country [7].

2.2. The change of doctors' workspace

In 2020 Beijing Chaoyang Hospital medical case, Yong Tao, a doctor who saved 15,000 patients, was cut 6 times by the patient in a dispute. This incident left Dr. Tao in serious injuries, and his left hand lost its function. After this incident, social awareness of doctor-patient conflicts rose to a new level. According to the analysis of previous medical dispute cases, most of the cases occurred in the clinic, wards, and other medical areas or in the office spaces that separate from public waiting area and only where few people have access. The Institute of Legal Studies of the Tianjin Academy of Social Sciences conducted a follow-up study on the relationship between the number of offenses and the location they take place. The study covers the three years 1990, 1993, and 1996. Reference can be made here to Figure 5 [8]. The results of the study show that the number of incidents are negatively correlated with the extent of public access. Private space and public space have different psychological influence on the potential perpetrator [9]. Generally speaking, private space brings less pressure to

the perpetrator, the cost of crime is lower, and the absence of security personnel increases the probability of success for the assault. Firstly, spatial changes need to take into account patient privacy to ensure that regular consultations are not compromised, and designers can only visually adjust the layout of the healthcare space, starting with the fact that the consulting rooms need to be redesigned to avoid doctors turning their backs on patients [10]. Secondly, when a doctor is on duty alone, the workspace can be made of more transparent material so that the whole space can be subjected to public attention and scrutiny, increasing the psychological pressure on the perpetrator to commit a crime. To protect patient privacy, translucent materials can be used, such as frosted glass and other fuzzy materials such as translucent frosted glass material used in the Nelson Atkins Museum of Art, which ensures patient privacy and also ensures an increase in the safety factor of the doctor's work.

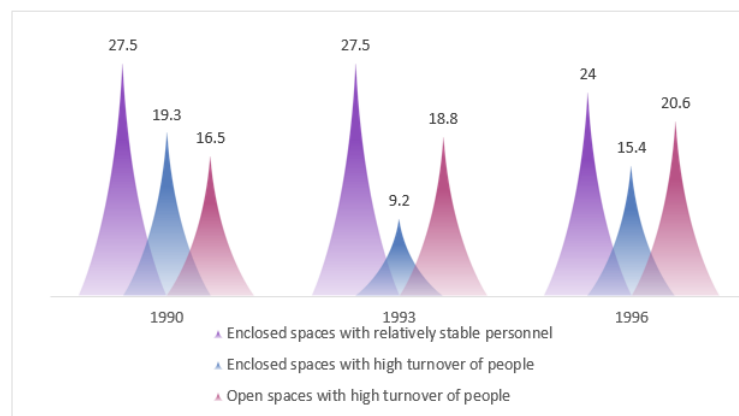


Fig 5. Comparison of the number of assaults in different spaces [8].

2.3. Kitchen Safety

May 2, 2023, Qing yuan, Guangdong. Diners were dissatisfied with the speed of the chef's meal preparation and broke into the back kitchen to vandalize. Diners' anxiety and false expectations of meal preparation time are the main reasons for vandalism [11]. The traditional chef's workspace is closed off from the diners' space, and the diners have no access to the progress of food preparation while waiting for the meal to be made, which may cause anxiety and greatly reduce patience with the food preparation. Pressure will be exerted on the waiter, the waiter will work on the chef to urge, and the chef in the process of work is constantly disturbed, work mood, work efficiency, and even physical health will be affected. In turn, the food safety and quality is affected, forming a vicious circle. Space needs to be adjusted, the first is to break the visual barrier between diners and chefs, so that the chef's workspace is more visible to the front of house, keeping a physical distance between the dinners and chefs, but allows the visual connections. Through the research of Din Tai Fung restaurant, we can learn that their kitchen has large transparent glass, the dinners and people waiting in line outside the restaurant can see the chefs prepare food food in rapid speed. This strong visual connection helps ease the the negative emotions for constomers waiting for their food. At the same time, the physical separation ensures the thehealth and safety of chefts' work environment. In general, without changing the closed physical space of the traditional kitchen based on adjusting the degree of visual openness of the traditional kitchen, the kitchen will be constructed using transparent materials. This visual connection helps alleviate the anxiety of diners and ensure that the chefs canfocus on cooking and reduce the operational errors.

3. Changes in spatial security aftermajor desasters

3.1. Changes in urban planning afterfire

The Great Fire of London in 1666 is a typical example of how fire changed people's lifestyles and led to changes in the reconstruction of safe spaces. The first major change is the change of building materials, after the fire people's awareness of fire prevention gradually increased, and the original

wooden buildings in the reconstruction process replaced the stone to shape the space. From the Middle Ages until the fire, more than 90% of the building's timber was oak, and stone was difficult to obtain and affordable only to the wealthy residents [12]. In the wake of the fire, wood was explicitly banned from the exterior of buildings under the London Urban Renewal Act of 1666 [13]. Material isolation from the possibility of combustion made living spaces safer to use, the city more stable in a fire, and fires easier to contain. The second major change is the change in road space, the narrow lanes were difficult to carry the huge crowds of people in London, carriages were difficult to get through, and even when they did, they traveled at a very slow speed [14]. In the fire, this passageway becomes a "life-threatening passageway" that is difficult to travel, people who fight the fire can't get in, and people who flee can't get out, which creates a unsafe consiton, and this is also one of the major reasons why the fire in London in 1666 was difficult to control. Before the fire, the streets were invaded by countless randomly erected "temporary buildings", overhanging houses, and overhanging windows affecting the road, difficult to pass through, without regulation. At a meeting in October 1666, the Redevelopment Commission decided on the width of the new city streets - 100 feet wide for arterial roads; 75 feet wide for collector roads; 50 feet for some main streets, 42 feet for others, 30 or 25 feet for Local Street; and 16 feet for other alleys. In the redevelopment bill, it was proposed to prohibit the building of overhanging houses and overhanging windows [15]. After this, the road space was planned to be very wide when rebuilt, and the widening of the road space made it possible for emergency vehiclesto pass through.

The high level allowed for mass evacuation in the event of another disaster, as well as a large number of disaster relief activities, making the city more secure. On May 26th, 1667, the fire broke out again, this time causing 600 houses to be burned down and then brought under control, which was a much more optimized situation compared to the 13,200 houses that had been destroyed by the fire before the rebuilding [16] [17]. Overall, the London government's intervention was very effective, starting from the space to adjust the building facade materials, and street width to cope with the fire. 1725, the Englishman Richard Niecham invented the hand snap pumper fire engine, the car is 5.04 feet high, 1.84 feet wide, and 1.44 feet deep and is very suitable for a variety of London alleys.

3.2. Change in landscapesafter flooding

Due to the El Niño phenomenon, the 1998 floods in China, destroyed many cities in Jiangxi, Hunan, Hubei, and Heilongjiang provinces. An area of 318 million acres was affected and 196 million acres of land was seriously damaged. The flood affected a population of 223 million people, caused 4,150 deaths, destroyed 6.85 million houses, and resulted in direct economic losses of 166 billion CNY [18]. The spatial reasons for the formation of floods are as follows: on the one hand, there are too many impervious pavement areas in the city, with poor infiltration; and on the other hand, the aging stormwater system in the cities was not able to carry a large volume of excess water fast enough [19]. In response to these issues above, designers have derived the concept of Sponge City to alleviate flooding. Sponge City is a proposal to re-activate the area in the public space of the city as a stormwater catchment area. On the one hand, the designers relieved the pressure on the drainage system by increasing the area of urban green space and enhancing soil infiltration [20]. On the other hand, the increase in urban green space can enhance rainwater infiltration and further promote water circulation, which can ultimately alleviate the urban heat island effect. The means of landscape space shaping is utilized to mitigate flooding to some extent to safeguard the safety of the people. This kind of spatial intervention is implemented and followed by many cities, and it is an effective intervention [21]. In the city of Wuxi implemented the Sponge City strategy. Many old neighborhoods was revitalized.

By examining the flow curve analysis of the graph prior to the implementation of Sponge City strategy, one can gain a deeper understanding of the alterations. Details can be found in Figure 6 [21]. Notably, there has been a significant deviation in the peak ground flow of nearly 500 liters per second. Subsequent to the transformation, the flow reduced on average, suggesting that this intervention is a valuable aid in mitigating urban flooding. Nevertheless, there remains further

potential for improvement to attain the ultimate intervention effect, and the designer should take this into account for the future.

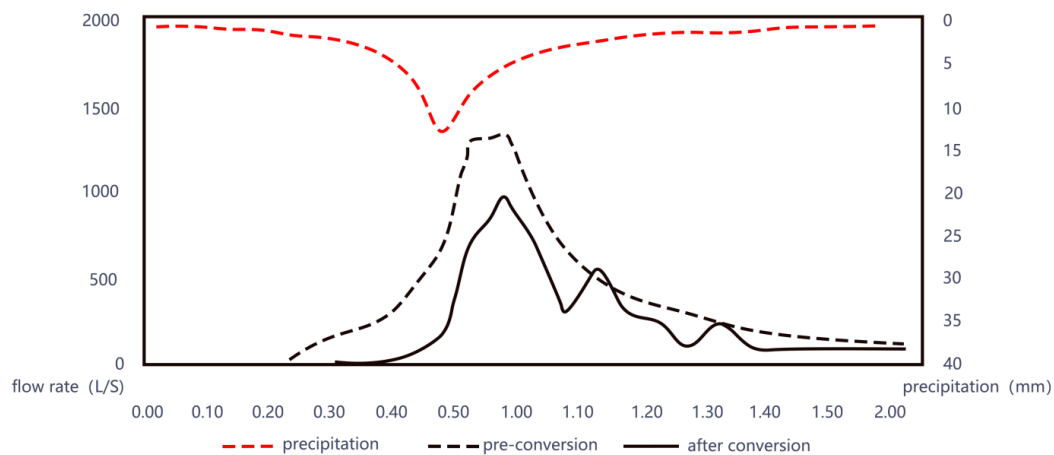


Fig 6. Flow curve analysis before and after Sponge City renovation [21].

4. Summary

This paper analyzes public safety incidents to conclude that physical space and visual connection can regulate human behavior and improve workplace safety. Designing spaces that solve the negative impact of environment on human behavior can reduce the danger of people in workspaces and enhance social stability. The article emphasizes the need for physical separation while maintaining visual connections, which is conducive to improving workplace safety. In urban areas, roads and green spaces should be expanded, and low or non-flammable building materials should be used to respond to major disasters. This paper provides research ideas for future scholars to delve deeper into the pain points and difficulties of public safety and propose practical opinions on urban development.

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