Exploring disaster risk reduction in the built environment

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Abstract

The purpose of this paper is to review the role of construction industry and built environment disciplines in disaster risk reduction. There is much evidence to show that every year natural disasters cause a substantial amount of damage throughout the whole world. This brought forward the importance of disaster risk reduction to prevent or mitigate the adverse impacts of disasters. The construction industry has a strong relationship with disaster management and therefore there is a high need in identifying how the construction industry and its related disciplines can contribute towards disaster risk reduction. Therefore the paper focuses on the role of the construction industry and the built environment professionals in disaster risk reduction. The literature review method has been used to address this emerging topic and therefore the paper is based on the academic literature, journal and conference papers and reports produced by various institutions.The review of literature reveals that there is a clear relationship between disaster risk reduction and the built environment disciplines. It has been identified that the construction industry and built environment professionals have a significant role to play in disaster risk reduction in both pre and post disaster situations. The risk reduction strategies can be incorporated in to all phases of construction projects, including planning, designing, construction and maintenance in addition to town and country planning and policy making.

Keywords: built environment, construction industry, disasters, disaster risk reduction

1. Background

Disasters cause a considerable amount of damage around the world every year (Ofori, 2001). There has been an increase in the number of natural disasters over the past few years, and the impact in terms of human, structural and economic losses has increased considerably. According to official statistics issued by the Centre for Research on the Epidemiology of Disasters (CRED) and the United Nations International Strategy for Disaster Reduction (UN/ISDR) in 2010, natural disasters have caused the death of more than 780,000 people over the past ten years and destroyed a minimum of US $ 960 billion worth of property and infrastructure.

It has been identified that the severity of the impact by natural disasters is directly linked to unplanned urban development and ecosystems (ISDR, 2010). Haiti Earthquake which hit on 12 January 2010 resulted in the death of more than 200,000 people and made up to a million homeless which is an extreme illustration of either unplanned or total lack of development activity required for disaster risk reduction. According to Witte and Llana (2010), the powerful earthquake that struck Chile on 27 February 2010 was far stronger than the one that struck Haiti in January, but the damage was much more contained, with a death toll of 214 which is a thousand times lower than that of Haiti's. This highlights the importance in implementing disaster risk reduction measures to prevent or mitigate the impact of future disasters. Secretary-General (2006) too has identified the importance of incorporating disaster risk reduction strategies in all development activities, policies, programmes and investments for national and local governments.

The construction industry and built environment disciplines have a strong relationship with disaster management. "Disaster management" can be defined as the range of activities designed to maintain control over disaster and emergency situations and to provide a framework for helping those who are at risk to avoid or recover from the impact of the disaster (Kelly, 1996). It is evident that in the case of disasters, most of the material damages have been on engineering related facilities in the disaster areas such as buildings, roads, bridges, water supply plants, communication and power services, harbours, etc. Therefore clearing, salvaging, rehabilitation and reconstruction work fully or partly require serious effort of the construction sector. Disaster management deals with situations that occur prior to, during, and after the disaster and in all these phases the role-played by the construction sector is vital.

The main aim of this paper is to highlight the role of the construction industry and the built environment disciplines in disaster risk reduction. The paper first focus on the various definitions of disasters and explains the literature on disaster management. The next section is on disaster risk reduction practises where various existing literature has been brought forward to explain the concept of disaster risk reduction. The third section focuses on disaster risk reduction in the built environment where the relationship of the disasters and the built environment has been highlighted initially and then moved on to the role of the construction industry and the built environment disciplines in disaster risk reduction.

This paper is based on review of existing literature in order to explore the disaster risk reduction in the built environment. Therefore the academic literature, journal and conference papers and reports produced by various institutions has been used for the review of existing literature.

2. Disasters and disaster management

There have been many attempts to define the term “disaster”. ISDR (2002) has defined disaster as a “serious disruption, of the functioning of a society, causing widespread human, material, or environmental losses, which exceed the ability of the affected society to cope using only its own resources”. Parker (1992) identified a disaster as “an unusual natural or man-made event, including an event caused by failure of technological systems, which temporarily overwhelms the response capacity of human communities, groups of individuals or natural environments and which causes massive damage, economic loss, disruption, injury, and/or loss of life”. Some authors have stressed disaster as a social event. Neil (1986) has identified a disaster as a social event where the propensity is dependent upon the interplay between humans and their use of the physical and social world. According to Quarantelli & Perry (2005) disasters are “overt manifestations of latent social vulnerabilities, basically weaknesses in the social structures or social systems” and that the disaster stems from the social system and not necessarily the event itself (Quarantelli & Perry, 2005).

As per Shaluf et al (2003), there is no universally accepted definition for disasters and all the above definitions differ upon the discipline in which they have been defined. Therefore having a proper definition for a disaster is extremely important (Songer, 1999). Ginige et al (2009) has identified that almost all the definitions of disasters have described a disaster as an event, which disturbs the social structure or the environment, causing a significant loss and needs external assistance for recovery. As can be seen from the above definitions the key words and phrases in relation to a disaster are “sudden or unexpected, crisis situation, serious disruption of the functioning of a society, widespread human, material, or environmental losses and overwhelms the local capacity”. It should also be noted that in the case of a disaster there is no prior warning and as such the people are not adequately prepared. This can result in the disruption of the entire system.

Disasters can be categorized by their origin, natural or man-made. Most of the disasters investigated in the literature are natural disasters. Disasters may occur suddenly (a quick onset), or they may develop over a period of time (a slow onset). Most of the disasters occur suddenly and perhaps unexpectedly. According to Songer (1999), disasters, which are related to extreme weather conditions, (floods, cyclones, tornadoes, blizzards, droughts) occur regularly and events related to extremes of the earth’s geology (earthquakes, volcanic eruptions) occur less frequently, but results in major consequences when they happen.

The origin and the causes of disasters can be varied but the consequences to human society are frequently similar which includes, extensive loss of lives, particularly among vulnerable members of the community; economic losses, hindering development goals; destruction of the built and natural environment, increasing vulnerability; and widespread disruption to local institutions and livelihood, disempowering the local community (Haigh and Amaratunga, 2010)

Disaster management can be defined as a “collective term encompassing all aspects of planning for and responding to disasters, including both pre- and post-disaster activities” (CERO, 2004). It may refer to the management of both the risks and consequences of disaster. Amarasinghe et al. (2006), defined disaster management as “an applied science, which seeks, by the systematic observation and

analysis of disasters to improve the measures to prevent, respond and recover from the effects and consequences of a disaster".

Therefore disaster management can be identified as a cycle of inter related activities. According to Warfield (2004), the Disaster management cycle illustrates the ongoing process by which governments, businesses, and civil society plan for and reduce the impact of disasters, react during and immediately following a disaster, and take steps to recover after a disaster has occurred. Therefore it is important to take appropriate actions at all points in the disaster management cycle and it will lead to greater preparedness, better warnings, reduced vulnerability or prevention of disasters (Adams and Wisner, 2003).

According to Kawata (2001), disaster management can be divided into four parts Emergency response and relief, Recovery and reconstruction, Mitigation and Preparedness, which are mainly, categorized under two main headings - Crisis Management, and Risk Management. Disaster management cycle is an open ended process or an ongoing attempt to limit the effects of the disasters (Amarasinghe et al, 2006). The Figure 1 shows the schematic diagram of disaster emergency management as indicated by Kawata (2001).

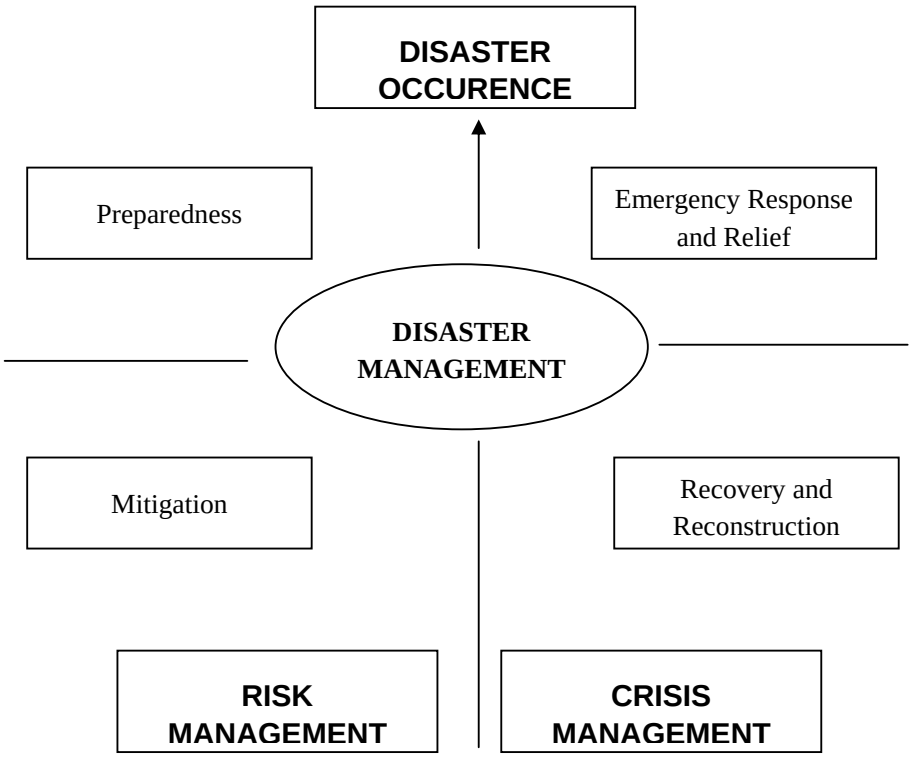

Figure 1: Disaster Management Cycle (Kawata, 2001)

The individual phases are often overlapped but it is crucial that they operate as a closed loop because a major aim of hazard management is to learn from experience and feedback (Smith, 2001). Further,

Smith (2001) has classified disaster management under two major headings Pre Disaster Protection and Post Disaster Recovery including sub elements of Risk Assessment, Mitigation, Preparedness, Relief, Rehabilitation and Reconstruction.

Pre disaster protection covers the range of activities, starting with risk assessment involving the accumulation of data and the preparation of the loss estimates. This leads to the use of various measures, such as the construction of engineering structures, insurance and land use planning aimed at long-term cost effective mitigation of hazards. The preparedness phase, which reflects the degree to which a community is alert immediately before the disaster strike, covers short term emergency planning, hazard warning and evacuation procedures plus the stock piling of supplies.

Post disaster recovery covers several phases. First, after the initial rescue of survivors, it is concerned with the distribution of basic supplies such as water, food, clothing, shelter, medical care, etc. to ensure no further loss of life. This covers the first few hours or days after the disaster impact. Second is the rehabilitation phase, which starts few weeks or months following the disaster and aims at bringing back normality to the livelihood. Next is the reconstruction, which is a much longer-term activity, and attempts to return to normality after severe devastation. Improved disaster planning should occur at this stage.

3. Disaster risk reduction

Disaster risk reduction (DRR) includes the systematic development and application of policies, strategies and practices to avoid (prevention) or limit (mitigation and preparedness) the adverse effects of hazards (ISDR, 2010). The impact of disasters can be reduced or prevented with the proper adoption of the disaster risk reduction strategies.

It has been identified that all individuals and communities are vulnerable to hazards in varying degrees and all have intrinsic capacities to reduce the vulnerability (Ginige et al, 2009). According to ISDR (2010), the vulnerability can be identified as the conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of a community to the impact of hazards. Vulnerability is also increasing due to rising poverty, a growing global population, armed conflict and other underlying development issues (Hayles, 2010). Therefore it is important to manage these vulnerabilities in order to reduce the impact of disasters.

As a result of growing vulnerability, the risk reduction has become one of the solutions to mitigate the impact of disasters in advance and for speedy recovery after a disaster (Palliyaguru and Amaratunga, 2008). It has been identified that the consequences of a disaster is very less if it happen in a place where people are well protected and the consequences are very high if it happen in a poorly protected environment. As can be seen the disaster risk can be minimised by the elimination of the unsafe conditions, in terms of people, property and infrastructure. (Pathirage et al, 2008). Furthermore, population expansion, urbanisation, inappropriate developments and global climate change has made the world increasingly unsafe and therefore it is essential to expand risk reduction measures to prevent or reduce the impact of future disasters.

Therefore disaster risk reduction should entail measures to curb disaster losses by addressing hazards and people's vulnerability to them, throughout the disaster management cycle (Palliyaguru and Amaratunga, 2008). Also, it is important to note that disaster risk reduction should be incorporated in to all development strategies, policies, programmes and investments for national and local governments (Secretary-General, 2006).

The World Conference on Disaster Reduction, held from 18 to 22 January 2005 in Kobe, Hyogo, Japan, has adopted a Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. Hyogo Framework was adopted by 168 governments at the World Conference for Disaster Reduction in January 2005. It seeks to achieve a substantial reduction of disaster losses in lives and in the social, economic and environmental assets. It identifies five priorities for action:

- Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
- Identify, assess and monitor disaster risks and enhance early warning.
- Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
- Reduce the underlying risk factors.
- Strengthen disaster preparedness for effective response at all levels.

The disaster risk reduction measures can be categorised in several ways and one such method of categorising disaster risk reduction is policy and planning measures, physical preventative measures, physical coping and/or adaptive measures and community capacity building measures (DFID, 2005). Policy and planning measures are implemented at the national or regional level and help to integrate DRR into the policy framework. Physical preventive measures are designed to reduce the vulnerability and exposure of infrastructure to natural hazards. Physical coping and adaptive measures includes coping and adaptive infrastructure which are capable to withstand in case of a disaster. Community capacity building measures are designed and implemented at the community level, particularly the strengthening of communities to better respond and cope to a disaster event through training and capacity building.

McEntire (2010) have identified four schools of thoughts for vulnerability reduction which in turn can be used for disaster risk reduction. The physical science school is about living in safe areas and focuses on exposure to hazards and risk reduction. The engineering school concentrates on the built environment and ways to increase resistance through construction practices and methods of fabrication. The structural school concentrates on traditional notions of vulnerability more than the other three, and it stresses susceptibility based on socioeconomic factors and demographic characteristics including race, ethnicity, gender, age, and other factors. The organizational school stresses resilience or the effectiveness of response and recovery operations concentrating on the

importance of preparedness, leadership, management, and the ability to adapt, improvise, and be creative.

4. Disaster risk reduction in the built environment

4.1 Disasters and the built environment

Much of the physical damage from disasters is to products of construction industry and therefore construction industry and built environment professionals have a vital role in the rectification of physical damages of disasters (Ofori, 2004). Construction practitioners can get involved in the future development of mitigation measures including enhancing building codes, standards, new materials, and construction technologies in hazard and risk areas by having partnerships with suppliers, institutions and authorities (Chang et al, 2010). As stated, the construction industry and built environment professionals have a vital role in all phases of the disaster management cycle including reconstruction, planning, prevention and mitigation. Therefore it is important to identify the nature and the composition of built environment before moving on to the contribution to the disaster risk reduction.

The built environment is an abstract concept used in some of the literature to describe the products of human building activity (Lawrence and Low, 1990). They have further elaborated the definition as any physical alteration of the natural environment, from hearths to cities, through construction by humans.

Bartuska (2007) has identified four main characteristics of built environment which are interrelated with one another. The importance of the built environment in the context of a disaster can be best illustrated by examining its above characteristics and can put forward the argument that those responsible for built environment have a vital role to play in effective disaster planning. (Haigh and Amaratunga, 2010).

First characteristic is, it is extensive and provides the context for all human endeavours. More specifically, it is everything humanly created, modified, or constructed, humanly made, arranged, or maintained. Haigh and Amaratunga (2010) further explained their argument stating that as built environment provides the context for all human endeavours and as a result of disasters the elements of the built environment can be damaged or destroyed affecting the ability of the society to function both economically and socially.

Second, it is the creation of human minds and the result of human purposes; it is intended to serve human needs, wants and values. According to Haigh and Amaratunga (2010) disasters will disrupt the economic growth of the country and will further hinder the person’s ability to emerge from poverty.

Third, much of it is created to help us deal with, and to protect us from, the overall environment, to mediate or change this environment for our comfort and well-being. This proactive characteristic of built environment will provide a means by which humanity can reduce or prevent the risks of disasters Haigh and Amaratunga (2010).

Last, is that every component of the built environment is defined and shaped by context; each and all of the individual elements contribute either positively or negatively to the overall quality of environments. Haigh and Amaratunga (2010) argued that this restrict the ability to apply generic mitigation and reconstruction solutions.

Traditionally, architecture, engineering and surveying has been identified as main built environment disciplines (Muir and Rance, 1995). The built environment discipline have developed further in the recent past and encompasses the professionals such as architects including landscape architects, interior designers and town planners and engineers including service engineers, structural engineers and electrical engineers and also the estate managers (Muir and Rance, 1995).

Disaster reduction involve in taking measures in advance, addressing risk reduction, involving environmental protection, social equity and economic growth, the three cornerstones of sustainable development, to ensure that development efforts do not increase the vulnerability to hazards (ISDR, 2002). According to Kibert (1999), the academics and professionals in planning, civil engineering, economics, ecology, architecture, landscape architecture, construction and related fields are responsible to discover ways of creating a more sustainable built environment. Therefore it is clear that there is a high relationship between the disasters and the built environment disciplines.

4.2 Disaster risk reduction in the built environment

Construction industry and built environment disciplines have to play a major role in disaster risk reduction. The role played by the construction sector in disaster risk reduction can be discussed under two headings namely the role played at the Pre Disaster Protection Phase and the role played at the Post Disaster Recovery Phase. The role played at each of these situations is discussed below in detail. However it should be noted that both the phases are interrelated, overlapping and multi dimensional (Haigh & Amaratunga, 2010; McEntire et al, 2002; Trim, 2004)

4.2.1 Pre disaster protection

The construction industry is not only a critical component of the nation's economy, but also a fundamental contributor in disaster management and mitigation (Chang, 2010). In the case of pre disaster protection, the experts of the construction industry and built environment disciplines are mainly required in the prevention and mitigation activities. These include design and construction of structural projects for example sea walls, drainage systems and quality infrastructure, imposing building regulations and codes, land use planning and zoning requirements, etc. The main responsibility for above preventive and mitigation actions lies with engineering and planning disciplines of the built environment. According to Sevin and Little (1998) the engineering community has a valuable role in finding and promoting rational and balanced solutions for existing unbounded threats. Mileti (1999) too identified the importance of improved engineering for buildings and infrastructure in order to minimise the adverse impacts of disasters.

Palliyaguru and Amaratunga (2008) highlighted the importance of quality infrastructure in disaster risk reduction and identified that the quality infrastructure can reduce the impacts of disaster risks.

Oh et al, (2010) too supported the argument by stating that with proper planning, the impact of natural disasters can be reduced and stated that it is necessary to identify the critical infrastructure that are vulnerable to natural disasters and the necessity of taking appropriate rehabilitation measures. Burby and Dalton (1994) argued that structural protection and building codes are conventional approaches to disaster mitigation. Mileti (1999) identified the importance of better land use planning to mitigate the impacts of disaster risks. Burby and Dalton (1994) too identified that land use planning can serve as a vehicle for limiting development of areas at risk from natural hazards and can produce tangible community benefits. These will in turn support the argument that built environment disciplines have a vital role in risk reduction in the pre disaster protection phase of the disaster management cycle in relation to rehabilitation and upgrading infrastructure, proper land use planning, designing of buildings and other structures which can withstand in case of a disaster by utilizing proper building codes etc. This includes, proper planning, designing, construction and maintenance of infrastructure and buildings in the disaster prone areas.

According to ISDR (2010) the local governments can play a major role in urban disaster risk reduction. They are in charge of critical development functions to reduce disaster risks, such as land use planning, urban development planning, public works, construction safety and licensing, social services and responding to the need of the poor and the under privileged and implementation and strengthening of the decentralization process (ISDR, 2010). It is understood that local government should take advice and consultancy from the built environment professionals in order to perform the above activities efficiently and effectively. In addition ISDR (2010) identified the following disaster risk reducing measures where local governments can incorporate professionals of built environment disciplines. This includes, invest and maintain risk reducing infrastructure such as flood drainage; apply risk compliant building regulations and land use planning norms appropriate to the needs and possibilities of low income citizens; ensure the safety of all schools and health facilities and upgrade as necessary; provide ecosystems and natural buffers to mitigate floods, storm surges and other hazards; adapt to climate change building on risk reduction practices. The built environment professionals have vital role in all the above activities including planning, designing, construction and project management and consultancy services.

4.2.2 Post disaster recovery

The post disaster recovery involves two phases, Emergency Response and Relief, and Recovery and Reconstruction. In both these phases the construction industry plays a major role mainly in terms of reconstruction work.

In the Emergency Response and Relief phase the role of construction industry is not that significant (Keraminiyage et al, 2007). However construction industry including built environment professionals have a role in providing water and sanitation to victims, construction of temporary shelters and in addition, the damaged basic infrastructure such as roads, telephone lines, bridges, electricity supply etc. should be restored immediately. All these show that construction industry plays a major role in the above situations.

The Recovery and Reconstruction phase is the most important phase for the construction industry. All construction professionals should get together with the construction organizations to cope up with the challenges of the reconstruction work. Massive reconstruction works are undertaken during this phase in sectors such as housing, health, education and upgrading national infrastructure etc. According to Keraminiyage et al (2007), the construction industry has a much broader role to anticipate, assess, prevent, prepare, respond and recover from disruptive challenges in the case of post disaster recovery. All reconstruction work should be well planned in order to avoid future vulnerabilities to disasters and in this regard the efforts of the construction professionals are very important in decision-making and implementation of reconstruction work.

Post disaster recovery stage is traditionally associated with construction and property sector (Haigh & Amaratunga, 2010). The authors have further highlighted, the requirement of the capacity for reconstruction including skilled resources expertise and project management expertise at the aftermath of a disaster. Therefore it is well understood that the construction industry and built environment professionals including, architects, engineers, quantity surveyors, town and country planners, land surveyors and construction and project managers have an important role to play in the recovery stage.

According to Chang et al (2010), the recent disaster literature has highlighted the role of the construction industry in the disaster-stricken areas and their inadequate engagement in the mitigation of such events. They further highlighted that the construction industry in China has not been sufficiently involved in disaster planning and management. According to Ofori (2004), it is necessary to provide the construction industries in developing countries with the requisite capacity and capability to enable them to plan, design and build constructed items to reduce their vulnerability to disasters, and to respond effectively to disasters to save and protect lives, rehabilitate vital infrastructure, and reinstate economic activities. Ofori (2004) further mentioned that systematic efforts should be made to develop the construction industry. This includes:

- Professionals should be equipped with the knowledge and skills required to undertake appropriate designs and construction
- A programme of material development should be instituted in each region to find high performing (disaster resistant) materials
- Measures must be placed towards the technological development of the industry to enable it to handle various projects, which will be required to provide protection against disasters
- The companies in the construction industry should be provided with the encouragement and incentives to progressively upgrade their operations and strengthen their organizations
- The professional institutions and trade associations should be strengthened.
- Conducive operating environment, which supports the continuous development of the construction companies to enhance their disaster prevention and management capabilities

5. Conclusions

Due to ever increasing adverse impacts of disasters, the disaster risk reduction has become a very demanding area in the recent past. Disaster risk reduction measures can be employed in both pre disaster planning and post disaster recovery stages of the disaster management cycles. The built environment disciplines together with the construction industry have a vital role in all phases of the disaster management cycles in relation to disaster risk reduction. They can involve in disaster risk reduction in numerous ways, including planning, designing, engineering, construction and maintenance of the built environment. Furthermore, it is understood that built environment disciplines such as architecture, engineering and town and country planning has a more important role in adapting disaster risk reduction methods in to their designs and construction work. Some of these measures includes, proper land use planning, incorporating building codes and regulations, proper designing and construction of quality infrastructure including structural work such as sea walls, drainage systems etc., use of quality construction materials and improving the quality of construction. Likewise, there is a clear relationship between disaster risk reduction and the construction industry including built environment disciplines. Several authors have identified the inadequate engagement of the construction industry and the built environment disciplines in incorporating disaster mitigation and risk reduction in actual context in the disaster stricken areas (Chang, 2010). The authors further argued that therefore there is a requirement within the construction industry to design programs to heighten the awareness of the industry players in order for them to actively engage in disaster management, planning, and mitigation activities. Therefore this research can be further extended to identify the gap between theoretical and actual contribution of construction sector in disaster risk reduction.

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