Chapter 12
Applying Dynamic Performance Management to Public Emergency Management: An Analysis of the Wenchuan Earthquake

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Abstract Previous studies in public emergency management confirm that collaboration assumes a relevant role in strengthening society's capacity to cope with complex phenomena, such as disasters. However, empirical researches on emergency management show problems in performance measurement, mainly in employing narrow measures focusing on the results of single organisations rather than the entire system. Starting from a Chinese earthquake (Wenchuan) case, as an example, we use the dynamic performance management approach to develop a performance framework. This framework aims at investigating the interrelationships of different actors involved in emergency management and designing appropriate public emergency management performance outcomes. Our study offers two significant findings. First, the use of dynamic performance management represents a novel approach to frame public emergency management performance outcomes. Second, such an approach, by making explicit how available strategic resources may impact on performance drivers, thereby influencing performance outcomes, offers a framework to support decision-makers in identifying key measures to monitor and designing effective policies to improve emergency management performance.

Keywords Emergency management · Disaster management · Dynamic performance management · Outcome measures · Network governance

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12.1 The Evolution of Emergency Management

In recent years, China, the Americas, the European Union and, particularly, developing countries were strongly affected by earthquakes, floods, cyclones, volcanic eruptions and other natural disasters. To understand the relevance of these phenomena, it is worth noting that only in 2010, the United Nations counted around the world more than 350 natural disasters, affecting about 208 million people, killing nearly 300 thousand people and generating US $110 billion in losses (UNDP, 2011). Such events did cause not only substantial economic loss but also endangered social harmony and stability.

Public organisations are often in the dominant position to cope with all aspects of emergency management, including losses in lives and property. Although studies focusing on emergency and disaster management are not new in the area of public management, only in the 1980s and, particularly, in 1990s, they became of greater interest for researchers and practitioners. Though in the 1980s, the growing number of research and practice in the emergency management made a substantial advancement (Comfort, Waugh, & Cigler, 2012), major disasters occurred in the 1990s actively contributed to generate a further evolution of the emergency management literature. New scholars oriented their works to understand and explain what conditions led to damaging consequences for communities exposed to risk (Schneider, 1995). Important initiatives, such as the National Science Foundation program titled "Enabling the Next Generation of Hazards Researchers" (Comfort et al., 2012), also raised the need to adopt a multidisciplinary approach to emergency management. Today, disaster research transcends its disciplinary borders and has become a relevant interdisciplinary field, ranging from urban planning, sociology, geography to public policy and management.

However, difficulties in effectively managing major events, such as 9/11 and Hurricane Katrina, highlighted gaps in emergency management theories and practices. Notably, the diffused emergency management approach focusing mainly on the response phase, as opposed to preparedness, mitigation and recovery, revealed its ineffectiveness. To overcome such limitations, researchers started exploring new issues of inter-governmental and inter-organisational collaboration, communication processes and information technology in the design and management of emergency operations (Comfort et al., 2012). The analysis of the above interrelationships made evident, more than in the past, the limits of stand-alone public sector interventions. Public, profit and non-profit organisations and the public have become more aware that to solve complex and difficult social problems, such as disasters, require active collaboration among actors.

This shift of research focus on understanding the relationships between the multiple institutions, profit and non-profit organizations in building productive capacity to mitigate risks and respond to damaging events, confirmed the critical role of collaboration in strengthening society's ability to cope with such extreme events (Boin & 't Hart, 2010; Kapucu, 2005; McGuire, 2006; Waugh & Streib, 2006; Wise, 2006).

To identify the key actors involved in these events and to examine the degree of centralisation/decentralisation of authority, researchers stressed the use of network analysis (Agranoff, 2006; Comfort et al., 2012; Head, 2007; Herranz, 2008; Imperial, 2005; Irvin & Stansbury, 2004; Maguire, 2006).

Despite the efforts to offer new methods and theories of collaborative performance (see, e.g. Public Management Review, 2008, Vol. 10, 6), there is still a lack of empirical works measuring outcomes (Kelman & Rauken, 2012; Nohrstedt, 2013). Such deficiencies appear more evident if we consider that previous studies often adopted a narrow perspective focusing on the performance of single organisations as opposed to measures of the network (Mandell & Keast, 2008).

Although applying network analysis in emergency management can make explicit the functional and dysfunctional links inside it, it shows multiple drawbacks. It does not effectively contribute to identifying those factors explaining variations in performance across collaboration; neither specify performance measures able to explain such differences (McConnell, 2011; Nohrstedt, 2013; Robinson & Gaddis, 2012). Also, it neglects how the dynamic interrelation between different actors intervening in the crisis management impacts on the overall performance (Kapucu & Demiroz, 2011).

Considering these limits, the contribution of this study is to offer a framework to make explicit the interrelationships between different actors involved in emergency management and appropriate performance outcomes. To this intent, we applied the dynamic performance management approach (Bianchi, 2016) to a Chinese earthquake (Wenchuan) case. This perspective makes explicit how available strategic resources may impact on performance drivers, thereby influencing outcomes. Therefore, it offers a framework to support decision-makers in identifying key measures to monitor and designing effective policies to improve emergency management performance. To the best of authors' knowledge, the use of the dynamics performance management represents a novel approach to frame public emergency management performance outcomes.

We divide the paper into four sections. The first section briefly introduces the background and relevance of this study. The second reviews the literature in emergency management and outlines the main limitations of performance measurement in this area of research. The third section, after introducing the dynamic performance management perspective, it clarifies the research strategy and analyses the Wenchuan earthquake case. Finally, it discusses the DPM framework to investigate the performance in public emergency management, based on the case mentioned above study. In the last section, we discuss our conclusions and limitations to the study.

12.2 Literature Review: Main Limitations of Performance Measurement in Emergency Management

There are multiple definitions of public emergency events (Lerbinger, 1997; Rosenthal & Kouzmin, 1997). According to article 4 of the International Covenant on Civil and Political Rights (The Office of the United Nations High Commissioner for Human Rights, 1976), "public emergency" is described as follows: "In time of public emergency which threatens the life of the nation and the existence of which is officially proclaimed, the States Parties to the present Covenant may take measures derogating from their obligations under the present Covenant to the extent strictly required by the exigencies of the situation".

Emergency and disaster management are often facilitated through plans, which aim to reduce communities' vulnerability to hazards and to cope with disasters (Drabek, 1991). However, in the last a few decades, changes in population, environment, technology and economic structure of developed and undeveloped countries led to radical modifications in the origins, mechanisms and effects generated by disasters (Boin, 2009; Missiroli, 2006). Therefore, emergency management performance must also adapt systematically. As discussed in the previous section, the use of the network perspective in emergency management performance did not always generate the desired results (Kapucu & Demiroz, 2011; McConnell, 2011; Nohrstedt, 2013; Robinson & Gaddis, 2012).

Several scholars remarked about the difficulties in measuring performance in public emergency management, especially when the problem is discussed from a network perspective (Kiefer & Montjoy, 2006; Nolte & Boenigk, 2013). Focusing on the operation of networks in preparing to evacuate residents in advance of a significant disaster, Kiefer and Montjoy (2006) argued the strengths and weaknesses of networks in the special circumstances. Nolte and Boenigk (2013) explored the enabling factors that have an impact on the performance of public networks during disaster response and outcome factors influenced by network performance. The analysis reveals that collaboration experience, mutuality and coordination have a substantial impact on the performance of networks. Scholars also proposed some methods to facilitate efficient analysis (Hu, Knox, & Kapucu, 2014; Kapucu & Demiroz, 2011). Subsequently, Hu et al. (2014) assessed the effectiveness of inter-organisational coordination and collaboration in response to the Boston Marathon bombing using affiliation networks. A recent study (Hu and Kapucu, 2014), using data from Florida emergency management networks, investigated whether the centrality of organisations in emergency management networks relates to the utilisation of information communication technology.

A first limitation in the literature is that network performance is seldom studied as a dependent variable. Instead, most of the studies focused on explaining the characteristics of networks and the measurement of the performance. The focus is typically to explain policy outcomes and service effectiveness at the level of the single organisation. Meier and O'Toole Jr. (2001), for example, used programme output as a measure of education network performance to assess the effectiveness of schools

and school districts. The performance in the network level is often ignored. To understand better why some networks perform better than others, we need studies where network performance is the dependent variable.

Another limitation is that most of the current researches only investigate the evaluation of single performance indicators. There are few investigations of the interrelationships and interaction among these indexes. Analysing the evaluation performance index system does not explain how the network evolves or how different participants take part in public crisis management. Using Hurricane Charley's coordination data, Abbasi and Kapucu (2012) analysed the evolution of inter-organisational response networks and the organisations' network structural changes over time. The results show that analysing static networks does not reflect how it evolves or how different organisations change their roles as the incident emerges.

The above-mentioned analysis illustrates the existing research gap in studying network emergency performance, adopting a single actor and static perspective. Therefore, this work aims to bridge such a gap. Based on the information collected from the Wenchuan case study and the use of the dynamic performance management approach, we built a framework aimed at investigating the interrelationships between different actors involved in emergency management and designing appropriate public emergency management performance outcomes. The DPM perspective explicates the impact of strategic resources on performance drivers. This impact influences performance outcomes and supports decision-makers in identifying key measures to monitor and designing effective policies to improve emergency management performance.

12.3 Applying the Dynamic Performance Management Framework to Public Emergency Management: The Wenchuan Earthquake Case Study

The dynamic performance management (Bianchi, 2016) approach investigates the interrelationships among actors and designs appropriate performance outcomes. This section first introduces the dynamic performance management perspective. Next, we apply it to emergency management through a research strategy and case analysis of the Chinese earthquake in Wenchuan. Finally, it discusses the framework to investigate the performance of public emergency management in a more general context.

12.3.1 The Dynamic Performance Management Perspective

The dynamic performance management (DPM) perspective (Bianchi, 2016) combines traditional performance management (PM) systems and system dynamics (SD) modelling. It aims to support the strategic learning processes of public sector

decision-makers with the intent to manage organisational performance (Bianchi, 2012, 2016; Bianchi & Tomaselli, 2015). It can be defined as a modelling approach to design and implement more reliable PM systems in public organisations.

Figure 12.1 depicts the "instrumental" dimensional of the DPM perspective. Such a framework illustrates how strategic resources allocation may affect performance drivers and end results. It also highlights how end results, in turn, are likely to influence strategic resources. While these changes on the strategic resources generated by the end results are indeed important, they only provide one limited snapshot. To understand the long-term results of the overall system, it is important also to focus on the performance drivers, i.e. the critical success factors for achieving these end results. To influence the achievement of the desired outcomes, performance drivers should be measured and monitored, and, where possible, changed to a more favourable state. Performance drivers are measured as ratios between the current strategic resource levels affecting performance and the desired levels (Bianchi, Bovaird, & Loeffler, 2017). For example, the performance of response time, as an essential factor to evaluate crisis management ability, can be assessed by the ratio of current response time and desired response time ratio. It is crucial also to outline the policy options which are believed to affect the strategic resources. Through the action on such policies, decision-makers can influence performance drivers, and—through them—end results, which in turn will feedback on the strategic resources.

Table 12.1 summarizes the symbols and related meaning in a typical system dynamics model (Sterman, 2000).

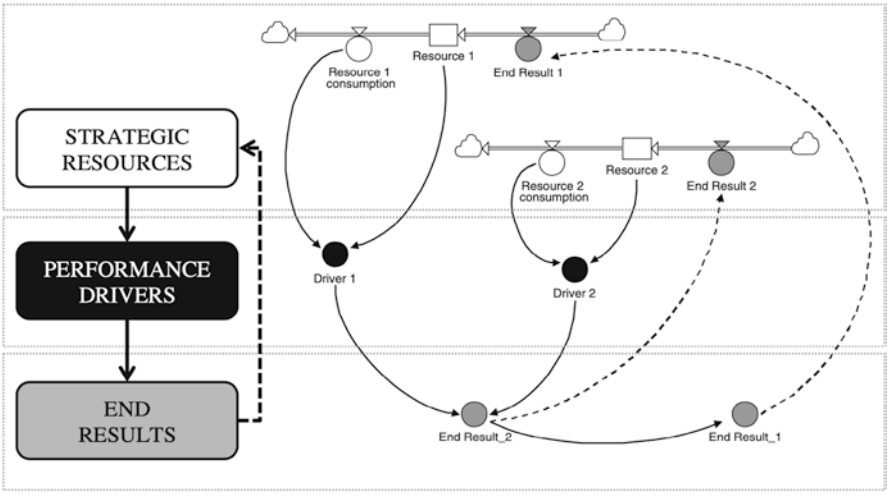
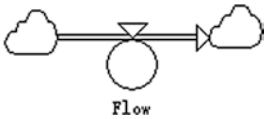
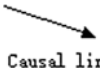


Fig. 12.1 The dynamic performance management view (Bianchi, 2016)

Table 12.1 Summary of system dynamics symbols and explanation (Sterman, 2000)

 Stock	An element of a system that accumulates or drains over time. Stocks are the memory of a system and are only affected by flows
 Flow	The movement of people or things between stocks within a system boundary or across the model boundary and thereby into out of the system (through sinks and sources). Changes in stock over time
 Converter	A variable that is not a flow and is capable of changing its value instantaneously
 Causal link	A relationship between two variables with the direction of casuality and the direction of impact

This study aims to investigate the interrelationships of different actors involved in emergency management. Particularly, understanding how strategic resources affect performance drivers and end results, it becomes a key issue to manage the performance in such a dynamic and complex public sector (Oh & Bush, 2015). Such an approach allows us to make explicit performance outcomes both in the short and in the long run. Furthermore, it does not only focus on the perspective of a single organisation but the relevant system.

Since time disjunctions between actions and results, and non-linear feedback relationships affect policy outcomes, a DPM approach is particularly valuable in such contexts. It implies that decision-makers cannot easily understand the structure and behaviour of the systems in which they implement policy (Bianchi, 2016). Therefore, the use of system dynamics quantitative models is particularly encouraged (Sterman, 2000). At present, this study focuses only on the qualitative side of the analysis, e.g. it aims to capture and to make explicit the causal relationships inside the DPM in emergency management. At a later stage of this analysis, we plan to build a quantitative simulation model. Through such a dynamic model, we can outline changes over time in outcome measures, performance drivers and strategic resources, and investigate their influence in emergency management performance.

12.3.2 The Wenchuan Earthquake Case Study

12.3.2.1 Research Strategy Motivations

The use of case studies is widely accepted and recognised in emergency and disaster management research (Comfort et al., 2012; Haibo & Xing, 2016). We adopt this approach for two important reasons. First, disasters are very often unpredictable and do not allow continuous observation by researchers. Second, the consequences of disaster link strongly with the dimension of the event, the actors involved and the

response of the emergency system. All of these have a high degree of dynamism. The ability of the case study approach to offer a depth analysis in the investigated phenomenon (Yin, 2009) fits well with the level of complexity in emergency management.

The motivation underlying the selection of the Wenchuan is twofold. First, since the founding of new China, the Wenchuan earthquake exceeds any previous earthquake, with regard to magnitude and degree of destruction. Second, due to its strong impact, the Wenchuan earthquake has been intensely investigated (Cui et al., 2011; Guo & Kapucu, 2015; Kapucu, 2011; Kapucu & Özerdem, 2013). Information can be gathered easily for study.

12.3.2.2 Case Study Analysis

The Wenchuan earthquake occurred in 2008, in the Chinese province of Sichuan (Kapucu, 2011). The epicentre was 80 km west-northwest of Chengdu, the provincial capital, with a focal depth of 19 km. The earthquake was not only felt in nearby counties but as far away as Beijing and Shanghai. Strong aftershocks, some exceeding a magnitude of 6, continued to hit the area months after the main quake and caused new damages. Official figures stated 69,197 were confirmed dead, 374,176 injured and 18,222 listed as missing. The earthquake left about 4.8 million people homeless, though the number could be as high as 11 million (Guo & Kapucu, 2015). According to official statistics, Sichuan province suffered the collapse or severe damage of more than four million houses. The total loss has been estimated above the US $100 billion (Cui et al., 2011).

In addition to the Chinese Government, through the "Office of National Headquarter for Earthquake Resistance and Disaster Relief", the emergency management system included non-profit and non-governmental entities, profit organisations and single individuals. The government played a leading role. It set up multiple emergency working groups. These included activities for rescue relief work, monitoring of aftershocks, the services of daily life, health and disease prevention, productivity restoration and other aspects of disaster-hit areas. It also coordinated the work of network members to make sure they were able to accomplish their network goals. For example, various emergency plans were activated, with several organisations participating in disaster response (Kapucu & Özerdem, 2013). The promptness of the government to set specific emergency working groups and the active coordination of network members led to an enlargement in rescue capacity and a boost in saving lives. Such a positive change in saving lives contributed to improving public satisfaction and government credibility, which in turn attracted new network members.

Many non-profit organisations promptly responded after the earthquake happened. For instance, the Chinese Red Cross Society immediately allocated tents and other materials and contributed to the emergency rescue. The extraordinary amplitude of the earthquake and the fast response time of the emergency management helped to attract more than the US$5 billion of donations. Additionally, nearly

US$10 million of emergency supplies, including goods, were collected and distributed in the disaster areas.

Private sector enterprises also intervened supplying relief materials directly in the disaster areas to meet people's immediate needs. Special funds were created to financially support orphans who lost their parents in the earthquake to the age of 18. There was also great support from the public. Citizens used various means to alleviate people injured in the earthquake, ranging from direct financial aids to living goods. Many professionals were directly involved in disaster relief activities.

Despite government efforts to improve the response time and the quality of the response to save lives and restore proprieties, a lack of coordination of network members' actions led to robberies of rescue materials supplied by charitable organisations. Although these unintended occurrences were perceived as minor events during the disaster management, they negatively impact on government credibility, which was damaged indirectly. Emergency management performance measures should be designed to focus not only on output indicators, such as, for instance, the value of donors and the number of organisations involved in the rescue, but also (and primarily) on outcome measures, i.e., changes in saving lives.

According to the above analysis, we can assert that the governance model of the emergency network in the Wenchuan earthquake assumed a lead organisation form (Kenis & Provan, 2009). Lead organisation governance is common in a network where there are a single powerful actor and many weaker participants. There is no doubt that the government played a leading role in the emergency management of the Wenchuan earthquake. The non-profit organisations, the private sector and the public, worked under the formal guidance of the government (see full line in Fig. 12.2). To carry out the single responsibilities assigned in the disaster management, network members can also interact with each other informally and spontaneously (see dotted links in Fig. 12.2).

The above remarks raise the need to support public decision-makers to design a comprehensive framework to monitor the relationships between network members

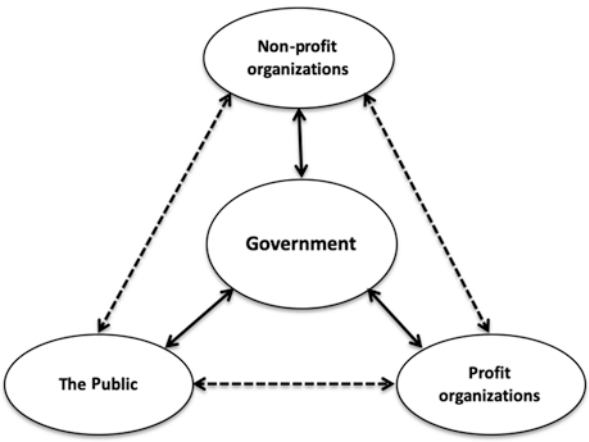


Fig. 12.2 The form of emergency network for the Wenchuan earthquake

during all phases of emergency management. Such a framework should, therefore, focus not on the single organisation's performance instead of on the network outcomes. The next section, based on analysis of the Wenchuan earthquake case study, discusses a DPM framework aimed at investigating the interrelationships of different actors involved in emergency management and designing appropriate performance outcomes.

12.3.3 The Design of a DPM Framework to Investigate the Performance in Public Emergency Management: The Wenchuan Earthquake Case

The DPM framework is built using the "instrumental" view, which is the first step to designing and implementing a full DPM system. The next step would imply the building of a simulation model capturing the quantitative and dynamic interrelationships among the variables included in the DPM framework. Our plans include the development of the model as an extension of this research.

Figure 12.3 illustrates three main dimensions, interacting with each other: strategic resources, drivers and end results. Starting from the bottom, initially, we can identify five outcomes, namely, "changes in public satisfaction", "change in saving lives", "change in government credibility", "change profit and non-profit organisations" and "change in donors".

Through the framework, we depict the influence of corresponding performance drivers, such as response time, cost-effectiveness, quality of response ability and

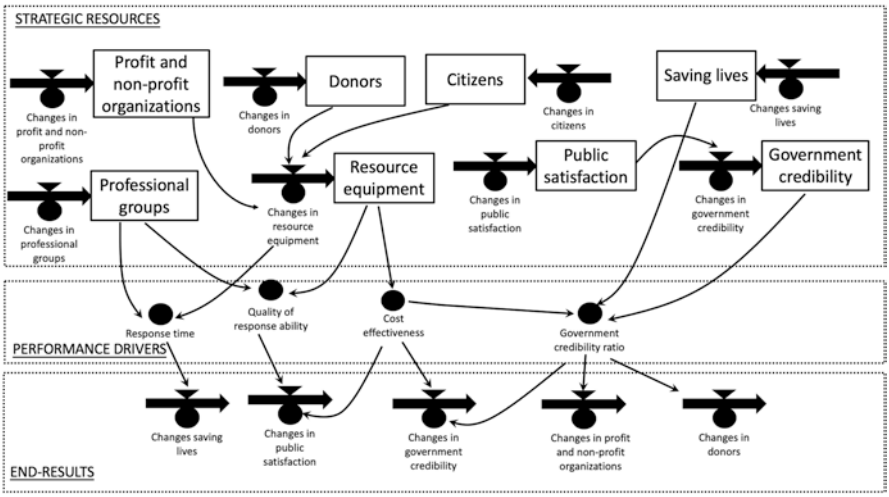


Fig. 12.3 A simplified DPM framework to evaluate networked-based public emergency management performance in the Wenchuan earthquake

government credibility ratio on the end results. Take the end result "change in public satisfaction" as an example. This end result is influenced by the response time, cost-effectiveness and quality of response ability. The response time hurts the change in public satisfaction, while cost-effectiveness and quality of response ability have a positive effect on it. Consequently, a high response time generates an adverse change in public satisfaction (see, for instance, the undesired event discussed in the case study analysis section related to the robberies of rescue materials supplied by charitable organisations). This phenomenon is likely to lead to public satisfaction strategic resource decline. A low level of public satisfaction deteriorates network performance drivers, such as government credibility, which in turn generates a reduction in profit and non-profit organisations and donors. This deterioration leads to a vicious cycle. Beyond that, the change in government credibility is determined by the government credibility ratio. An increase in government credibility ratio impacts on the change in government credibility. This increase may generate a reinforcing loop leading to a positive change in strategic network resources. The same reasoning can be applied to explain the changes in profit and non-profit organisations and donors.

This framework aims to help public decision-makers to identify the endowment of strategic resources required to manage public crisis management properly. The acquired assets can then positively influence performance drivers, which may, in turn, generate a more significant impact on performance outcomes.

12.4 Conclusions

This chapter explores the different complexity factors underlining network cooperation in public emergency management performance. Very often performance systems are designed to capture results provided by the single actor inside the network, rather than approaching it through a holistic perspective. The use of a DPM approach is particularly effective in providing a systems view. The approach highlights the interaction among network stakeholders as well as the support of decision-makers to design a set of outcomes able to deal with such dynamic complexity.

Therefore, this study confirms the importance of key performance drivers and end results in the collaborative network of public emergency management. The DMP framework provided in this preliminary study aims to support decision-makers to gain an in-depth understanding, in terms of complexity and system interdependencies, of the network cooperation in public crisis management. Neglecting such a level of interactions among stakeholders engaged in the network may lead to the design of ineffective and short-term policies.

This study contributes both at a conceptual and a managerial level. At the first level, it explores the relationships between network participants in public emergency management from an outcome-based perspective. From a managerial point of view, the suggested framework outlines the key drivers affecting the overall disaster management performance. The framework may result in guiding public

decision-makers on how to improve system success and enhance its resilience. It also raises the critical role of collaboration between network participants in improving public emergency management performance.

This research has the following limitations, which require future research efforts. The first limitation is the lack of information on how the collaboration among network stakeholders evolved during the different stages of public emergency management. Collaboration among various network stakeholders is an expected outcome in emergency management, including crisis mitigation, preparedness, response and recovery, which needs to be addressed in future research. Another issue is the absence of a simulation model to explore how performance measures evolve once linked to a given set of policies.

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