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A framework to construct post-disaster housing

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Abstract

Purpose – Natural disasters often destroy hundreds of homes that leave victims homeless and leads to community displacement. In the USA, such disasters happen over 60 times per year. This leads to logistical and contractual nightmare for the planning agencies and political/community leaders required to provide shelter for displaced citizens. One of the most important challenges for the policy makers and aid providers is to make homes available to the homeless victims in as short a period as possible. Temporary shelter is costly and often excessively delayed. Also quality and long stay (more than four years for the Katrina victims) in temporary shelter affected victims both mentally and physically. The aim of this paper is to propose a strategic framework that assists responsible entities to provide housing to the disaster victims in a short period of time, for example to construct 200 homes in 30 days after disaster (representing a subdivision).

Design/methodology/approach – The main objective of this research is to perform feasibility study of implementing such a strategy that would enable agencies to provide better solutions for post disaster housing assistance. This paper mainly explains four phases that constitute the development of the strategic framework. The first two phases of the framework carry out pre-disaster planning and establish relationships among the participating entities. Whereas, the third phase includes simulating post disaster processes identified in the previous phases to evaluate response trade-offs. The last phase is about the real implementation of this strategy after disaster that also incorporates its outcomes and experiences into previously planned strategy.

Findings – It was found through second part of research, simulation studies, that such a strategy can be prepared before the disaster and activated when needed. This would drastically reduce the housing response time.

Originality/value – This would help in improving the strategy for future disasters. Successful execution would facilitate opportunities to reduce stress for the victims and encourage faster recovery.

Keywords Disaster response, Disaster mitigation, Temporary shelter, Capacity, Construction management, Post disaster housing, Disaster housing strategy, Disasters, Housing

Paper type Research paper

1. Introduction

Disasters, both manmade and natural, are the extreme events that have low probability of occurrence and high consequences that affect individuals and communities. However, global warming and rise in average global temperature have increased their frequency of occurrences (NOAA, 2009; Arndt *et al.*, 2010). It is also evident from the increase in numbers of presidential disaster declarations over last few years in the USA (NOAA, 2000). Natural disasters have become more devastating and costlier over the years. Destruction rates and expenses are on a mount compared to previous encounters with

International Journal of Disaster Resilience in the Built Environment
Vol. 4 No. 1, 2013
pp. 95-114

1759-5908
DOI 10.1108/17595901311299026

the same disasters (NOAA, 2008). Scientists have predicted that these estimates are going to rise in coming years due to increase in number of disasters and rise in global temperature (Weiss, 2006).

These extreme events have raised challenges for emergency agencies, and have imposed radical constraints on planners and logistic managers. One of the challenges emergency agencies have faced is to provide emergency or temporary shelters to victims (McCarthy, 2009). Individuals often lose their homes, properties, workplaces and infrastructure facilities in disasters that leave them dependent on government and other agencies. On the other side, agencies have to plan and organize their response operations and services to minimize the stress for the victims. Based on the damage done to homes and availability of funds, emergency agencies have to decide on relocating and housing victims. This relocation can be for a short or long duration. Apart from planning for housing, emergency planners have to prepare for financial aid, food, clothing, opportunities to work and earn, modes of transportation, medical and health care facilities, K-12 education, schools and colleges, community centers, and church (Labadie, 2008). Also social impacts on the communities, both host and displaced communities, are seen due to difference in composition of society, cultural characteristics, and economic conditions. Thus, relocation affects social and economic structures of both regions. Therefore, it is indispensable to provide housing to victims in their own region to aid its social and economic redevelopment and rebuilding processes.

During recent disaster events, planners have also faced problems with the type and quality of shelter provided to victims. Hurricane Andrew struck the South Florida region in 1992 and destroyed around 47,000 homes. Approximately 3,500 victims were housed in FEMA trailers established in 12 parks as temporary shelter till they got their permanent homes. Many of them lived in those trailers for more than two years, and reported various social as well as health-related troubles. Hurricane Katrina is referred as the most devastating hurricane in the history of the USA where around 1,800 people died in the Gulf Coast and thousands of citizens were displaced to other places in the country. FEMA made around 140,000 FEMA trailers available to the Katrina affected regions (FEMA 2006a, b). Many of FEMA trailer dwellers found trailer parks unsafe, crowded and less attractive. This lead to consequences like increased domestic violence, insomnia, and higher divorce rates, suicide rates and depression (Scurfield, 2007; NCDP, 2009). People felt that their privacy had been compromised. Due to toxic environment inside the trailer, materials used in construction, small space for a large family and unsecure conditions, many victims had shown symptoms of post-traumatic stress, respiratory and nervous disorders like headache, vomiting, skin rashes, aches and pain, loss of appetite or overeating, social withdrawal, and isolation. Children were found avoiding schools and behaving aggressively with others (Scurfield, 2007). The main consequences due to the FEMA trailers post-Katrina were health-related disorders increased due to presence of formaldehyde used as a construction material. This forced many victims that were staying in the FEMA trailer to look for alternative housing.

The extent of the damage done due to hurricane Katrina made evident the need for a long-term housing recovery strategy (NLIHC, 2007). Also undesirable effects of FEMA trailers made them highly inappropriate for extended temporary housing needs. Thus, to identify, design and construct alternate housing that can be used after disasters for long term and more permanent use, FEMA was allotted $400 million by the Congress in June 2006. FEMA in partnership with Department of Housing and Urban

Development (HUD) introduced Alternate Housing Pilot Program (AHPP) to use these funds for both homeowners and renters in the Katrina affected states of Alabama, Mississippi, Louisiana and Texas (AAI, 2009).

AHPP introduced in the aftermath of hurricane Katrina faced delays due to various reasons (Stock, 2009). Changes were made in the design and installation process of housing units which led to a time consuming phase of changes in materials to be used, skillfulness of workers, and architecture. Different housing units had different designs, color, architecture, and compliance to include accessibility of the unit for disabled according to Uniform Federal Accessibility Standards (UFAS). This variety in housing units increased intricacies while manufacturing and distribution and thus delay in construction. Moreover, Park Models and Cottages did not have sufficient space required for permanent homes, leaving the purpose of AHPP of providing long-term housing unresolved (Johnson, 2009). Local government and community leaders also showed resistance to AHPP units as they did not want to affect the economic and physical redevelopment process which they had already started. Experience of AHPP verified the need of a quality long-term shelter within short period of time after disaster.

All these quandaries are caused by delay in appropriate housing after disaster. There is an absence of a protocol that provides guidance to emergency agencies to avoid this delay. This would also help them utilize the funds effectively rather than spending them on experimental programs such as AHPP. Thus, there is a need of a strategy that assists emergency managers to respond swiftly and to divert these funds in better direction.

2. Objective

The main objective of the research presented in this paper was to propose a framework to develop and implement an emergency strategy to provide quality temporary shelter in short period of time after disaster. This would enable emergency agencies to prepare for rapid response and provide housing assistance to alleviate stress and sufferings of victims. Such a strategy would accelerate post-disaster housing construction, and shorten redevelopment and recovery phases.

3. Research methodology

To achieve the above mentioned objectives, this study was performed in four tasks as shown in Figure 1. Task-1 included literature review that summarized current practices and programs for disaster housing assistance, roles and responsibilities of various agencies, and housing alternatives and their feasibilities. This included but not limited to, reviewing current response programs such as National Disaster Housing Strategy and Alternate Housing Pilot Program by FEMA, Disaster Housing Assistance Program by US Department of Housing and Urban Development (HUD, 2011) and FEMA, National Response Framework and National Incident Management System by Department of Homeland Security (DHS, 2008), National Strategy for Homeland Security by Homeland Security Council, and Disaster Recovery Plan by US Small Business Administration (SBA).

Task-2, Framework of developing the strategy, included identifying and defining four phases of strategy development. It also explained the transition from one phase to other in the framework. The detail explanation about the first two phases was given in Task-3. The first phase, pre-disaster planning, established task structure and

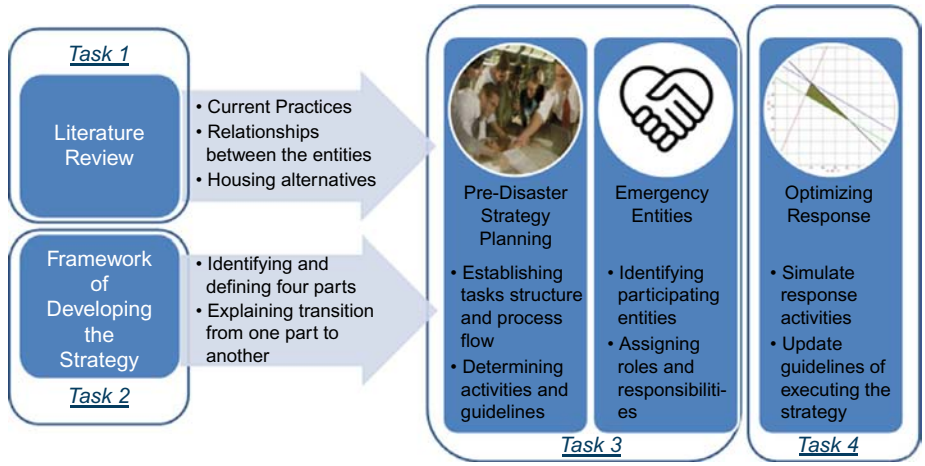

Figure 1.
Research methodology

determine process flow. The second phase of emergency entities for strategy defined organization chart and their roles in strategy development and implementation. Personal interviews and discussions were held with the representatives of Tippecanoe Emergency Management Agency, Area Plan Commission of Tippecanoe County, All Clear Emergency Management Group, Purdue Homeland Security Institute, Core of Engineers and a manufactured home. These experts acknowledged the need of such a strategy and provided essential information related to existing systems. Task-4 briefly explained how entities can execute this strategy by simulating trade-offs between three response characteristics – time, cost, and resources like labor and/or equipments. This paper summarizes Tasks-2 and -3, and briefly introduces Task-4.

4. Development of post-disaster housing strategy

Presence of uncertainty during disaster events prevents clear identification of needs. Most of the response plans are multifaceted that include complex requirements of individuals and communities. Moreover, constraints are enforced on emergency managers when required resources and necessary infrastructure are not available. More deliberated and detailed response plans are required in order to reduce response time as effectiveness of the response reduces drastically with time. Housing response time is the most critical part, as delay in providing assistance leads to many consequences like community displacement and mental stress. Proposed framework would assist entities to develop a strategy that would improve their preparedness and reduce housing response time. Such strategy would not only help emergency agencies and allow them to concentrate on other emergency operations, but would also accelerate recovery for individuals and their families. As shown in Figure 2, there are two basic parts involved in the framework:

(1) pre-disaster strategy planning; and

(2) execution of the strategy.

First part includes phases of strategy planning that are processed before disaster and the second part includes a phase that is processed after the disaster. Pre-disaster strategy

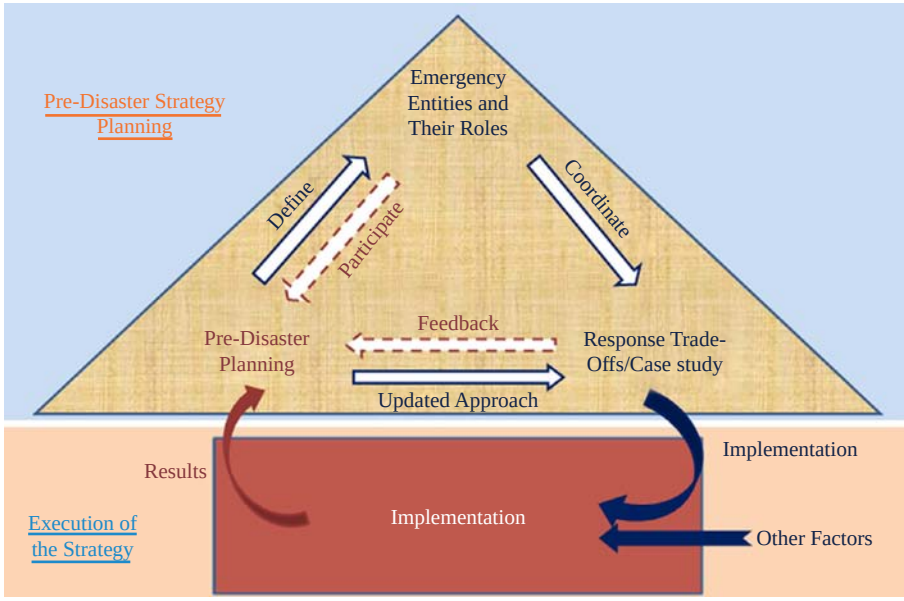

Figure 2.
Interrelationships among different phases of strategy development

planning includes three phases: pre-disaster planning, emergency entities, and response trade-offs. Execution of the strategy includes the fourth phase of implementation. The process of developing the strategy starts with pre-disaster planning. In this phase, decision makers are involved in estimating the scope of the work, preparing list of possible tasks and activities to be performed. A comprehensive scheme for approach, planning, communication and execution is outlined in this phase.

The second phase of pre-disaster strategy planning defines the roles and responsibilities of different emergency entities, and assigns tasks identified in the first phase. Legal agreements such as contracts would be required between decision makers and participating entities. Once contracts are established, entities can participate in finalizing the scope of activities, and other development tasks. They also participate and assist decision makers to define logical sequence of construction activities.

After defining the scope of work, activities and responsibilities, studies are done to evaluate trade-off between response characteristics – time, resources and cost. Techniques such as computer simulation model or implementing the strategy through pilot project or drills are used to incorporate external factors in this process. This helps planners in determining the level of coordination required among the participating entities and in scrutinizing communication techniques used. This would also help entities in defining the level of accuracy needed in estimating resources and time required to perform assigned tasks. Emergency planners get feedback from such simulation studies which help them to update the approach, activities and timeline of execution.

After going through these three phases of strategy development, decision makers have a well defined scheme and roles of various entities, logical sequence of activities and timeline for execution. The strategy would really be tested once implemented in a real disaster scenario where actual results may vary depending on the assumptions and other external factors included planning and trade-off phases. Such results can be

the product of other factors like unexpected damage done to essential infrastructure, unavailability of funds, damage done to properties of involved entities, etc. The strategy can be modified and improved using these actual data.

4.1 Pre-disaster planning

Pre-disaster planning is defined as the first phase in the framework that identifies and determines steps prior to disaster for successful strategy development and execution, and provides better housing assistance to victims after disasters. This phase instigates strategy development by identifying and defining scope of pre- and post-disaster tasks and activities, strategy implementation and initiation steps, and detailed guideline for implementation. Emergency planners start this process by defining the scope of work as it would be different for different towns, cities, counties and states. Responsible entities like the local or state governments, defines this scope of work depending on their experiences and requirements during previous disaster events. This helps in avoiding any interruption that can cause delay in implementing and thus reducing the duration, cost as well as the effect of efforts of planners, managers and workers who provide their services during emergency time. It is important for emergency planners to involve individuals or local community leaders in planning process as they may not be available after disasters because of their participation in redevelopment and reconstruction process. Moreover, these homes would primarily replace temporary shelters and can also be used as permanent homes depending on requirements and financial consequences.

Due to rehabilitation processes after disaster, it is likely that the region would have unavailability of resources such as labor, and services offered by infrastructure in disaster hit area. Housing recovery planning might take more time which might delay post-disaster housing construction. Therefore, it is important to establish a flow of tasks in pre-disaster planning phase. Such a flow is referred to as the process flow that directs strategy development before disaster and its execution after disaster. This process flow helps planners to view all necessary tasks at once and makes the planning steps simpler to visualize. It is easier to modify or update while incorporating inputs from different entities in the later stage. It also provides guidelines for developing housing recovery programs for different scales of disasters. All tasks can be classified into two categories (Figure 3):

(1) preparation (pre-disaster) tasks; and

(2) execution (post-disaster) tasks.

4.1.1 Preparation (pre-disaster) tasks. Preparation tasks are the tasks that are defined, planned and finished before the disaster events. Therefore, they can also be termed as pre-disaster tasks. The first task in this list is the initial planning that includes establishing basic fundamentals of strategy such establishing strategy goals, objectives, scope and definition. It can be compared to pre-project planning phase of any other project where important decisions, are made by planners and managers during initial stage of the project (Figure 4).

To develop the post-disaster housing strategy, entities like the local and state governments initiates the task of initial planning. They take help from the federal government agencies like Federal Emergency Management Agency (FEMA) and the Department of Housing and Urban Development (HUD) or their representatives. This assists them making strategy more effective and exploring alternatives of resources that

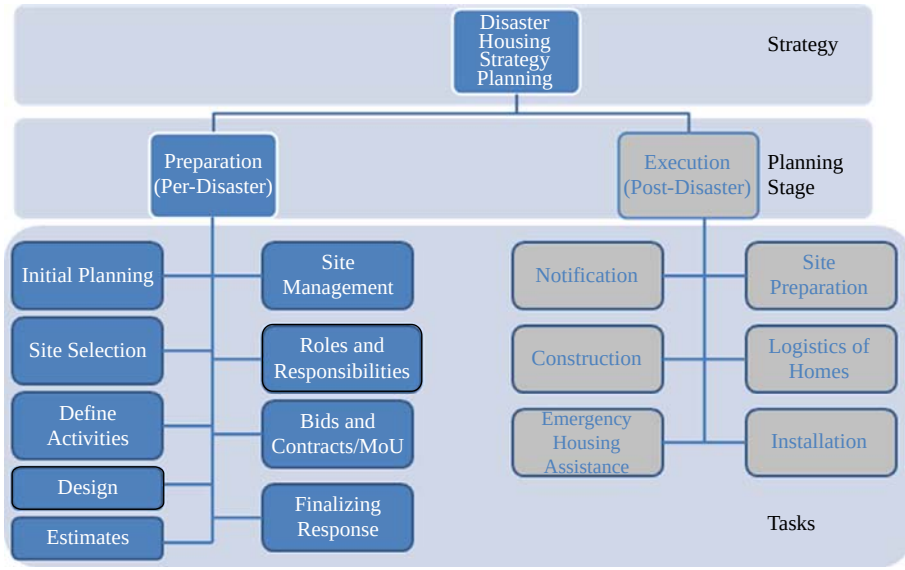

Figure 3.
Tasks involved in strategy development

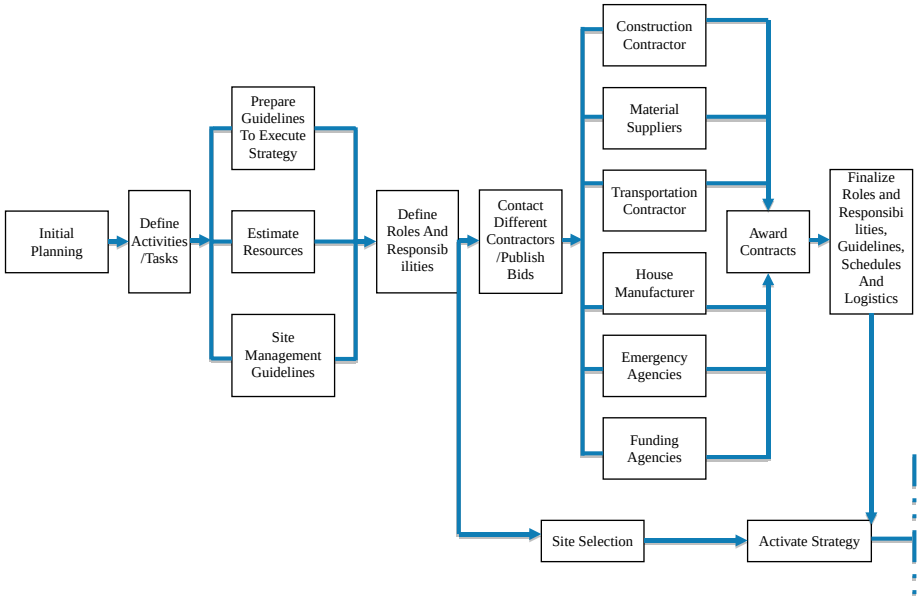

Figure 4.
The process flow for preparation (pre-disaster) tasks

are available during emergency time. As mentioned earlier, planning entities involves local community leaders to know requirements of their communities during the emergency time. Also their opinions and views in selecting post-disaster housing alternative are essential for community satisfaction. They help in selecting sites for reconstruction after disaster to make such strategy a success and acceptable by the individuals.

Pre-disaster planning team compiles requirements of individuals and communities during and after emergency time.

For better planning, design and implementation, these tasks are broken into simpler activities. Defining the scope of activities in planning phase helps planners to estimate time, cost and resource requirements. It also helps them to determine probable outcome and compare them with initial strategy goals. Planners establish requirements and conditions to perform any particular activity. These well defined activities are then assigned to different entities for their exercise.

After determining list of activities, planners prepare the guidelines to execute them. Here, it is necessary that all entities involved in execution should know their scope of work. They should have a clear notion about the steps they should follow prior to activation of the strategy. Their timing of responding to the need, level of preparedness, mobilizing resources, and coordinating their response with other involved agencies are key criteria for effective and timely implementation and completion. Thus, it is necessary to produce a project schedule of identified activities along with the guidelines and specifications to execute them. For example, the city of Lafayette and West Lafayette, Indiana, USA, can have a combined housing response strategy for possible disasters occurrences. These entities define the scope and guidelines for better planning and execution.

Now at this stage of strategy development, planners and decision makers have a draft of guidelines to execute the strategy after disaster and perceptions about the roles and responsibilities of participating entities. Planners take different approaches in order to confirm the participation of identified agencies. For example, planners may establish formal agreements like Memorandum of Understanding (MoU) with governmental agencies through which special services could be made available at the time of emergency. Planners may use formal bidding procedure and establish pre-positioned contracts to get expertise and services from non-governmental agencies and contractors. At the end of this task, participation of these agencies is confirmed either through formal agreements or through legal contracts. This helps in preparing organization structure that facilitates the flow of information and hierarchy for the entire process. For instance, the city of Lafayette and West Lafayette sign MoUs with other state and federal governments' agencies, and establish contractual relations with private entities to ensure their participation in planning and execution of disaster response.

It is important for planners to carry out the task of site selection simultaneously. It helps in designing site layout and planning other activities like construction of water supply systems, sewer systems and other necessary utilities. It also helps in selecting viable routes to mobilize resources and other necessary supplies needed after disaster. It goes through activities like identifying sites, their comparison, and acquiring and preparing them for emergency use before disaster. This assists both planners and participating entities in estimating and planning logistics. Planners include local government engineers, emergency managers and community leaders to take advantage of their knowledge about local conditions. This definitely saves time after disaster. The site is selected that would fulfill some of the criteria such as no or less utilities already in place, availability of transportation and facilities of schools, church, and shopping at nearby locations. In the Lafayette and West Lafayette case, the Area Plan Commission identifies different sites within the city limits that fulfill most of criteria and zoning requirements. City's emergency planners also involve

Lafayette-West Lafayette community leaders to get their opinion about selected sites and to ensure acceptance of site by community for post-disaster dwellings.

Planners and participating agencies then finalize above information to simulate the post-disaster tasks to identify and correct loopholes overlooked during planning. Simulating the post-disaster events also helps all the participating agencies in having a clear vision about the tasks that they will perform. They would realize the coordination required with other entities and clear out any issue related to schedule, site or space management, etc. The main aim of this task is to establish and evaluate response trade-offs after disaster to check if the housing strategy would be able to accomplish its goal of providing post-disaster housing in predefined short time span. For example, the strategy outlined by the city emergency planners is simulated using computer programs to achieve balanced cost-time-resources trade-offs.

4.1.2 Execution (post-disaster) tasks. Post-disaster tasks are the tasks that would be defined and planned through different pre-disaster tasks during pre-disaster planning. But these tasks are executed after disaster and that is why they could also be termed as post-disaster tasks. The next task in the process flow is activating the strategy that occurs after disaster when the need to provide post-disaster housing arises. Figure 5 shows flow of tasks that will occur after disaster situation. The decision of activating the strategy is followed by notifying all the participating agencies about activation. Notifications are triggered as soon as the decision is made. Different mode of communication like public announcements through web sites, media, news papers and e-mails, and phone calls, etc. are used for notifying entities. They are also provided information about the disaster and damages occurred. The decision maker also notifies selection of site for laying out houses if more than one site were selected during the preplanning process.

Once all the agencies receive notification, they start taking actions as per the guidelines prepared and start responding. They revisit the schedule and start mobilizing resources to the declared site and coordinate with other agencies. After mobilization, site is prepared for construction of utilities like water supply, sewer system, electricity, etc. The site layout is divided into segments to facilitate several construction tasks to take place simultaneously. This would speed up overall execution. Construction of roads within community is also started simultaneously. Once the utilities are constructed in a part, the foundation construction task starts where foundations for home are constructed on site. The houses are manufactured in the factories during the house

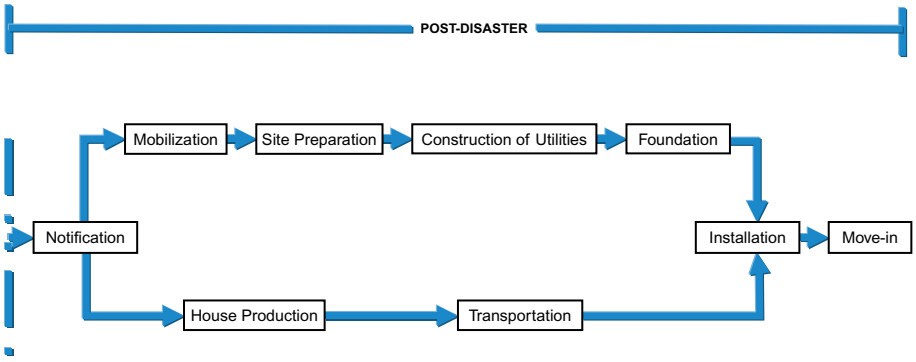

Figure 5.
Process flow for post-disaster tasks

production task simultaneously. The manufactured homes are then transported to site using planned method and routes. Then in the installation task, homes are installed on the already constructed foundation. For other types of home, suitable post-disaster tasks can be prepared and replaced in this process flow. For example, house production and installation can be replaced by material fabrication and preparation, and house construction, respectively. Final inspection is carried out before being occupied by the victims in the move in task.

Thus, pre-disaster tasks represent logical steps to develop detailed guidelines for construction of homes for disaster victims. These tasks include initial planning, identifying post-disaster tasks and activities, estimating response parameters, assigning activities to different entities and establish formal agreements with these entities to confirm their participation. Moreover, once all the entities are finalized, the responses are once again reiterated to give process a final shape. The post-disaster tasks represent mainly the construction tasks to fulfill the post-disaster housing needs. All these tasks can further be divided into activities for ease of planning as shown in Figures 6 and 7. For example, site management guidelines task is simplified into three activities – organization chart, inventory management and space management.

4.2 Emergency entities for strategy

During normal disaster scenario in the USA, local government is the first respondent to events (Comerio, 1998). Though it carries most of the responsibilities, preparedness of individuals and households is crucial for initial hours. They have to develop personal emergency plan and a kit to survive for their households and pets. The kit carries day-to-day supplies for a few days following the disaster event. This releases some pressure off the emergency agencies. Individuals can also volunteer in different national and local disaster service organizations such as National Voluntary

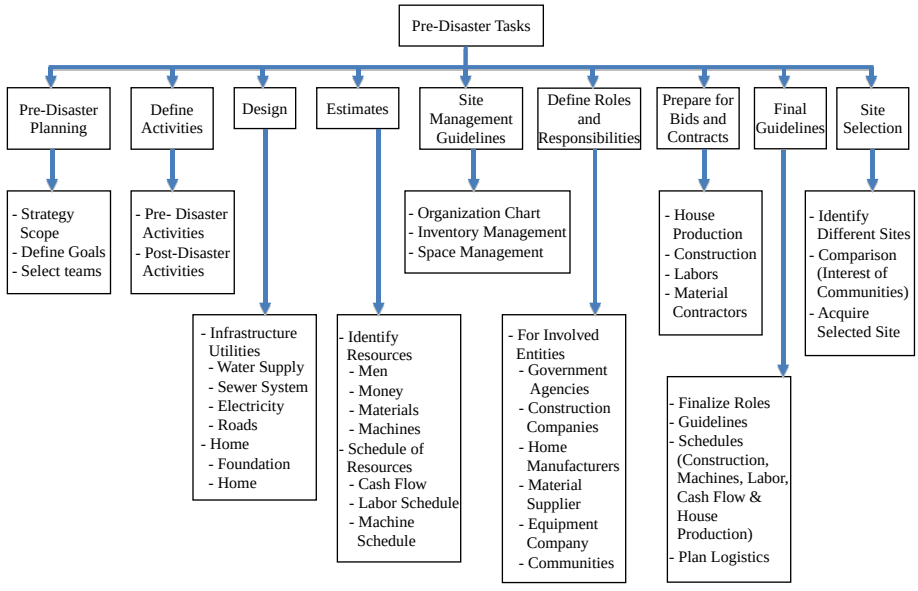

Figure 6.
Pre-disaster activities

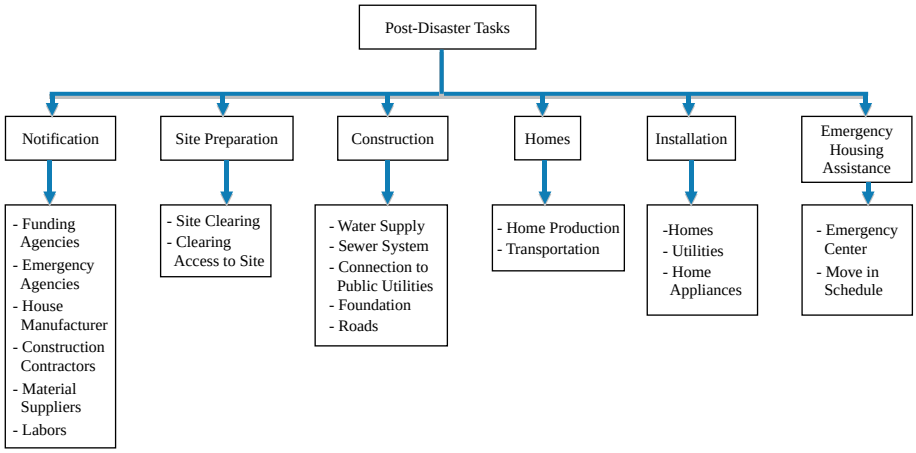

Figure 7.
Post-disaster activities

Organization Active in Disaster (NVOAD) (FEMA, 2009). Non-governmental organizations like American Red Cross, organized church groups, food pantry, etc. provide their emergency services and relief goods. With the increase in extent of damage, local governments declare the disaster situation and acquire assistance as needed from neighboring jurisdictions, and state governments, federal government and their agencies. Depending on the devastation spread, different agencies take the lead in providing emergency assistance.

Based on the weather reports and forecasts, citizens are warned by the agencies. In case of major disasters like hurricanes, they are evacuated and provided emergency shelter, till the danger of the disaster passes by. Local government takes responsibility of assessing damage done to homes, buildings and infrastructure facilities. The extent of damage is determined through wind shield survey or aerial survey. They also have to look for alternatives for temporary shelters. These alternatives may include schools, convention centers, rental properties, motels, and stadiums in and around the area of jurisdiction. Local governments also repair or reconstruct important infrastructure facilities to speed up the redevelopment process and resume services. When local governments need more resources, they approach state government who works closely to find alternatives, identify housing needs of victims, and develop plan to fulfill those needs.

In case of large-scale disasters, when local and state governments do not have enough resources and facilities to provide housing assistance, they seek help from the federal government through its agencies. Different federal agencies offer different housing assistance programs for victims. For instance, FEMA provides individual assistance program to victims that provides financial support to rent a place or government provided unit for temporary shelter, repair or rebuild uninsured damaged homes, replace damaged homes or to construct permanent houses. FEMA also coordinates efforts made by other federal agencies in providing housing assistance in the form of rental assistance, repairs, loan assistance, factory built housing, permanent construction and accessible housing. However, HUD provides housing alternatives to assist disaster victims through its network of around four thousand Public Housing Agencies (PHAs). The network of PHAs becomes a medium for federal grants and victims who require housing assistance. HUD, through its website, National Housing

Location (NHL) provides details about rental housing available to victims anywhere in the country in case of presidentially declared disasters. HUD through Federal Housing Administration (FHA) provides a list of approved lenders from whom victims can get mortgages for their homes (HUD and NRF, 2008).

These already established relationships among different entities are used to develop and implement the strategy. All these agencies are divided into two groups, which are (Figure 8):

(1) planning and execution entities, planners; and

(2) execution only entities, contractors.

4.2.1 Planning and execution entities. The first groups, planners, are the agencies that would initiate strategy development, hire contractors and/or other agencies to accomplish and finance entire process or a part of it. The entities that are included in this group are mainly governments and their agencies, as they are responsible for providing emergency assistance in their respective jurisdiction. They also establish contracts with different entities to ensure proper and timely completion. So agencies in this group would develop, activate when needed, and monitor execution of strategy. The entities in this group can further be divided into two groups:

(1) preliminary entities; and

(2) complimentary entities.

Preliminary entities are directly involved in the strategy planning and executing as per the guidelines. These are the lower level entities such as local governments, while complimentary entities are upper level entities such as state and federal governments. Though preliminary entities plan the strategy for their jurisdictional area, they need support from complimentary entities to confirm availability of resources when needed and eliminate roadblocks unresolved by them.

4.2.2 Execution only entities. The second groups of agencies are mainly the entities that provide their services and/or resources after the disaster for executing the strategy. These entities also participate in strategy development but cannot make decisions. These entities have formal relationships established with group one entities

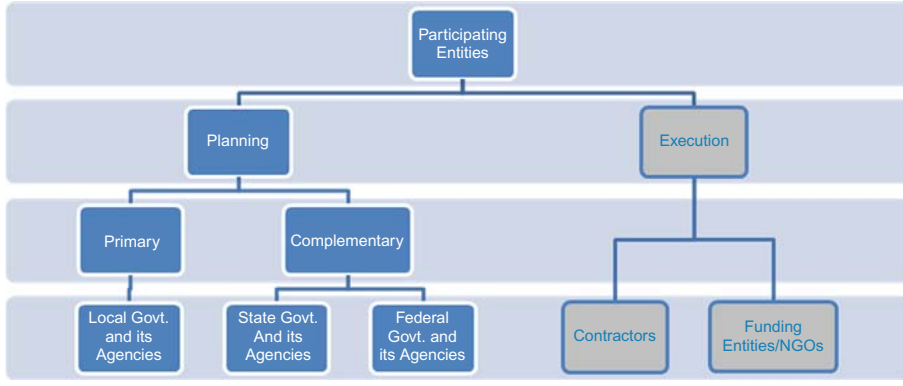

Figure 8.
Classification of entities involved in strategy planning and execution

in the form of pre-positioned contracts or memorandum of understanding. These entities can be of two types:

(1) entity carrying out construction; and

(2) entity providing financial assistance, such as banks, insurance companies and donors.

Private contractors have pre-positioned contracts already established before disaster events. Though they have not participated in initial planning process, they participate in the last task of finalizing comprehensive guidelines. They also take part in simulating response trade-offs where they exercise their roles and responsibilities after disaster. There are three major types of contractors:

(1) construction contractors;

(2) house manufacturers; and

(3) resource suppliers.

It should be noted that there can be more than one entity to carry out one particular activity on different parts of the site. Coordination among these contractors is the key to successful completion of construction process. The established guidelines include details for site and space management. It is exercised through drills and training programs.

4.2.3 Possible organization chart. Figure 9 shows the possible organization chart for planning and execution of proposed strategy. It is different than the Joint Field Office that is mainly established to manage Federal response (NRF, 2008). Whereas, this strategy is developed before disaster, its organization chart includes planning as well as response entities.

4.2.3.1 Planning and execution entities in the possible organization chart. The local government is the main preliminary entity and holds most of the responsibilities to prepare for, respond to and recover from disasters just similar to normal disaster scenarios.

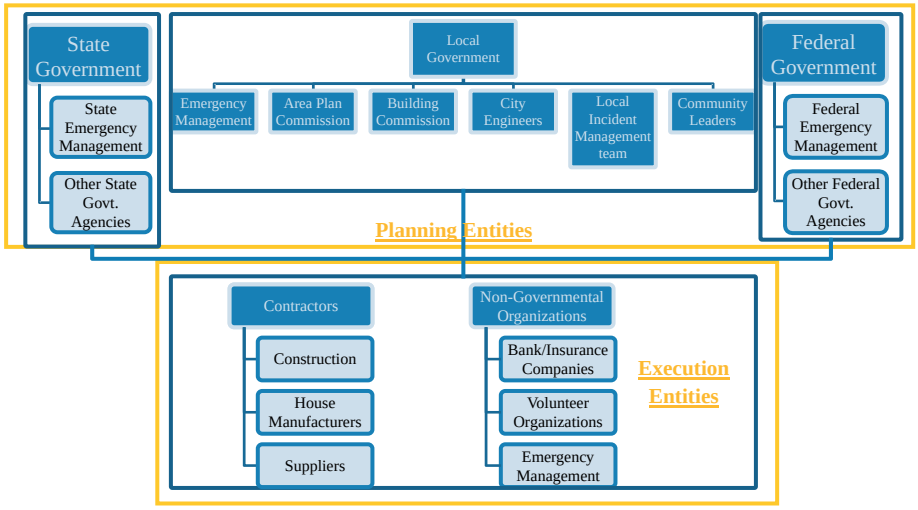

Figure 9.
Possible organization chart of participating entities

Local government starts with the pre-disaster planning phase where its officials would identify needs and requirements, and define goals and scope. It selects a team of preliminary entities for developing the strategy and provides necessary data. The main participants in the planning team are emergency management, area plan commission, building commission, city engineers, incident management team, and community leaders. All these entities provide their expertise and knowledge about the area as and when required at different stages of planning. They hold different responsibilities and work together in both strategy development and implementation.

Emergency management team develops or proposes different mechanisms that could be used to activate the strategy and notify all execution entities. There are different triggering mechanisms to send notification. One of them is directly contacting them to get prompt response. For this, emergency managers foster relationship with participating entities in normal circumstances and update their contact details frequently. Media in the form of newspapers, television and radio, could be used as another triggering mechanism. This method is a little uncertain, as planners do not know if entities have received the notification. In such cases, there should be a clause in contracts or agreements where all participating entities are asked to report to the local government as soon as they receive notifications. Other ways like e-mails, cell-phones and texting could also be used as triggering mechanisms. Emergency management also provides information related to disaster during emergency time and share it with all entities. It may include information about extent of damage caused to infrastructure and facilities.

Moreover, emergency management team also helps local government to assess severity of damages done to homes of individuals, and to determine need of implementing the strategy. Emergency managers along with the local incident management team assist in coordinating the response. They provide their services in carrying out four functions, i.e.: operations, planning, logistics and financial during emergency time for better coordination and execution of plan.

Area plan commission plays an important role in site selection task. Using their database of the region, they identify potential alternatives for a site that could be used for construction after the disaster. They have database of the area with details like zoning, utilities installed and future plans. They determine sites that have other essential facilities such as schools, hospitals, groceries stores and transport systems at nearby locations. These facilities are the basic need of citizens once they are provided proper shelter. Area plan commission assists local government in getting approval for constructing houses after a disaster. Apart from that, building commission helps in reviewing the plans and getting permissions for constructions. If the site is within the city limits, then city engineers need to review and approve. In other cases, where site is outside the city limits, the county building commission helps in reviewing and giving permissions for emergency use. City engineers have to check the capacity of existing utilities and if they would be able to take up the extra burden increased by the new community. These teams also have to get drainage approval from the county surveyor.

Complimentary entities, the state and federal governments and their agencies provide their support to the local government in developing and executing the strategy. They provide their resources and funds when needed to local government. Local government notifies the state government about disaster declaration so that its agencies start responding. State and federal agencies assist local agencies in assessing damage

and preparing list of victims who need housing assistance. They categorize victims based on the damage done to their homes and the duration of housing assistance they require. This would help later while assigning constructed homes. Moreover, Department of Transportation assists in getting permissions for transporting materials, goods, equipment and manufacture homes. It is essential to get these permissions during the planning phase. City engineers are helped in designing utilities and site layout from respective planning agencies of state and federal government. Agencies like FEMA, HUD, SBA, Department of agriculture, and Department of Veterans Affairs provide funds through their various housing assistance programs and loans. FEMA, HUD and SBA also provide their resources to local government to assist bidding process and establish pre-positioned contracts. Agencies like corps of engineers provide expertise to manage site during construction process after disaster. Thus, all the first group agencies would work together and utilize their resources and experts.

4.2.3.2 Execution only entities in the possible organization chart. Construction contractors are responsible for the construction of utilities, foundations and houses. These contractors are assigned specific start and finish time in earlier defined schedule. The contractors have to follow the schedule for mobilization, construction and de-mobilization to avoid delay and release site space. During the construction process, contractor assigns a project manager along with required resources (men and machines). The project manager directly report to the site manager who could be a city engineer or someone from the corps of engineers. In case of manufactured homes, factories are responsible for acquiring permits to transport homes on roads prior to disaster and working with HUD to finalize the design. Moreover, they make arrangements to manage their supply chain to start production soon after receiving notification. Resource suppliers have to provide resources like materials, equipment and labor to ensure uninterrupted construction. Planners and contractors have already established these requirements and schedules before disaster occurrence. All these contractors have to finalize designs during the planning process. All entities have to actively participate in pre-disaster drills, training or simulations for practice.

All this planning and execution processes are well supported through funding agencies. Apart from funds, from the local government, state government, FEMA, HUD, SBA, etc. there is a need of more financial assistance for post-disaster housing. Entities like banks and insurance companies could provide loans to the local government for execution of the strategy. Whereas NGOs and private donors could be other funding sources.

Figure 10 shows a sample of possible relationships among participating entities that are involved at different stages of the strategy in USA. All these emergency entities from both groups are responsible for coordinating, developing, planning and executing the strategy successfully. Their main focus is on efficiently managing operations, planning, logistics and finances to accomplish goals.

4.3 Response trade-offs

The third phase of developing the strategy is named as response trade-offs among three important response characteristics – time, cost, and resources like labor and equipments. All three characteristics are related to each other where increase or decrease in one would impact others. For example, with the increase in number of labor and equipments would reduce time but would increase the cost of construction. This may

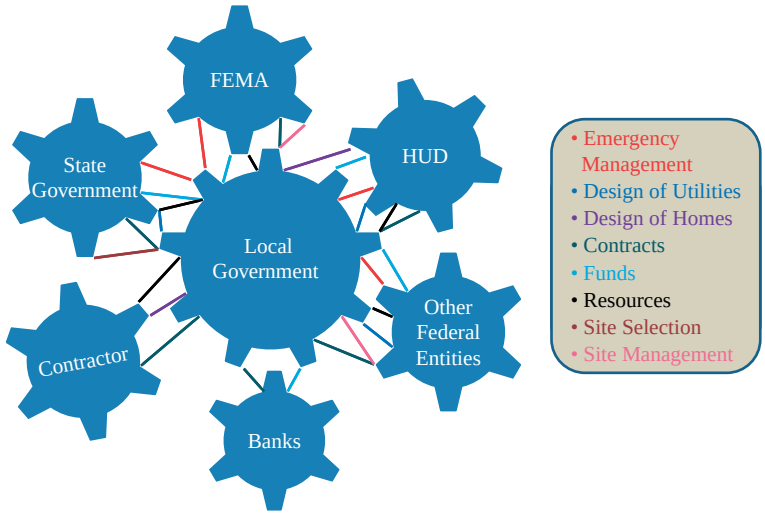

Figure 10.
Possible relationships among different participating entities

also create problems in site management due to limited space. Thus, trade-offs between response characteristics is studies to avoid such consequences. This could be done by simulating the post-disaster activities using a computer model or organizing practice drills. In organizing practice drills, an assumed disaster scenario is created and all agencies start responding where as in a computer simulation model, execution is examined using software. In practice drills, it is necessary for all the entities to participate and such drills give them idea about durations to perform different activities. Drills are time consuming and require involvement of all labor and equipments to be used at site. This certainly requires funds and significant time. While in a computer simulation model, all the characteristics of activities are inserted in the model and results are studied. By sharing results, time and money could be saved unlike in the case of practice drills. Though it is difficult to simulate a real disaster scenario, certain assumptions are made to include external factors. This study enables planners and entities to develop a schedule with required daily outputs. Planners also prioritize characteristics to compare different alternatives (Figure 11).

Results from the simulation are important, as they are used to modify guidelines established in the pre-disaster planning phase. There could be some changes in initially developed schedules and guidelines at the end of this phase. The simulation process assists all participating agencies in understanding requirements to fulfill their responsibilities and coordinating response with other entities. Thus, the strategy for post-disaster housing response is better designed with feedback from these experiments.

5. Issues

Apart from setting up of goals for activities involved to structure an effective strategy, there are some issues that should be addressed. It would be better to resolve these issues in the planning stage to avoid their consequences during the execution period. These issues are given below.

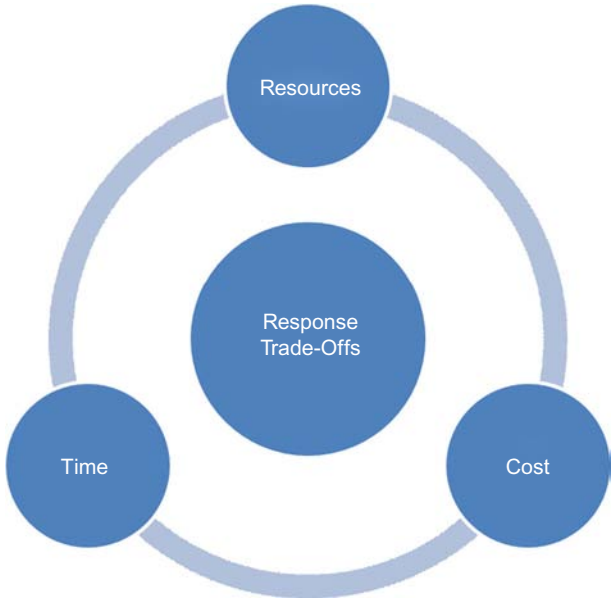

Figure 11.
Response trade-offs

5.1 Availability and sources of funding

As a result of this strategy, there would be a subdivision added to the city. These homes can be used as temporary shelters as well as permanent homes. And so the cost of construction would be higher than that of providing FEMA trailers or mobile park homes. Thus, the sources of funding required for this strategy should be identified in early stages of planning. However, this cost can be retrieved through mortgages or selling these homes to rental agencies after their use as temporary housing. More of such options should be explored to make this strategy economical for emergency planners.

5.2 Coordination and collaboration among the entities

As discussed earlier, entities of different levels and background are involved in this strategy. It is important to coordinate responses for timely completion of construction as all activities would be critical and delay in one would delay the completion. It is likely that some entities may get little or no time to get familiar with disaster situation. Moreover, the strategy's main aim is to complete construction of homes in a short span of time. This can be achieved by scheduling daily team meetings among agencies to mark milestones. Practice drills or simulation would help them to understand post-disaster situation where they will be working head to head with each other.

5.3 Pre-positioned contracts

Pre-positioned contracts would be established with contractors to involve them in strategy planning and execution. These contracts could be indefinite quantity (IQ), indefinite delivery (ID) contracts with the definite time frame of around five years. These contracts can be modified based on the disaster experiences to improve post-disaster performances. Therefore, contracts should be flexible for modifications based on earlier experiences.

5.4 Logistics and transportation

During pre-disaster planning phase, local government decides and establishes contracts with contractors and suppliers. They have to finalize routes together that would be used to transport resources and materials to site. Multiple routes should be identified to have options for damaged ones, and convenient and economical method of transportation should be preferred. Homes and materials can be transported using truck trailers, rails or water in some cases and permission should be acquired on time. For example, if a state or national highway is selected as preferred transportation route, then all related permissions should be acquired from the highway department. Such planned logistics for homes, material and equipment, and obtaining related permissions from particular agencies before disasters would definitely help in reducing response time after disasters.

5.5 Availability of infrastructure facilities and resources

There is a high possibility that the local infrastructure would get damaged due to a disaster. It may take some time to restore or repair that infrastructure facility. Therefore, planners along with contractors have to finalize infrastructure facilities that would be required to activate and implement the strategy. Entire infrastructure may not be needed at their full serviceability and the necessary level of serviceability for each of the infrastructure facility should be decided. Moreover, the resources of local government would be occupied in providing emergency assistance and in restoring their own facilities, buildings and homes. In such cases, they may not have enough resources for housing assistance. So planners have to plan for such scenarios and arrange for resources from neighboring jurisdictions or state or federal governments. Furthermore, as discussed before, planners should also finalize and acquire land for housing construction in the pre-disaster planning stage. This would provide them opportunity to set up infrastructure and connect the site to available utilities before the disaster. Such a pre-disaster establishment would certainly save time during emergency.

5.6 Damage done to the contractors resources

During the bidding procedures, local contractors and companies are given priorities over others in order to get their resources quickly on site and to help local businesses. But it may be possible that contractor's resources like equipment and/or labor may get damaged and become unavailable for construction process. Planners have to consider such situations in planning phase, where contractors would not be able to provide their resources and thus not be able to participate in strategy execution. Planners have to prepare the list of alternate emergency contractors who can be contacted during emergency. Local government could also involve neighboring jurisdictions' strategy partners if those regions are not affected in disaster.

5.7 Supply chain of industries

In a normal scenario, an order takes time before it gets processed. It has to get through different departments within the organization before the purchasing department orders the required material from suppliers. Then suppliers take their time in processing that order and supplying the ordered materials to the factory. This process would take certain time in normal scenarios. To avoid delay due to this supply

chain issue, factories have to make arrangements so that the production would start soon after the disaster and necessary products are transported within a week after activating the strategy. Planners have to closely review the arrangements made by the factories and choose factories that have made sufficient changes in their supply chain to provide services on time.

6. Conclusion

Emergency agencies have observed delay in post-disaster housing construction and its consequences to communities during various disaster events. There is a need to establish deliberate housing response plans to accelerate construction process and provide essential emergency housing services. This paper introduces a basic framework that is used to develop a strategy to construct homes for victims. The main objective of this strategy is to provide good quality shelters in short time that can also be used as permanent homes. The first two of four phases of framework describe the strategy development process that goes through different pre- and post-disaster tasks and assigns them to certain entities. Tasks also describe the relationship among the entities during pre and post-disaster events. This sets up a foundation for the next phase of response trade-offs, and prepare an organization to respond to disasters including all participating entities. This framework can also serve many emergency agencies across the world to build effective response plans for rapid construction of post-disaster housing.

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Further reading

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